

### ARTICLE TITLE: Nutrition and Physical Activity Guidelines for Cancer Survivors

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This activity has been reviewed and revised on the basis of feedback provided by the American Cancer Society 2011 Nutrition, Physical Activity and Cancer Survivorship Advisory Committee. The committee had no conflicts of interest to disclose.

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# Nutrition and Physical Activity Guidelines for Cancer Survivors

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Cancer survivors are often highly motivated to seek information about food choices, physical activity, and dietary supplements to improve their treatment outcomes, quality of life, and overall survival. To address these concerns, the American Cancer Society (ACS) convened a group of experts in nutrition, physical activity, and cancer survivorship 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 with which to help cancer survivors and their families make informed choices related to nutrition and physical activity. The report discusses nutrition and physical activity guidelines during the continuum of cancer care, briefly highlighting important issues during cancer treatment and for patients with advanced cancer, but focusing largely on the needs of the population of individuals who are disease free or who have stable disease following their recovery from treatment. It also discusses select nutrition and physical activity issues such as body weight, food choices, food safety, and dietary supplements; issues related to selected cancer sites; and common questions about diet, physical activity, and cancer survivorship. *CA Cancer J Clin* 2012;62:242-274. © 2012 American Cancer Society.



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## Introduction

A cancer survivor is defined as anyone who has been diagnosed with cancer, from the time of diagnosis through the rest of their life.<sup>1</sup> Given advances in early detection and treatment, the number of US cancer survivors is estimated to exceed 12 million and is growing steadily, so that approximately one in every 25 Americans is now a cancer survivor.<sup>1,2</sup> 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 their risk of recurrence, and improve their quality of life.<sup>3</sup>

The trajectory of cancer survivorship is marked by 3 general phases: 1) active treatment and recovery; 2) living after recovery, including survivors who are disease free or who have stable disease; and 3) advanced cancer and end of life. Approximately 68% of Americans diagnosed with cancer now live more than 5 years,<sup>4</sup> and their nutritional needs change over the course of survivorship. The need for informed lifestyle choices for cancer survivors becomes particularly important as they look forward to the successful completion of therapy and seek self-care strategies to improve their long-term outcomes. For many long-term cancer survivors, healthy weight management, a healthful diet, and a physically active lifestyle aimed at preventing recurrence, second primary cancers, and other chronic diseases should be a priority. For other survivors, regaining health following a difficult treatment or managing nutritional needs and activity levels while living with advanced cancer becomes a particular challenge.

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**DISCLOSURES:** The authors report no conflicts of interest.

© 2012 American Cancer Society, Inc. doi:10.3322/caac.21142. Available online at [cancerjournal.com](http://cancerjournal.com)

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 gain or 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 they should take, if any. Unfortunately, this advice is often inconsistent and not supported by data.

## Overview of the Report

The American Cancer Society (ACS) convened a group of experts in nutrition, physical activity, and cancer to evaluate and synthesize 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 2006.<sup>5</sup> Although this report is intended for health care providers caring for cancer survivors, it can also be used directly by highly motivated survivors and their families. The ACS also provides shorter and simpler summaries of the recommendations in this report, which are written specifically for survivors and caregivers. New scientific evidence has emerged since 2006 on the relationship between nutrition, physical activity, and issues of quality of life, comorbid conditions, cancer recurrence, the development of second primary cancers, and overall survival. Although this evidence is incomplete, reasonable conclusions and recommendations can be made on several issues that can guide choices about body weight, foods, physical activity, and dietary supplement use.

This report presents information in 4 sections. The first section addresses nutrition and physical activity across the phases of cancer survivorship; the second section addresses the guidelines for cancer survivors in specific areas of weight management, physical activity, food choices, alcohol intake, and food safety; the third section provides information regarding selected cancer sites; and the fourth section includes answers to common questions many survivors have.

It is important that health care providers, cancer survivors, and caregivers 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 dietary suggestions for persons with bowel changes and fatigue, we recognize that other medical interventions may be more effective in controlling those symptoms. Furthermore, just as standard treatment options vary by the type of cancer, nutrition and physical activity factors may impact some cancer types but not others. In writing these recommendations, we have assumed that survivors and their caregivers are receiving

appropriate medical and supportive care and are seeking high-quality information on self-care strategies to provide further relief of symptoms and to enhance health.

Physicians and other health care providers have a unique opportunity to guide cancer patients toward optimal lifestyle choices, and thus can favorably influence the survivorship trajectory regardless of the individual's survivorship phase. The power of physician advice in facilitating preventive health behaviors has been consistently demonstrated. A study of 450 breast cancer survivors<sup>6</sup> showed that a simple recommendation from the oncologist to exercise resulted in significant increases in physical activity. This is not to say that the physician needs to provide in-depth counseling to patients, but rather to at least plant an appropriate message and then either refer patients to registered dietitians or exercise trainers who are certified within the area of cancer supportive care, or to provide user-friendly self-help brochures or other resources to support lifestyle changes.

## Nutrition and Physical Activity Across the Continuum of Cancer Survivorship

The continuum of cancer survivorship includes treatment and recovery; long-term disease-free living or living with stable disease; 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.

### Nutrition During Cancer Treatment and Recovery

Prior to the identification of effective cancer screening and treatment, many people were diagnosed with cancer in a late stage, when they may have already experienced the weight loss and cachexia that was common among patients with late-stage cancer. In addition, patients undergoing cancer treatment often experienced significant untreated nausea and vomiting, which led to further weight loss. Because of these clinical experiences, cancer was considered to be a disease associated with weight loss, rather than obesity. However, many patients now being diagnosed have early stage disease and treatments are more effective. Therefore, with growing numbers of patients beginning the cancer treatment process already overweight or obese,<sup>7</sup> additional weight gain is a frequent complication of treatment.<sup>8</sup> While highly variable depending on the type of cancer and stage at diagnosis, cancer can cause profound metabolic and physiological alterations that can affect the nutrient requirements for macro- and micronutrients.<sup>9</sup> Symptoms such as anorexia, early satiety, changes in taste and smell, and disturbances of the bowel are common side effects of cancer and cancer treatment and can lead to inadequate nutrient intake and subsequent malnutrition. Substantial weight loss and poor nutritional status can still occur early in the course of some cancers, although the

**TABLE 1. Suggestions for Locating Specialized Nutrition Counseling**

- Survivors should ask their health care provider for a referral to see an RD, preferably an RD who is also a CSO, if they experience nutrition-related challenges.
- If an oncology dietitian is not available in the medical or surgical practice or medical center where they receive their cancer treatment and care, an appointment with a dietitian associated with their primary care provider clinic may be arranged.

Survivors, caregivers, and providers can also consult the Academy of Nutrition and Dietetics to identify a private practice dietitian in their area.

RD indicates registered dietitian; CSO certified specialist in oncology.

prevalence of malnutrition and weight loss varies widely across cancer types and stage at diagnosis.<sup>10</sup> Consuming enough calories to prevent additional weight loss is therefore vital for survivors at risk of unintentional weight loss, such as those who are already malnourished or those who receive anticancer treatments affecting the gastrointestinal tract.<sup>10,11</sup>

All of the major modalities of cancer treatment, including surgery, radiation, and chemotherapy, can significantly affect nutritional needs; alter regular eating habits; and adversely affect how the body digests, absorbs, and uses food.<sup>9,12</sup> Nutritional assessment for survivors should therefore begin as soon after diagnosis as possible and should take into consideration treatment goals (curative, control, or palliation) while focusing on both the current nutritional status and anticipated nutrition-related symptoms.<sup>12</sup>

During active cancer treatment, the overall goals of nutritional care for survivors should be to prevent or resolve nutrient deficiencies, achieve or maintain a healthy weight, preserve lean body mass, minimize nutrition-related side effects, and maximize quality of life. Studies confirm the benefit of dietary counseling during cancer treatment for improving outcomes, such as fewer treatment-related symptoms, improved quality of life, and improved dietary intake.<sup>13-16</sup> Suggestions for finding an oncology nutrition expert to provide dietary counseling are provided in Table 1.

Providing individualized nutritional advice can improve dietary intake and potentially decrease some of the toxicities associated with cancer treatments.<sup>9</sup> Examples of situations that may benefit from seeking individualized advice include the following:

- For survivors experiencing anorexia or early satiety, and who are at risk of becoming underweight, consuming smaller, more frequent meals with minimal liquids consumed during meals can help to increase food intake. Liquids can and should be consumed in between meals to avoid dehydration.
- For survivors who cannot meet their nutritional needs through foods alone, fortified, commercially prepared or homemade nutrient-dense beverages or foods can improve the intake of energy and nutrients.
- For survivors who are unable to meet their nutritional needs through these measures and who are at risk of becoming malnourished, other means of nutritional

support may be needed, such as pharmacotherapy using appetite stimulants, enteral nutrition via tube feeding, or intravenous parenteral nutrition.

The use of vitamins, minerals, and other dietary supplements 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 antifolate therapies such as methotrexate.<sup>9</sup> Many dietary supplements contain levels that exceed the amount normally found in food and recommended in the Dietary Reference Intakes for optimal health.<sup>17-21</sup> Because of emerging evidence on detrimental effects from even the modest use of dietary supplements in the oncology population, many cancer experts continue to advise against taking supplements during and after treatment, or suggest limiting use to those dietary supplements needed to treat a deficiency or promote another aspect of health. One reason for concern involves the theory that a subgroup of dietary supplements, antioxidants, could prevent the cellular oxidative damage to cancer cells that is required for treatments such as radiation therapy and chemotherapy to be effective.<sup>22</sup> In contrast, some clinicians have noted that the possible harm from antioxidants is only hypothetical and that there may be a net benefit to helping protect normal cells from the collateral damage associated with these therapies.<sup>23,24</sup> With compelling evidence against the use of select supplements in certain oncology populations, health care professionals and survivors need to proceed with caution.<sup>25</sup> If interested in supplementation, individuals should first assess whether they are nutrient deficient, avoid ingesting supplements that exceed more than 100% of the Daily Value, and consider limiting dietary supplement use to therapeutic interventions for chronic conditions such as osteoporosis and macular degeneration, for which scientific evidence supports the likelihood of benefits and low risk of harm.

### Exercise During Cancer Treatment

An increasing number of studies have examined the therapeutic value of exercise during primary cancer treatment.<sup>26,27</sup> Existing evidence strongly suggests that exercise



is not only safe and feasible during cancer treatment, but that it can also improve physical functioning, fatigue, and multiple aspects of quality of life.<sup>28</sup> Some studies have also suggested that physical activity may even increase the rate of completion of chemotherapy.<sup>29</sup> Current evidence is unclear on the interaction of exercise and chemotherapy efficacy, but in at least one randomized controlled exercise study, there was no evidence of a negative exercise effect on response to chemotherapy in a cohort of lymphoma survivors.<sup>30</sup> One animal study also reported that exercise did not interfere with the efficacy of chemotherapy.<sup>31</sup>

The decision regarding when to initiate and how to maintain physical activity should be individualized to the patient's condition and personal preferences. Exercise during cancer treatment improves multiple posttreatment adverse effects on bone health, muscle strength, and other quality-of-life measures.<sup>32-36</sup> Persons receiving chemotherapy and/or radiation therapy who are already on an exercise program may need to exercise at a lower intensity and/or for a shorter duration during their treatment, but the principal goal should be to maintain activity as much as possible. Some clinicians advise certain survivors to wait to determine their extent of side effects with chemotherapy before beginning an exercise program. 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 individuals and those with bone metastases or osteoporosis, or significant impairments such as arthritis or peripheral neuropathy, careful attention should be given to balance and safety to reduce the risk of 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 can help to counteract fatigue and depression.

### Recovery Immediately After Treatment

After cancer therapy has been completed, the next phase of cancer survivorship is recovery. In this phase, many symptoms and side effects of treatment that have affected nutritional and physical well-being begin to resolve. Typically, survivors recover from the acute effects of their specific treatment within weeks or months after completing therapy, although in some instances, side effects of treatment persist. In addition, late-occurring or latent effects of treatment may appear long (months or years) after treatment has been completed.<sup>37-39</sup> Examples of continuing side effects or complications of cancer treatment relevant to nutritional status include persistent fatigue, peripheral

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

Achieve and maintain a healthy weight.
• If overweight or obese, limit consumption of high-calorie foods and beverages and increase physical activity to promote weight loss.
Engage in regular physical activity.
• Avoid inactivity and return to normal daily activities as soon as possible following diagnosis.
• Aim to exercise at least 150 minutes per week.
• Include strength training exercises at least 2 days per week.
Achieve a dietary pattern that is high in vegetables, fruits, and whole grains.
• Follow the American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention.

neuropathy, changed sense of taste, difficulty chewing and swallowing, difficulty in replenishing lean body mass after the completion of therapy, and persistent bowel changes such as diarrhea or constipation.

Survivors may require ongoing nutritional assessment and guidance in this phase of survival.<sup>40-42</sup> For those who emerge from treatment underweight or with compromised nutritional status, continued supportive care, including nutritional counseling and pharmacotherapy to relieve symptoms and stimulate appetite, is helpful in the recovery process.<sup>13,43</sup> After treatment, a program of regular physical activity is essential to aid in the process of recovery and improve fitness.

### Long-Term Disease-Free Living or Stable Disease

During this phase, setting and achieving lifelong goals for weight management, a physically active lifestyle, and a healthy diet are important to promote overall health, quality of life, and longevity.<sup>44</sup> While cancer survivorship is a relatively new area of study and much needs to be learned regarding the optimal diet and physical activity practices for cancer survivors, current evidence supports recommendations in 3 basic areas: weight management, physical activity, and dietary patterns. These guidelines are featured in Table 2. Because individuals who have been diagnosed with cancer are at a significantly higher risk of developing second primary cancers,<sup>45</sup> and may also be at an increased risk of chronic diseases such as cardiovascular disease, diabetes, and osteoporosis, the guidelines established to prevent those diseases are especially important for cancer survivors.<sup>46-51</sup> Because family members of cancer survivors may also be at a higher risk of developing cancer, they should also be encouraged to follow the ACS nutrition and physical activity guidelines for cancer prevention.<sup>52</sup>

Convincing data exist that obesity is associated with an increased risk of breast cancer recurrence,<sup>53,54</sup> and similar evidence on obesity and prognosis is also accumulating for other cancers.<sup>55-57</sup> On the opposite end of the spectrum,

those with aerodigestive tumors such as head and neck, esophagus, or lung cancers may be malnourished and underweight at the point of diagnosis, and could therefore benefit from increasing their body weight.<sup>58-61</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 long-term health and well-being.

Extensive research has been conducted on the benefits of physical activity during recovery from cancer-related treatments, and an increasing number of studies have examined the impact of physical activity on cancer recurrence and long-term survival.<sup>28</sup> 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. In addition, exercise studies have targeted certain symptoms particular to specific cancers and the adverse effects of specific therapies (eg, lymphedema in survivors of breast cancer) and shown beneficial effects that are more cancer-specific. At least 20 prospective observational studies have shown that physically active cancer survivors have a lower risk of cancer recurrences and improved survival compared with those who are inactive, although studies remain limited to breast, colorectal, prostate, and ovarian cancer, and randomized clinical trials are still needed to better define the impact of exercise on such outcomes.<sup>62-65</sup>

### Living With Advanced Cancer

For individuals living with advanced cancer, a healthy diet and some physical activity may be important factors in establishing and maintaining a sense of well-being and enhancing their quality of life. Although advanced cancer is sometimes accompanied by substantial weight loss, it is not inevitable that individuals with cancer lose weight or experience malnutrition.<sup>9</sup> Many patients with advanced cancer need to adapt their food choices and meal patterns to meet nutritional needs and to manage cancer symptoms or treatment side effects such as fatigue, bowel changes, and a diminished sense of taste or appetite. For persons experiencing anorexia, negative changes in weight, or difficulty in gaining weight, convincing evidence exists that some medications (eg, megestrol acetate) can help to enhance appetite.<sup>66</sup>

Additional nutritional supplementation such as nutrient-dense beverages and foods can be consumed by those who cannot eat or drink enough to maintain sufficient energy intake. The use of enteral nutrition and parenteral nutrition support should be individualized with recognition of overall treatment goals (control or palliation) and the associated risks of medical complications and/or ethical dilemmas. Both the American Society for Parenteral and Enteral

Nutrition<sup>67</sup> and the Academy of Nutrition and Dietetics position papers recommend that nutrition support be used selectively and with clear purpose.<sup>68,69</sup>

Several systematic reviews have suggested that some level of physical activity is feasible and may improve quality of life and physical function in persons with advanced cancer, although this is likely specific to certain cancer types.<sup>70,71</sup> Thus, the evidence of a benefit from exercise for survivors of advanced cancer is insufficient to make general recommendations. Recommendations for nutrition and physical activity in those who are living with advanced cancer are best based on individual nutrition needs and physical abilities.

## Selected Issues in Nutrition and Physical Activity for Cancer Survivors

### Body Weight

In the United States, obesity is a problem of epidemic proportions<sup>72</sup> and is a well-established risk factor for some of the most common cancers.<sup>52</sup> Overweight and obesity are clearly associated with an increased risk of developing many cancers, including cancers of the breast in postmenopausal women<sup>73</sup>; colon and rectum<sup>74</sup>; endometrium; and adenocarcinoma of the esophagus, kidney, and pancreas.<sup>47,75</sup> Obesity is also probably associated with an increased risk of cancer of the gallbladder,<sup>47</sup> and may also be associated with an increased risk of cancers of the liver, cervix, and ovary, as well as non-Hodgkin lymphoma, multiple myeloma, and aggressive forms of prostate cancer.<sup>52</sup> Thus, many cancer survivors are overweight or obese at the time of diagnosis. Increasing evidence indicates that being overweight increases the risk of recurrence and reduces the likelihood of disease-free and overall survival among those diagnosed with cancer.<sup>53,54,63,76-89</sup> Such data suggest that the avoidance of weight gain and weight maintenance throughout treatment may be important for survivors who are normal weight, overweight, or obese at the time of diagnosis, and that intentional weight loss following treatment recovery among those who are overweight and obese may be associated with health-related benefits.<sup>90</sup>

Although currently there is limited evidence to support the hypothesis that intentional weight loss posttreatment in cancer survivors will result in improved prognosis and overall survival,<sup>53</sup> results of the Women's Intervention Nutrition Study (WINS) found that a low-fat diet that resulted in a 6-pound weight loss (approximately 4% of initial weight) reduced the risk of recurrence among postmenopausal breast cancer survivors (especially those with estrogen receptor [ER]-negative tumors).<sup>91</sup> However, this trial was not designed to specifically address weight loss, and the results are confounded by the impact of a low-fat diet that was the focus of the intervention. Nonetheless, it is hypothesized that improvements in cancer-related

outcomes are possible, and likely probable, through intentional weight reduction in overweight or obese cancer survivors.<sup>92</sup> Currently a National Cancer Institute-funded vanguard study is underway (Exercise and Nutrition to Enhance Recovery and Good Health for You [ENERGY]) (1R01 CA 148791-01) to test the feasibility and impact on quality of life of a diet and exercise weight management intervention in 800 overweight and obese breast cancer survivors, as well as set the stage for a larger study examining the effects of weight loss on survival and other cancer outcomes. Evidence already exists that weight loss that results from intentional exercise and caloric restriction can improve the hormonal milieu<sup>93,94</sup> and quality of life and physical functioning among survivors who are obese or overweight.<sup>95</sup> It may be difficult for individuals to pursue a host of new dietary, exercise, and behavioral strategies to reduce body weight through reduced energy intake and increased energy expenditure while at the same time balancing the demands of daily life during initial treatments.<sup>96</sup> Thus, for many, active efforts toward intentional weight loss may be postponed until surgery, chemotherapy, and/or radiation treatment is complete. However, for cancer survivors who are overweight or obese and who choose to pursue weight loss, there appears to be no contraindication to modest weight loss (ie, a maximum of 2 pounds per week)<sup>97</sup> during treatment, as long as the treating oncologists approve, weight loss is monitored closely, and it does not interfere with treatment. Past studies showing deleterious associations with decreases in body weight after diagnosis have been unable to separate intentional from nonintentional weight loss. Safe weight loss should be achieved through a nutritious diet that is reduced in energy density and increased physical activity tailored to the specific needs of the patient.<sup>7,28,98</sup>

After cancer treatment, weight gain or loss should be managed with a combination of dietary, physical activity, and behavioral strategies. For some who need to gain weight, this means increasing energy intake to exceed energy expended and for others who need to lose weight, reducing caloric intake and increasing energy expenditure via increased physical activity to exceed energy intake. Reducing the energy density of the diet by emphasizing low-energy dense foods (eg, water- and fiber-rich vegetables and fruits) and limiting the intake of foods and beverages high in fat and added sugar promotes healthy weight control.<sup>99</sup> Limiting portion sizes of energy-dense foods is an important accompanying strategy.<sup>99</sup> Increased physical activity is also an important element to prevent weight gain, retain or regain muscle mass, promote weight loss, and promote the maintenance of weight loss in patients who are overweight or obese. For survivors who are severely obese and have more pressing health issues, more structured weight loss programs or pharmacologic or surgical means may be indicated.<sup>100</sup> It should be noted that among those

who need to lose weight, even if ideal weight 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>90,99,100</sup> Although most evidence related to these weight management strategies does not come from studies of cancer survivors per se, it is likely that these approaches can apply in the special circumstances of the cancer survivor.

Throughout the cancer continuum, therefore, individuals should strive to achieve and maintain a healthy weight, as defined by a body mass index (BMI) (Table 3) between 18.5 kg/m<sup>2</sup> and 25 kg/m<sup>2</sup>. Some cancer survivors can be malnourished and underweight at diagnosis or as a result of aggressive cancer treatments.<sup>101</sup> For these individuals, further weight loss can impair their quality of life, interfere with the completion of treatment, delay healing, and increase the risk of complications. In survivors with these difficulties, dietary intake and factors affecting energy expenditure should be carefully assessed.<sup>13,58-60</sup> For those at risk of unintentional weight loss, multifaceted interventions should focus on increasing food intake to achieve a positive energy balance and therefore increase weight.<sup>13,58-60</sup> Physical activity may be useful to the underweight survivor when tailored to provide stress reduction and to increase strength and lean body mass, but exceptionally high levels of physical activity make weight gain more difficult.<sup>102</sup>

## Physical Activity in Cancer Survivors

Since the 2006 update of these guidelines for cancer survivors, there has been a marked increase in the number of studies that have addressed the association between physical activity and a variety of outcomes in patients who have completed the initial phase of therapy for their cancer.<sup>27,63,76</sup> The outcomes of interest in this update include cancer recurrence, cancer-specific and overall survival, health-related fitness, patient-reported outcomes, lymphedema, and comorbid conditions.<sup>28</sup>

Prospective, observational studies have demonstrated that physical activity after cancer diagnosis is associated with a reduced risk of cancer recurrence and improved overall mortality among multiple cancer survivor groups, including breast, colorectal, prostate, and ovarian cancer.<sup>62,64,65,103-107</sup> Among breast cancer survivors, physical activity after diagnosis has consistently been associated with reduced risk of breast cancer recurrence and breast cancer-specific mortality. A recent meta-analysis demonstrated that post-diagnosis exercise was associated with a 34% lower risk of breast cancer deaths, a 41% lower risk of all-cause mortality, and a 24% lower risk of breast cancer recurrence.<sup>62</sup> Among survivors of colorectal cancer, at least 4 large cohort studies have found an inverse association between being physically active after diagnosis and recurrence, colorectal cancer-specific

TABLE 3. Adult BMI Chart

BMI	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
HEIGHT	WEIGHT IN POUNDS																
4'10"	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167
4'11"	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173
5'	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179
5'1"	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185
5'2"	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191
5'3"	107	113	118	124	130	135	141	146	152	158	163	169	175	180	186	191	197
5'4"	110	116	122	128	134	140	145	151	157	163	169	174	180	186	192	197	204
5'5"	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210
5'6"	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216
5'7"	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223
5'8"	125	131	138	144	151	158	164	171	177	184	190	197	203	210	216	223	230
5'9"	128	135	142	149	155	162	169	176	182	189	196	203	209	216	223	230	236
5'10"	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243
5'11"	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250
6'	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258
6'1"	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265
6'2"	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272
6'3"	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279
	HEALTHY WEIGHT						OVERWEIGHT					OBESE					

BMI indicates body mass index.

Source: US Department of Health and Human Services, National Institutes of Health, National Health, Lung, and Blood Institute. the Clinical Guidelines on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults: Evidence Report. NIH Pub. No. 98-4083. Bethesda, MD: US Department of Health and Human Services, National Institute of Health, National Health, Lung, and Blood Institute; 1998.

mortality and/or overall mortality, with improvements of up to 50% for each outcome.<sup>104-107</sup> There is now a randomized, phase 3 trial underway comparing a physical activity program with health education in survivors of stage II and III colon cancer after standard chemotherapy.<sup>108</sup>

Exercise has been shown to improve health-related fitness outcomes in several cancer survivor groups. As a result of both their cancer and treatment, cancer patients are often in a deconditioned state. Aerobic and resistance training consistently show a benefit for cardiopulmonary fitness, muscle strength, body composition, and balance.<sup>27</sup> A substantial number of randomized controlled trials have tested the effects of physical activity after diagnosis on various patient-reported outcomes. In many studies, exercise improves quality of life, fatigue, psychosocial distress, depression, and self-esteem. For example, in one randomized study in men with prostate cancer who were undergoing androgen suppression therapy, those assigned to a program of resistance and aerobic training had increases in lean mass, improved muscle strength, improved walk time, and improved balance,<sup>26</sup> and in a randomized controlled trial of breast cancer survivors,

women assigned to moderate intensity resistance and impact training experienced improvements in bone mass and lean muscle mass.<sup>33</sup>

A recent meta-analysis of 78 exercise intervention trials showed that exercise interventions resulted in clinically meaningful improvements in quality of life that persisted after the completion of the intervention.<sup>109</sup> In another meta-analysis of 44 studies that included over 3000 participants with varying cancer types, cancer survivors randomized to an exercise intervention had significantly reduced cancer-related fatigue levels, with evidence of a linear relationship to the intensity of resistance exercise.<sup>110</sup>

Historically, there were concerns that cancer survivors with upper extremity lymphedema should not engage in upper extremity resistance training or vigorous aerobic physical activity. There are now multiple trials that have demonstrated that such physical activity is not only safe, but actually reduces the incidence and severity of lymphedema.<sup>29,111,112</sup>

Many cancer survivors have an increased risk of comorbid conditions that can be reduced through increased physical activity.<sup>113,114</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.

Despite the many benefits of exercise for cancer survivors, particular issues may affect the ability of survivors to exercise. Effects of treatment may also increase the risk of exercise-related injuries and adverse effects, and therefore specific precautions may be advisable, including:

- 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 public pools 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 one year after transplantation.
- Survivors experiencing severe fatigue from their therapy may not feel up to an exercise program, and therefore they may be encouraged to do 10 minutes of light exercises daily.
- Survivors undergoing radiation should avoid chlorine exposure to irradiated skin (eg, from swimming pools).
- Survivors with indwelling catheters or feeding tubes should be cautious or avoid pool, lake, or ocean 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 multiple or uncontrolled comorbidities need to consider modifications to their exercise program in consultation with their physicians.
- 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.

After consideration of these and other specific precautions, it is recommended that cancer survivors follow the survivor-specific guidelines written by an expert panel convened by the American College of Sports Medicine (ACSM).<sup>28</sup> The ACSM panel recommended that individuals avoid inactivity and return to normal activity as soon as possible after diagnosis or treatment. For aerobic physical activity, the ACSM panel recommended that survivors follow the US Department of Health and Human Services 2008 Physical Activity Guidelines for Americans.<sup>114</sup> According to those guidelines, adults aged 18 to 64 years should engage in at least 150 minutes per week of moderate intensity or 75 minutes per week of vigorous intensity aerobic physical activity, or an equivalent combination of moderate and vigorous intensity aerobic physical activity (Table 4). Some activity is better than none and exceeding the

guidelines is likely to provide additional health benefits. Activity should be done in episodes of at least 10 minutes per session and preferably spread throughout the week. Furthermore, adults should do muscle-strengthening activities involving all major muscle groups at least 2 days per week. Adults aged older than 65 years should also follow these recommendations if possible, but if chronic conditions limit activity, older adults should be as physically active as their abilities allow and avoid long periods of physical inactivity. Cancer type-specific recommendations will be discussed in the individual cancer sections below.

### Supporting Exercise Behavior Change

Based on the current evidence, cancer care professionals can expect that fewer than 10% of cancer survivors will be active during their primary treatments and only about 20% to 30% will be active after they recover from treatments.<sup>115,116</sup> Consequently, unless behavioral support interventions are provided, the majority of cancer survivors will not benefit fully from regular physical activity. Behavioral support interventions to assist cancer survivors in adopting and maintaining a physically active lifestyle have been reviewed elsewhere.<sup>115-117</sup> Some successful strategies include short-term supervised exercise (eg, 12 weeks), support groups, telephone counseling, motivational interviewing, and cancer survivor-specific print materials. The key point for cancer care professionals is that cancer survivors have unique motives, barriers, and preferences for physical activity. Table 4 shows examples of moderate and vigorous intensity activities.<sup>118</sup>

### Dietary and Food Choices

As summarized in recent reviews, results from observational studies suggest that diet and food choices may affect cancer progression, risk of recurrence, and overall survival in individuals who have been treated for cancer.<sup>3,7,98,119</sup> Breast cancer survivors have been the focus of the majority of these studies, although a growing number of studies involving cohorts of colorectal and prostate cancer survivors have been conducted and published over the past decade. The majority of this research has focused on the effect of individual nutrients, bioactive food components, or specific foods. Disentangling the effects of these dietary constituents and related lifestyle factors and characteristics (eg, physical activity, obesity) that influence risk and progression of cancer has proved to be very challenging. Furthermore, people eat food, not nutrients, and even specific foods are generally consumed in a pattern that is characterized by several features and bioactive components that potentially influence cancer progression. Evaluating the relationship between survival and diet as a dietary pattern rather than by focusing only on specific foods may also be informative.

TABLE 4. Examples of Moderate and Vigorous Activities<sup>118</sup>

MODERATE ACTIVITIES (I CAN TALK WHILE I DO THEM, BUT I CAN'T SING)	VIGOROUS ACTIVITIES (I CAN ONLY SAY A FEW WORDS WITHOUT STOPPING TO CATCH MY BREATH)
<ul style="list-style-type: none"> <li>• Ballroom and line dancing</li> <li>• Biking on level ground or with few hills</li> <li>• Canoeing</li> <li>• General gardening (raking, trimming shrubs)</li> <li>• Sports where you catch and throw (baseball, softball, volleyball)</li> <li>• Tennis (doubles)</li> <li>• Using your manual wheelchair</li> <li>• Using hand cyclers (also called ergometers)</li> <li>• Walking briskly</li> <li>• Water aerobics</li> </ul>	<ul style="list-style-type: none"> <li>• Aerobic dance</li> <li>• Biking faster than 10 miles per hour</li> <li>• Fast dancing</li> <li>• Heavy gardening (digging, hoeing)</li> <li>• Hiking uphill</li> <li>• Jumping rope</li> <li>• Martial arts (such as karate)</li> <li>• Race walking, jogging, or running</li> <li>• Sports with a lot of running (basketball, hockey, soccer)</li> <li>• Swimming fast or swimming laps</li> <li>• Tennis (singles)</li> </ul>

For example, a dietary pattern high in fruits, vegetables, whole grains, poultry, and fish was found to be associated with reduced mortality compared with a dietary pattern characterized by a high intake of refined grains, processed and red meats, desserts, high-fat dairy products, and French fries in women after breast cancer diagnosis and treatment.<sup>120</sup> Similarly, a 43% reduction in overall mortality was observed in a study of breast cancer survivors in association with a dietary pattern characterized by the high intake of vegetables and whole grains.<sup>121</sup> Breast cancer survivors who reported eating at least 5 servings of vegetables and fruits each day and having weekly physical activity equivalent to 30 minutes of walking for 6 days per week were observed to have a higher survival rate, although a significant survival advantage was not observed for either of these behaviors alone.<sup>122</sup> In patients with colorectal cancer, one observational study of over 1000 survivors found that a diet characterized by a higher intake of red meat, processed meat, refined grains, and sugary desserts was associated with a statistically significant increase in cancer recurrence and poorer overall survival.<sup>123</sup>

### Diet Composition

Protein, carbohydrate, and fat all contribute energy to the diet, and each of these dietary constituents is available from a wide variety of foods. Because many cancer survivors are at high risk of other chronic diseases, such as heart disease, the recommended amounts and types of fat, protein, and carbohydrate to reduce cardiovascular disease risk are also appropriate for cancer survivors, particularly if they are at or above their recommended body weight.<sup>46,47,49,52</sup>

The Institute of Medicine and current Federal Guidelines, as well as the American Heart Association (AHA), recommend a spectrum of dietary composition for the adult population: fat: 20% to 35% of energy (AHA: 25%-35%), carbohydrate: 45% to 65% of energy (AHA: 50%-60%); and protein: 10% to 35% of energy (at least 0.8 g/kg).<sup>46,49,124</sup>

Several studies have examined the relationship between fat intake and survival after the diagnosis of breast cancer; evidence from these observational studies is mixed.

Inverse associations have been found between fat intake and recurrence and/or survival in some of these studies, although these associations typically disappear with energy adjustment.<sup>98,125,126</sup> A U-shaped relationship between dietary fat intake and mortality following the diagnosis of breast cancer was identified in one observational study,<sup>127</sup> suggesting that extremes in fat intake may be associated with poorer outcomes.

Two large randomized controlled trials have tested whether a reduction in fat intake following the diagnosis of early stage breast cancer affects cancer outcomes. The WINS tested a low-fat diet (aiming for less than 15% of energy) in 2437 postmenopausal women with early stage breast cancer and found an effect on relapse-free survival that was of borderline statistical significance.<sup>91</sup> On average, the women in the intervention arm decreased their fat intake to 20% of energy at year one, and the intervention resulted in a 24% reduction in new breast cancer events, with subset analyses suggesting that this effect was greater among women with ER-negative disease. Of note, as previously described, women assigned to the low-fat diet study arm lost an average of 6 pounds over the course of the study, thus confounding whether the reduction in breast cancer events was due to dietary fat restriction or lower body weight.

The Women's Healthy Eating and Living (WHEL) Study tested the effect of a diet low in fat (aiming for 20% of energy intake) and very high in vegetables, fruits, and fiber on cancer outcomes in 3088 pre- and postmenopausal breast cancer survivors who were followed for an average of 7.3 years.<sup>122</sup> At 4 years, women in the intervention group reported a reduction in fat intake (from 31.3% at enrollment to 26.9% of energy intake), but recurrence-free survival did not differ between the 2 study arms.<sup>122</sup> Notably, women in the WHEL Study intervention group did not exhibit weight loss, in contrast to the low-fat diet intervention group in WINS. The WHEL Study intervention was observed to improve prognosis in women without hot flashes when enrolled in the study, and who were therefore likely to have higher circulating estrogen concentrations,<sup>128</sup> suggesting that there may be survival benefits for this subgroup.

A few observational follow-up studies of diet and survival after the diagnosis of prostate cancer have also been reported. In one of these studies, a higher saturated fat intake predicted shorter disease-specific survival and in another, greater monounsaturated fat intake predicted longer survival.<sup>129,130</sup> Given that men with prostate cancer are at a significant risk of death due to cardiovascular disease, these heart-healthy recommendations appear prudent not only for cancer prevention but also for competing causes of death.

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>131,132</sup> These findings are not entirely consistent, however, and more research is needed.<sup>133</sup> Regardless, including foods that are rich in omega-3 fatty acids (eg, fish, walnuts) in the diet should be encouraged, because this is associated with a lower risk of cardiovascular diseases and a lower overall mortality rate.<sup>46,49</sup>

Adequate protein intake is essential during all stages of cancer treatment, recovery, long-term survival, and living with advanced disease. The best choices to meet protein needs are foods that are also low in saturated fat (eg, fish, lean meat, skinless poultry, eggs, nonfat and low-fat dairy products, nuts, seeds, and legumes).

Vegetarian diets can be healthy or unhealthy, depending on one's food choices. Vegetarian diets differ with respect to the inclusion of dairy foods, fish, and/or eggs, but avoiding red meat is a universal feature. Fish, dairy foods, or both contain a 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. No direct evidence has helped to determine 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.

Healthy carbohydrate sources are foods that are rich in essential nutrients, phytochemicals, and fiber, such as vegetables, fruits, whole grains, and legumes. These foods should provide the majority of carbohydrate in the diet. 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 the risk and progression of cancer as well as cardiovascular disease.<sup>134</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, minerals, and fiber that are lower than those in 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 biologically active phytochemicals, have not been added back.

High sugar intake has not been shown to increase the 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 added sugar do not contribute many nutrients to the diet and often replace more nutritious food choices. Therefore, limiting the consumption of products with added sugar is recommended.

Vegetables and fruits contain numerous dietary constituents that potentially inhibit cancer progression, such as essential vitamins and minerals, biologically active phytochemicals, and fiber. In addition, these are low-energy-dense foods that promote satiety, and thus may promote healthy weight management.<sup>135</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 best choice.

As noted above, results from more recent studies suggest that a dietary pattern that is rich in vegetables and fruits is associated with increased overall survival following cancer diagnosis and treatment.<sup>120</sup> In addition to being rich in vegetables and fruits, this dietary pattern is characterized as having more fish and poultry rather than red meat and processed meat, low-fat rather than full-fat dairy products, whole grains rather than refined grain products, and tree nuts and olive oil rather than other sources of fat. A study of colon cancer survivors found that a Western diet characterized by high intakes of meat and added sugars, was associated not only with poorer cancer-specific survival, but a reduced likelihood of overall survival as well.<sup>123</sup>

In the observational studies that have examined the relationship between intakes of vegetables and fruits (or nutrients indicative of those foods) and the risk of breast

cancer recurrence, the findings have been mixed.<sup>136</sup> The WHEL Study tested the effect of a diet very high in vegetables, fruits, and fiber on the risk of recurrence and overall survival in early stage breast cancer survivors who reported a high average intake of vegetables and fruits (7.3 servings/ay) at enrollment. At 6 years, the intervention group had increased to an average of 9.2 servings per day, whereas the control group averaged 6.2 servings per day, yet recurrence-free survival did not differ between the 2 study arms.<sup>122</sup> However, serum estrogen levels at baseline were independently associated with poor prognosis, and a protective effect of the diet was observed in the subgroup of women who did not report hot flashes at enrollment (an indication of higher estrogen levels).<sup>128</sup> These findings suggest that reproductive hormonal status may determine whether a diet high in vegetables, fruits, and fiber affects prognosis. In addition, longitudinal exposure to carotenoids was associated with breast cancer-free survival regardless of study group assignment.<sup>137</sup> Thus, diet prior to the diagnosis of cancer and over the long term may be more important than short-term dietary changes postdiagnosis.

A few studies have evaluated the association between diet and ovarian cancer survival.<sup>138</sup> A higher prediagnosis intake of vegetables, especially yellow and cruciferous vegetables, was associated with longer survival in these studies.<sup>139,140</sup> A single observational study of diet after diagnosis and risk of prostate cancer progression found those men who consumed more tomato sauce had longer survival.<sup>141</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. Current public health recommendations for adults are to eat at least 2 to 3 cups of vegetables and 1.5 to 2 cups of fruits each day. Colorful choices such as dark green and orange vegetables are good sources of nutrients and potentially 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 the absorption of others. For example, carotenoids are better absorbed from cooked vegetables than from raw vegetables. There is no evidence that organically grown vegetables and fruits are superior in their content of potential cancer-preventive constituents.

### Dietary Supplements

According to the Dietary Supplement Health and Education Act (DSHEA) of 1994, dietary supplements include vitamins; minerals; herbs/botanicals; amino acids; and a concentrate, metabolite, constituent extract, or combination of any of

the aforementioned. Dietary supplement use is reported by 52% of US adults<sup>142</sup> and studies report ranges between 64% and 81% among cancer survivors.<sup>98,143</sup> A recent systematic review indicates that 14% to 32% of cancer survivors initiate supplement use after their diagnosis.<sup>143</sup> Breast cancer survivors report the highest prevalence of supplement use, whereas prostate cancer survivors report the lowest.<sup>143</sup> Cancer survivors 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 general insurance of adequate nutrient intake.<sup>144,145</sup>

Evidence from both observational studies and clinical trials suggests that dietary supplements are unlikely to improve prognosis or overall survival after the diagnosis of cancer, and may actually increase mortality. A 2006 meta-analysis found no association between antioxidant or vitamin A supplementation and all-cause mortality among cancer patients, although the authors noted that this report was limited by the small number of trials, particularly those of high quality.<sup>146</sup> The use of multivitamins or vitamins E or C was not associated with protection from cancer death in a cohort of 77,719 Washington state residents followed over a 10-year period.<sup>147</sup> In 2 large observational studies, the use of a full range of dietary supplements or multivitamins in particular was not associated with breast cancer recurrence, breast cancer-specific mortality, or overall mortality among women diagnosed with early stage breast cancer.<sup>148,149</sup> A similar finding was reported for multivitamin use among colorectal cancer survivors.<sup>150</sup> In addition, one trial suggests that beta-carotene supplements may increase the rate of colorectal adenoma recurrence in persons who smoke cigarettes, consume alcohol, or both.<sup>151</sup> A randomized clinical trial of 540 head and neck cancer patients receiving radiation therapy in which participants were randomized to either 400 IU/day of vitamin E or placebo found that supplement use was associated with significantly higher cause-specific and all-cause mortality.<sup>152</sup> In addition, the recent Selenium and Vitamin E Cancer Prevention Trial (SELECT) found that men who were assigned supplemental selenium or vitamin E had a higher incidence of diabetes and prostate cancer, respectively.<sup>153</sup>

Some observational studies have reported that breast cancer survivors have high rates of vitamin D insufficiency,<sup>154</sup> suggesting the need for vitamin D supplementation. Although supplemental vitamin D may help to meet nutritional needs for this vitamin, circulating concentrations have not been shown to affect the risk of breast cancer recurrence.<sup>155</sup> Two observational studies have found that a higher circulating prediagnosis vitamin D or higher postdiagnosis vitamin D level is associated with significant improvements in overall and/or colorectal cancer-specific mortality among colorectal cancer survivors.<sup>156,157</sup> A recent review, however, suggests that taking vitamin D



supplements has not been proven to improve outcomes in cancer patients.<sup>158</sup> These findings underscore the need to first assess whether nutrient status is indeed deficient before initiating supplements, since individuals who are truly deficient may derive some benefit, whereas those who take additional supplements but who are already well-nourished are unlikely to benefit and may incur harm.

Although the use of standard multiple vitamin and mineral supplements has previously been recommended during and after treatment as an “insurance policy” for obtaining adequate amounts of nutrients, this practice has recently come under scrutiny as more recent data suggest that multivitamin supplements may actually increase the risk of mortality among healthy individuals or, at the very least, may not be helpful.<sup>150,159-162</sup> The current body of evidence regarding supplement use by cancer survivors suggests that some general guidance should be considered:

- Before supplements are prescribed or taken, all attempts should be made to obtain needed nutrients through dietary sources.
- Supplements should be considered only if a nutrient deficiency is either biochemically (eg, low plasma vitamin D levels, B12 deficiency) or clinically (eg, low bone density) demonstrated.
- Supplements should be considered if nutrient intakes fall persistently below two-thirds of the recommended intake levels. Such a determination should be made by a registered dietitian, who is most qualified to assess the nutrient adequacy of the diet, especially in view of emerging data suggesting that higher nutrient intakes, especially through sources other than foods, may be harmful rather than helpful.

Open dialogue between patients and health care providers should occur regarding dietary supplementation to ensure there is no contraindication in relation to the prescribed cancer therapy or for longer term health effects.<sup>163,164</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 that related to potential drug interactions. It is most prudent to encourage cancer survivors to obtain the potentially beneficial compounds from food.

## Alcohol

Substantial observational evidence indicates that alcohol intake has both positive and negative health effects.<sup>47,165-167</sup> Alcoholic drinks up to one or 2 drinks per day (for women and men, respectively) can lower the risk of heart disease, but higher levels do not offer additional benefit and may increase the risk not only of complications of alcohol overuse, but also of specific cancers.<sup>168</sup> 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, treatment-related side effects, risk factors for recurrence or new primary cancers, and comorbid conditions should be considered in making recommendations. Many health care professionals ask individuals receiving chemotherapy or biological therapy to avoid alcohol consumption during treatment. This advice is also often given if receiving radiation therapy to the head, neck, or thoracic region. For example, during the time of active treatment, 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 radiation therapy or chemotherapeutic regimens that put them at risk for mucositis. Among cancer survivors, the prevalence of alcohol use generally mirrors that in the general population, although among some survivor groups (ie, survivors of prostate and head and neck cancers) it is higher.<sup>169</sup>

The link between alcohol intake and risk of some primary cancers has been established, including cancers of the mouth, pharynx, larynx, esophagus, liver, and breast and, for some forms of alcohol beverages, colon cancer.<sup>47,165,170</sup> In individuals who have already received a diagnosis of cancer, alcohol intake could also increase their risk of new primary cancers of these sites<sup>171</sup>; moreover, a long-standing literature in patients with head and neck cancer suggests that continued alcohol consumption (as well as smoking) leads to lower survival rates, thus supporting the need to limit alcohol consumption in this population.<sup>168,172</sup> In breast cancer, the relationship with alcohol intake after diagnosis is less clear, although there is irrefutable evidence that alcohol intake is linearly associated with primary risk.<sup>52</sup> Alcohol intake can increase the circulating levels of estrogens, which theoretically could increase the risk of recurrence of breast cancer. To date, a few studies have explored outcomes of breast cancer survivors by alcohol intake. The results are mixed, with some studies<sup>173-175</sup> suggesting that alcohol confers a protective effect on overall survival and subsequent ovarian cancer, and others<sup>176,177</sup> finding an increased risk of contralateral disease and disease-specific and overall mortality.

## Food Safety

Food safety is of special concern for cancer survivors, especially during episodes of treatment-related immunosuppression that can occur with certain cancer treatment regimens.<sup>178</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 particularly careful to avoid

TABLE 5. General Guidelines for Food Safety

- Wash hands with soap and water thoroughly before eating.
- Keep all aspects of food preparation clean, including washing hands before food preparation and washing fruits and vegetables thoroughly.
- Use special care in handling raw meats, fish, poultry, and eggs.
- Thoroughly clean all utensils, countertops, cutting boards, and sponges that have contact with raw meat; keep raw meats and ready-to-eat foods separate.
- Cook to proper temperatures; meats, poultry, and seafood should be thoroughly cooked and beverages (milk and juices) should be pasteurized. Use a food thermometer to check internal temperatures of meats before serving.
- Store foods promptly at low temperatures (below 40°F) to minimize bacterial growth.
- When eating in restaurants, avoid foods that may have potential bacterial contamination such as items from salad bars; sushi; or raw or undercooked meat, fish, shellfish, poultry, and eggs.
- Avoid raw honey, milk, and unpasteurized fruit juice, and choose pasteurized versions instead.
- If there is any question or concern about water purity (eg, well water), it can be checked for bacterial content by contacting your local public health department.

eating foods that may contain unsafe levels of pathogenic microorganisms. By following safe food practices, cancer survivors and their caregivers can reduce the risk of foodborne illness. General guidelines for food safety, as shown in Table 5, should be followed.

## 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 lymph node status, as well as a variety of undesirable outcomes (eg, contralateral disease, recurrence, comorbid disease, and/or disease-specific or overall mortality, as well as treatment effects such as lymphedema).<sup>8,54,87,179-186</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 percentage of breast cancer survivors. A compounding problem is the fact that additional weight gain is frequently reported after diagnosis.<sup>187-189</sup> Analyses conducted on a cohort of nonsmoking breast cancer survivors within the Nurses' Health Study corroborated these findings. Women who increased their 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 a 53% greater chance of recurrence compared with those who did not gain more than 0.5 BMI units.<sup>86</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>190</sup> Although it must be considered that unexplained weight loss may be a symptom of recurrent disease and should be monitored closely,<sup>191</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 priority standard of care for overweight women diagnosed with early stage breast cancer.<sup>8,192</sup> A decade of previous research,<sup>193-196</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 increased adipose tissue mass, with no change or a decrease in lean body mass.<sup>82,189,197,198</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 or rebuilding 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>188,199</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.<sup>90</sup> Furthermore, a recent review of the scientific literature documented that intentional weight loss promotes favorable changes in breast cancer-relevant biomarkers, such as estrogens, sex hormone-binding globulin, and inflammatory markers.<sup>200</sup>

There is substantial research on physical activity in breast cancer survivors and multiple systematic reviews focused on its role in these individuals.<sup>62,201</sup> In a meta-analysis of 717 breast cancer survivors participating in 14 randomized controlled trials, physical activity led to statistically significant improvements in quality of life, physical functioning, and peak oxygen consumption, as well as a reduction in symptoms of fatigue.<sup>201</sup> Another meta-analysis of 6 prospective cohort studies that included over 12,000 breast cancer survivors showed that postdiagnosis physical activity was associated with a 24% and 34% lower rate of breast cancer recurrence and mortality, respectively, and a 41% lower rate of all-cause mortality. Despite these promising findings,

there remains a need for a randomized controlled trial to further test the benefit of exercising in preventing cancer recurrence and improving survival in women with breast cancer.<sup>62</sup>

Even with the increased use of sentinel lymph node dissection, lymphedema remains a concern among breast cancer survivors. However, aerobic physical activity and resistance training appear to be both safe and effective in reducing the incidence of lymphedema among survivors at high risk of this condition, and in improving the symptoms and severity of lymphedema for those in whom the condition was preexisting.<sup>111,112</sup> Progressive resistance training under the supervision of a trained exercise therapist and using appropriate compression garments is recommended. In addition, because obesity is a major risk factor for lymphedema, weight loss is recommended among survivors who are overweight or obese.

Research is currently under way to evaluate various components of dietary patterns on cancer-specific outcomes, as well as overall health. An observational study found that dietary pattern was important for overall survival among breast cancer survivors, with those who ate a Western diet having poorer overall survival and those who ate a dietary pattern characterized by high amounts of fruits, vegetables, and whole grains having better overall survival; however, neither dietary pattern was associated with breast cancer recurrence specifically.<sup>120</sup> One factor that tends to separate these 2 dietary patterns is fat; however, to date, evidence that dietary fat intake could be associated with risk of recurrence or survival is not strongly or consistently supported, especially when total energy intake and the degree of obesity are considered.<sup>202,203</sup>

Two large clinical trials tested whether change in diet composition can reduce the risk of recurrence and increase overall survival in women who have been diagnosed with breast cancer. While the WINS low-fat dietary intervention group exhibited a borderline significant 24% reduction in risk of recurrence, the group also lost weight, so it is possible that the benefits were due to weight loss and not a reduction in fat intake. In the WHEL Study, a reduction in dietary fat was among the dietary goals, and an effect of the diet intervention (which was not associated with weight loss) was not observed.

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>204,205</sup> In the WHEL Study, the major intervention was increased vegetable and fruit intake, although women in the intervention group were also encouraged to reduce their fat and increase their fiber intakes.<sup>206</sup> Recurrence-free survival did not differ between the 2 study arms in that study,<sup>122</sup> although the fruit and vegetable intake of these women was already high, averaging greater than 7 servings per day at the beginning of the study.

The WHEL Study intervention did improve prognosis in women without hot flashes when enrolled in the study,<sup>128</sup> suggesting that there may be survival benefits among women with higher circulating estrogen levels. Also, longitudinal exposure to carotenoids (a biologic marker of intake of deeply colored vegetables and fruits) was found to be associated with longer recurrence-free survival, regardless of study group, suggesting that vegetable and fruit intake prior to the diagnosis of breast cancer may improve prognosis.<sup>137</sup> Vegetables can reduce the total energy density in the diet, and both vegetables and fiber are associated with improved satiety. 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 healthy diet, with higher intakes of fruits, vegetables, and whole grains and lower intakes of added sugar, refined grains, and animal products, may not have had 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, such as heart disease, when compared with those who eat typical Western diets.<sup>120</sup>

Soy foods and flaxseed are both rich sources of phytoestrogens, biologically active compounds called isoflavones that can exhibit both antiestrogenic and estrogen-like properties. High circulating estrogen levels are a documented risk factor for breast cancer recurrence.<sup>207</sup> Because soy isoflavones have been shown to promote *in vitro* growth of breast cancer cells and mammary tumor growth in laboratory animals, there has been some concern about the potential adverse effect of soy consumption on prognosis in women who have been diagnosed with breast cancer. However, 3 large epidemiological studies in the recent past have found no adverse effects of soy food intake on breast cancer recurrence or total mortality either alone or in combination with tamoxifen, and there is the potential for these foods to exert a positive synergistic effect with tamoxifen.<sup>208-210</sup> Two of these studies were focused on US samples and included isoflavone supplements in the data collection and analysis. Current evidence does not suggest that consuming soy foods is likely to have adverse effects on risk of recurrence or survival. Isoflavone supplement use was uncommon in the populations in these recent cohort studies, and therefore the evidence relating to the effects of these supplements is more limited.

Alcohol intake has been linked with an increase in the risk of primary breast cancer<sup>170</sup>; however, among cancer survivors, associations have been mixed, with protective effects found between alcohol intake and risk of subsequent ovarian cancer in one study,<sup>174</sup> increased risk of contralateral disease and recurrence and death found in 2 other studies,<sup>176,177</sup> and one study that showed neither risk nor protection for breast cancer recurrence with low to

moderate alcohol intake.<sup>175</sup> The discrepancy noted with regard to alcohol and overall survival may be due in part to the fact that alcohol intake is associated with a reduced risk of cardiovascular disease, a common comorbidity among breast cancer survivors, and also is usually inversely associated with obesity. Theoretically, however, alcohol intake could affect the risk of 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 of cardiovascular disease.<sup>166</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 recurrent or second primary breast cancer as well as cardiovascular disease.

It is important to remember that nutrition and physical activity recommendations to reduce the risks of a second primary breast cancer and heart disease are especially important for breast cancer survivors.<sup>49,52,211,212</sup> Diets should emphasize vegetables and fruits, have low amounts of saturated fats, and include sufficient dietary fiber.<sup>124</sup> Most importantly, breast cancer survivors should strive to achieve and maintain a healthy weight through eating a well-balanced diet and regular exercise.<sup>136</sup> In addition, regular physical activity should be maintained regardless of any weight concerns.

## Colorectal Cancer

Epidemiologic, clinical, and laboratory research indicates that diet, adiposity, and physical activity have a significant influence on the risk of developing colorectal cancer.<sup>213,214</sup> Over the past decade, there has been an increasing number of studies that have examined the influence of these modifiable host factors on physical well-being, quality of life, and cancer recurrences and survival.<sup>78</sup>

Several observational studies have shown that higher physical activity levels or meeting physical activity guidelines is associated with better patient-reported quality of life, physical functioning, and fatigue.<sup>215-220</sup> One randomized trial of an exercise intervention in colorectal cancer survivors demonstrated that participants whose aerobic fitness increased over the course of the intervention, regardless of group assignment, reported significantly improved quality of life, physical functioning, and psychosocial distress compared with participants whose fitness decreased.<sup>221</sup>

Recently emerging, prospective, observational data have shown that colorectal cancer survivors who are physically active lower their risk of cancer recurrence, colorectal cancer-specific mortality, and/or overall mortality.<sup>104-107,222</sup> These data have led to the initiation of the *Colon Health and Life-Long Exercise Change* (CHALLENGE) trial,

a randomized, controlled, multinational collaboration between Canada and Australia to determine the effects of a 3-year structured physical activity intervention on disease outcomes in survivors of high-risk stage II and III colon cancer who have completed adjuvant chemotherapy within the previous 2 to 6 months.<sup>108</sup>

The impact of obesity on outcomes in colorectal cancer survival has been less certain.<sup>89,223-225</sup> Most prospective observational cohort studies have used a single measurement of weight and height at the time of diagnosis and have primarily demonstrated that only class II and III obesity ( $\text{BMI} \geq 35 \text{ mg/m}^2$ ) may modestly worsen outcomes (approximately 20% worse disease-free survival).<sup>89,225</sup> A recent study from the ACS Cancer Prevention Study II Nutrition Cohort reported that an obese BMI before the diagnosis of colorectal cancer (mean, 7 years prior to diagnosis) was associated with higher risks of death from all causes, colorectal cancer-specific causes, and cardiovascular disease, while the BMI reported after a diagnosis of colorectal cancer was not associated with any of the mortality outcomes.<sup>226</sup>

Although diet has been extensively studied as a risk factor for developing colorectal cancer, there are very limited data concerning diet in colorectal cancer survivors as related to survival outcomes. The largest prospective study to date included survivors of stage III colon cancer and demonstrated that a Western dietary pattern, resulted in a worse disease-free and overall survival.<sup>123</sup> In contrast, a diet characterized by high intakes of fruits and vegetables, poultry, and fish was not significantly associated with cancer recurrence or mortality. Vitamin D status has been shown fairly consistently to influence the risk of developing colorectal cancer.<sup>227</sup> Emerging data suggest that vitamin D status may influence outcomes in colorectal cancer survivors as well and this is an active area of research as both a secondary preventive and treatment strategy in colorectal cancer.<sup>156,157</sup>

Because most colorectal cancers arise from adenomatous polyps, the prevention of polyp recurrence has also been a focus of considerable clinical research. To date, trials have failed to show benefits in preventing new polyp growth during a 3-year or 4-year period from antioxidant vitamins, fiber supplements, or modest dietary changes to increase fruit and vegetable intake.<sup>228</sup> Folate has not been shown to reduce polyp recurrence in clinical trials<sup>229,230</sup> and was associated with an increased risk of having multiple adenomas.<sup>230</sup> Calcium supplements, however, provided a modest benefit in preventing polyp recurrence.<sup>231</sup>

Colorectal cancer survivors should be advised to maintain a healthy weight, participate in regular physical activity, and eat a well-balanced diet consistent with guidelines for cancer and heart disease prevention. 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.

### Endometrial Cancer

Endometrial cancer is the most common gynecologic cancer and the fourth most common cancer in women.<sup>4</sup> The prognosis of endometrial cancer is related to the stage of disease at diagnosis, with a 90% survival rate if diagnosed at stage I,<sup>232</sup> which is common because the main symptom, abnormal bleeding, is easy to detect and likely to cause women to seek medical attention.

Obesity is a strong risk factor for the development of endometrial cancer. Approximately 70% to 90% of women with type 1 endometrial cancer (the most common type) are obese.<sup>233</sup> However, there are few studies of the role of obesity in endometrial cancer prognosis. Prediagnosis obesity has been shown to be associated with a significant increase in endometrial cancer mortality.<sup>234</sup> This may be related to common comorbidities among obese women, such as type 2 diabetes and hypertension, which may complicate cancer treatment.<sup>76</sup> In a study using data from participants in a Gynecologic Oncology Group trial of early stage endometrial cancer, obesity was associated with higher mortality from causes other than endometrial cancer but not with recurrence.<sup>235</sup> Obese women tend to develop less aggressive endometrial cancer<sup>236–238</sup>; however, decreased overall survival among obese endometrial cancer patients has been seen in some studies,<sup>235,239</sup> but not in others.<sup>236–238</sup> No studies have reported on the role of dietary factors and physical activity in the prognosis of endometrial cancer. Although the role of obesity in endometrial cancer prognosis is not completely understood, studies have shown that a higher BMI and a sedentary lifestyle are associated with a poorer quality of life among endometrial cancer survivors.<sup>233,240,241</sup>

### Ovarian Cancer

Ovarian cancer is the leading cause of death from gynecologic malignancies in the United States.<sup>4</sup> Symptoms tend to be nonspecific, making early detection difficult. Consequently, most ovarian cancers are diagnosed at an advanced stage when the prognosis is poor, with an overall 10-year survival rate of 39%.<sup>4</sup> The role of lifestyle factors in ovarian cancer prognosis is largely unknown.<sup>138,242</sup> To our knowledge, only 3 studies<sup>139,140,243</sup> have evaluated the role of dietary factors in ovarian cancer survival. These 3 studies were based on prospective follow-up of the cases participating in case-control studies and evaluated the association between prediagnosis dietary intake and mortality outcomes. One study, conducted in China, focused on the role of green tea and reported that a higher frequency and quantity of green tea intake after

diagnosis was associated with better survival.<sup>243</sup> The other 2 studies, conducted in Australia<sup>140</sup> and the United States,<sup>139</sup> suggested that prediagnosis dietary intake may influence the survival experience of patients with ovarian cancer. Both studies tended to support the association of fruit and vegetable consumption with better survival. Dairy food intake was associated with poorer survival in one of the studies,<sup>140</sup> while in the other, only milk consumption and not total dairy food consumption was inversely associated with survival.<sup>139</sup> Meat consumption was associated with better survival in the Australian study,<sup>140</sup> and with lower survival in the study conducted in the United States.<sup>139</sup> While these studies controlled for most relevant covariates, they did not include treatment information. In addition, these studies did not evaluate dietary intake after diagnosis. However, they do suggest that dietary intake may influence ovarian cancer survival and warrant further research in this area.

Only one study, also following cases in a case-control study for mortality, has evaluated the role of physical activity in ovarian cancer survival.<sup>244</sup> Prediagnosis physical activity was ascertained as hours per week for 3 life periods (childhood, between ages 18–30 years, and in recent years). The study also evaluated the role of changes in physical activity over time. There was not much indication of an association with survival for any of these variables, except for physical activity at aged 18 to 30 years, which seemed to be associated with better survival for women with early stage ovarian cancer and with worse survival for women with an advanced stage of disease at diagnosis.<sup>245</sup>

The relationship between excess weight and ovarian cancer survival has been evaluated by relatively few studies. Obesity may affect ovarian cancer survival by having a negative impact on optimal surgical and cytotoxic treatment and increasing the likelihood of postoperative complications.<sup>246</sup> Overall, the literature evaluating the association between weight/BMI and ovarian cancer survival is limited and inconclusive.<sup>76,242</sup> Cohort studies evaluating the role of prediagnosis obesity obtained at baseline on ovarian cancer mortality have generally found elevated ovarian cancer mortality among obese women.<sup>234,247</sup> Other studies evaluating the role of prediagnosis BMI on ovarian cancer survival by following cases in a case-control study or clinical trial (using baseline data) have offered conflicting results.<sup>242</sup> The role of postdiagnosis body size and weight changes on ovarian cancer survival is largely unknown. Only one study has reported on weight changes during chemotherapy and ovarian cancer survival and found that, among patients with advanced ovarian cancer, weight loss during chemotherapy was associated with worse prognosis; however, it is difficult to determine whether this weight loss was involuntary or intentional.<sup>248</sup>

In summary, while the current evidence is limited and inconclusive, it points to a possible role of dietary factors, physical activity, and body size and weight changes in modulating ovarian cancer survival, and for physical activity in improving the quality of life among ovarian cancer survivors. Further studies are needed before public health recommendations can be made.

### Hematologic Cancers and Cancers Treated With 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 appears to adversely affect prognosis for patients who undergo 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>249</sup>

Observational research has shown that the physical activity levels of survivors of hematological cancer are low, with deleterious health consequences. Multiple intervention studies have tested the benefit of exercise in both adult and pediatric survivors of hematological cancer.<sup>30,250,251</sup> Systematic reviews of adult interventions have reported that physical activity can improve body composition, cardiorespiratory fitness, fatigue, muscle strength, physical functioning, and quality of life.<sup>250</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 posttransplant 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 specialized nutritional support typically eat poorly for a prolonged period and are at high risk of poor nutritional status.<sup>252-254</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>255</sup> Because many food restrictions are imposed with

this strategy, the nutrient adequacy of the 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 posttransplant treatment at most transplant centers. In a recent review of the evidence regarding the relative effectiveness of enteral nutrition versus parenteral nutrition support, the issue could not be evaluated due to a lack of evaluable data.<sup>256</sup> Recent trends include prescribing less parenteral nutrition support and more enteral nutrition support,<sup>255</sup> which could reduce the risk of medical complications and control costs.

### Lung Cancer

Lung cancer treatment is often aggressive and causes adverse effects. Furthermore, many lung cancer survivors are underweight and have low blood nutrient levels even before diagnosis as a result of the adverse effects of inadequate diets, 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 easy to swallow. Small, frequent meals may be easier to manage than 3 large meals per day. Medications and nutritional support via energy-dense nutritional supplements or enteral nutrition may be helpful for those experiencing weight loss.<sup>257</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.

Patients with lung cancer present with a complex variety of symptoms that can limit physical function and lead to distress, including dyspnea, air hunger, anxiety, muscle weakness, fatigue, and limited cardiopulmonary function. Despite these issues, there have been several clinical trials that have successfully demonstrated the feasibility of exercise interventions in select lung cancer patients. A recent systematic review of 16 studies inclusive of 675 lung cancer patients demonstrated that patients participating in an exercise intervention prior to surgery reported improvements in exercise capacity but no change in health-related quality of life immediately after the intervention.<sup>258</sup> Furthermore, other studies of exercise following standard lung cancer treatment demonstrated improvements in exercise capacity but had conflicting results with respect to the impact on quality of life. More research is needed in this cancer patient population.

The possible effect (either beneficial or harmful) of nutritional supplements other than beta-carotene after the diagnosis of lung cancer has not been extensively studied. One clinical trial of selenium and skin cancer noted a reduced incidence of lung cancer in association with selenium supplementation.<sup>259</sup> While some researchers have

found that individuals with early stage lung cancer who have better vitamin D status have improved survival,<sup>260</sup> these findings need replication.

Few studies have examined the relation between dietary factors and lung cancer prognosis. Two small studies sought to determine whether dietary intervention with selected vegetables improved survival among those with advanced lung cancer.<sup>261,262</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 their energy intake.<sup>263-265</sup> Although successful in increasing energy intake, none of the strategies used within these studies prevented weight loss.

Recommendations for nutrition and physical activity for individuals 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 nutritious diet and a multivitamin-mineral supplement, if needed, to achieve adequate levels of intake.

## Prostate Cancer

Most research on nutrition and prostate cancer has focused on prostate cancer incidence.<sup>266,267</sup> Because asymptomatic prostate cancer is very common in older men, the same lifestyle factors that are associated with a reduced prostate cancer incidence might also reduce the rate of prostate cancer growth after diagnosis, thus preventing or slowing the progression of early stage prostate cancer. However, notable exceptions are body weight and obesity, which appear to be related to cancer progression and the more aggressive forms of prostate cancer, and not the latent or indolent disease that appears to be an artifact of aging.<sup>268</sup> 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 [PSA] 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 an increased risk of prostate cancer.<sup>203,266</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 2 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>269</sup> and the other found that monounsaturated fat intake is associated

with better survival.<sup>129</sup> Based on what we currently know and on the role of saturated fat in cardiovascular disease and its potential role in prostate and colon cancer incidence, decreasing saturated fat intake is likely very beneficial in this population.<sup>47,49</sup> Recently, a secondary analysis of a trial of prostate cancer patients found that those who were assigned to the low-fat diet had significantly decreased blood levels of inflammatory markers that are linked to cancer progression.<sup>270</sup> Similar to the WINS study, however, it is unknown whether this response was due more to dietary fat restriction or to weight loss.

In one study in which the relationship between dietary intakes and risk of prostate cancer recurrence was examined, intakes of fish and tomato sauce were observed to be associated with reduced risk.<sup>141</sup> Although benefits to prostate cancer risk and progression from vegetables and fruits are far from certain, a diet high in these foods has been found to reduce the risk of cardiovascular diseases.<sup>49</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 of prostate cancer, no rigorous studies have been reported that examined the effects of soy or other phytoestrogens on the progression of prostate cancer after diagnosis. In a randomized controlled trial of 161 men, those assigned to consume 30 g of ground flaxseed per day (a concentrated source of lignans, as well as omega-3 fatty acids) were found to have significantly lower prostate tumor proliferation rates compared with the control group.<sup>271</sup>

Prostate cancer survivors undergoing androgen deprivation therapy (ADT) are at a high risk of osteoporosis. In addition, a recent study indicated that low 25-hydroxyvitamin D (25(OH)D) levels (the major form of vitamin D in the circulation) were associated with lethal prostate cancer.<sup>272</sup> It is not known if calcium or vitamin D supplements would be useful or detrimental in these cases, since high amounts of calcium, particularly through supplements, have been linked to more aggressive disease.<sup>273</sup> It would seem prudent for men to adopt a diet that provides at least 600 IU of vitamin D per day and to consume adequate, but not excessive, amounts of calcium (ie, exceeding 1200 mg/day), 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 currently being studied; 2 preliminary studies suggest that vitamin D, administered either separately or in conjunction with chemotherapy, may reduce PSA levels, although further research is needed to determine the longer term effects of vitamin D supplementation.<sup>274,275</sup>

Vitamin E supplementation in a large prevention trial intended to affect lung cancer was shown to be associated with a reduced risk of prostate cancer, but vitamin E had no effect on survival in the men in whom prostate cancer developed in that study,<sup>276,277</sup> and results from a recently published randomized controlled trial indicated that men randomized to receive vitamin E were at a slightly greater risk of developing prostate cancer.<sup>153,278</sup> Likewise, although selenium supplements reduced prostate cancer incidence in a small trial intended to prevent skin cancers,<sup>259,279</sup> the same recently published trial (SELECT) found no protection from selenium in prostate cancer, and it actually predisposed men to diabetes.<sup>278</sup>

Two large cohort studies have found that obese men are at a much greater risk of prostate cancer mortality and prostate cancer specific mortality following diagnosis.<sup>234,280</sup> Moreover, in a single-institution study, Freedland et al found that obesity was associated with a higher risk of biochemical failure in men treated with radical prostatectomy,<sup>56</sup> and in another single-surgeon prostatectomy cohort, men who gained weight after diagnosis had almost twice the risk of recurrence (most being cases of biochemical failure) compared with men who maintained their weight after taking into account other prognostic factors. In this latter study, men who lost weight also appeared to have a lower risk of recurrence, although this observation was not statistically significant.<sup>281</sup>

Many prostate cancer survivors are confronted with profound changes in body composition related to ADT, including bone loss, muscle loss, and fat gain. These changes lead to significant deconditioning, muscle weakness, fatigue, and depression. Multiple trials have tested the impact of exercise, particularly resistance training, at different stages of the spectrum of treatment in men with prostate cancer. A systematic review of 9 studies on the effects of exercise on health outcomes demonstrated promising effects of physical activity on muscular fitness, physical functioning, fatigue, and health-related quality of life.<sup>282</sup> A recent randomized trial of 121 prostate cancer patients initiating radiation therapy with or without ADT randomly assigned to usual care, resistance training, or aerobic exercise demonstrated that resistance training improved short- and long-term fatigue, quality of life, aerobic fitness, and upper and lower body strength, and prevented an increase in body fat.<sup>283</sup> Aerobic exercise improved short-term fatigue and fitness.

Recently, a prospective observational cohort of over 2700 men with nonmetastatic prostate cancer found that physically active men had significant improvements in all-cause and prostate cancer-specific mortality.<sup>65</sup> Men who engaged in at least 3 hours per week of vigorous activity had a nearly 50% reduction in all-cause mortality and a 60% reduction in prostate cancer-specific deaths.

Men in whom prostate cancer has been diagnosed should strive to achieve and maintain a healthy weight, pursue a physically active lifestyle, and consume a diet that is rich in

vegetables and fruits and low in saturated fat, with reliance on dietary sources of calcium that are within moderate levels. Such dietary suggestions, however, need to be considered within the context of an increased risk of fractures from antiandrogen 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

Few studies have considered whether dietary factors or physical activity influence prognosis in survivors with upper gastrointestinal or head and neck cancers. A clinical trial of the effects of a beta-carotene supplement (vs placebo) among survivors with head and neck cancers found that those administered beta-carotene had rates of cancer recurrence or survival that were similar to those in the control group.<sup>284</sup> In contrast, a clinical trial of vitamin E found an increased risk of recurrence compared with a placebo in this same patient population.<sup>152</sup>

Head and neck cancers can directly compromise food intake, and a high percentage of patients have lost weight or are malnourished at the time of diagnosis. Comprehensive care of these survivors includes 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 at diagnosis or after surgery and from xerostomia, mucositis, and taste alterations resulting from radiation therapy or concurrent chemoradiation therapy. Many long-term survivors of head and neck cancers will experience at least some degree of aspiration associated with substantial weight loss, diminished swallowing efficiency, and lower quality-of-life scores.<sup>285</sup> During and immediately after treatment, the texture, temperature, consistency, nutrient content, and frequency of oral feedings often need to be modified. Acidic, salty, or spicy foods and foods at extreme temperatures may not be well tolerated. Sugar-free gums and mints as well as the use of commercial oral rinses and gels and the consumption of water may provide limited relief of symptoms and enhance appetite. Pureed or blenderized foods may be better tolerated during treatment and recovery. Chemoradiation may have a significant effect on a patient's ability to eat, which should improve by 12 months after treatment.<sup>286</sup> Health care providers may offer alternate approaches to meeting nutrient requirements if eating and drinking by mouth cannot support these needs. Gastrostomy tubes are commonly placed prophylactically to support the patient through



treatment and the period of time immediately after treatment. Patients are encouraged to eat soft, moist foods throughout treatment to maintain their swallowing function. Patients with esophageal and gastric cancers may need support through treatment as well. This population may require placement of either a gastrostomy tube or a jejunostomy tube, depending on anticipated or performed surgical interventions. 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>286,287</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>288-290</sup> One study of 52 head and neck cancer survivors that compared progressive resistance exercise with standard physical therapy demonstrated that resistance training significantly improved self-reported shoulder pain and disability, upper extremity strength, and upper extremity endurance.<sup>289</sup> Furthermore, changes in neck dissection impairment, fatigue, and quality of life nonsignificantly favored those patients treated with resistance training.

Patients with esophageal or gastric cancer may have symptoms such as early satiety, dumping syndrome, or malabsorption that affect food and nutrient intake, as well as absorption and digestion; the effects of treatment may result in long-term or permanent nutritional complications. Survivors with esophageal cancer can experience temporary or long-term dysphagia, odynophagia, gastroesophageal reflux, and early satiety.<sup>9</sup> Diet modifications determined with the assistance of an oncology-certified registered dietitian can help to manage some of these treatment-related conditions, help regain or maintain a healthy weight, and restore some quality of life.

The nutritional management of patients with gastric cancer is based on determining the portion of the stomach involved with disease or the condition after surgical resection. If either the esophageal or pyloric sphincter has been affected, diet modifications will involve small, more frequent meals/snacks, no concentrated sweets, and the consumption of fluids between meals due to early satiety. In addition, the patient is advised to stop eating 3 hours before bedtime or going to bed to avoid aspiration. There is a significant risk of micronutrient deficiencies in this patient population due to the alteration of the digestion process and absorption of minerals such as iron and calcium and vitamins such as vitamin B12. If possible, a patient's status should be tested pretreatment and followed through the treatment and long-term survivorship period.

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>291-294</sup> Weight loss is common at diagnosis in this population, and these patients often experience profound exocrine dysfunction, in addition to endocrine dysfunction, throughout the course of their cancer treatment. Pancreatic enzymes can be very helpful, along with diet modification, to manage disease symptoms and treatment side effects. Consultation and close follow-up with a registered dietitian for an individualized dietary prescription is recommended.

In the absence of more definitive information, survivors of head and neck and upper gastrointestinal cancers should follow, to the extent they are able, the ACS nutrition and physical activity guidelines for the prevention of cancer.<sup>52</sup>

## Common Questions About Diet, Physical Activity, and Cancer Survivorship

Cancer survivors often request information and advice from their health care 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 appear to be new or 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 of some primary cancers, including cancers of the mouth, pharynx, larynx, esophagus, liver, breast, and probably colon cancer.<sup>47,170,165</sup> In individuals who have already received a diagnosis of cancer, alcohol intake could also affect the risk of new primary cancers of these sites.<sup>171</sup> Alcohol intake can increase the circulating levels of estrogens, which theoretically could increase the risk of a recurrence of ER-positive breast cancer; currently, however, only a few studies have explored alcohol use among breast cancer survivors, with approximately one-half showing a detrimental effect and one-half showing benefit or no harm. One study suggests that the detrimental effects of alcohol may be exacerbated in women who are overweight or obese.<sup>176</sup> Given that alcohol does exert cardioprotective effects, the question of whether to consume it or not depends heavily upon hereditary disposition and risk of recurrence versus risk of cardiovascular disease.

### ***Should Alcohol Be Avoided During Cancer Treatment?***

The cancer type and stage of disease, as well as treatment, should be considered when making recommendations on alcohol use during treatment. Many chemotherapeutic agents are metabolized in the liver, and inflammation of the liver from alcohol, particularly around the time of treatments, may affect the clearance of chemotherapeutic drugs and worsen toxicities. It is generally advised to avoid or keep consumption to a minimum to prevent interaction with chemotherapeutic drugs, and to avoid further aggravation to treatment areas during radiation therapy. Alcohol, even in the small amounts found in mouthwashes, can be irritating to survivors with oral mucositis, can exacerbate that condition, and can compromise healing.<sup>295</sup>

### **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 been hypothesized that increasing intake of antioxidants from foods or supplements may help prevent cancer. Some 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 of some types of cancer.<sup>296</sup> Because cancer survivors are at an increased risk of second cancers,<sup>45</sup> they should be encouraged to consume a variety of these antioxidant-rich foods each day. However, clinical studies of antioxidant dietary supplements have not demonstrated a reduction in cancer incidence.<sup>297,298</sup> The best advice presently is to obtain antioxidants through food or beverage sources rather than dietary 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>17,21,299</sup> At the present time, evidence is limited, but taking high doses of supplements with antioxidant activity during chemotherapy or radiation therapy may be unwise because antioxidants could potentially repair the cellular oxidative damage to cancer cells that contributes to the effectiveness of these treatments.<sup>300,301</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>23</sup> Whether antioxidants or any other dietary supplements specifically are beneficial or harmful during chemotherapy or radiation therapy is a question without a clear scientific answer at this time.<sup>22,302-304</sup>

Given this uncertainty, until more evidence is available that suggests more benefit than harm, it is prudent for cancer survivors currently receiving chemotherapy or radiation therapy to limit the usage of supplements to nutrients for which a deficiency has been demonstrated, and avoid dietary supplements exceeding 100% of the Daily Value for antioxidant vitamins, unless specifically recommended by a physician for the treatment of a specific condition.<sup>17,20,21</sup>

### **Fat**

#### ***Will Eating Less Total Fat, or Less of Certain Types of Fat, Lower the 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>136</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 ER-negative disease.<sup>91</sup> It is important to note that although there is not conclusive evidence that total fat consumption influences cancer outcomes, diets very high in fat tend to be high in calories and may contribute to obesity, which in turn is associated with an increased cancer incidence at several sites, an increased risk of recurrence, and a reduced likelihood of survival for many cancer sites (see "Obesity").

There is evidence that certain types of fat, such as saturated fats, may have an effect on increasing cancer risk.<sup>47,48,305</sup> There is little evidence that other types of fat (omega-3 fatty acids, found primarily in fish and also walnuts; 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>129,130</sup> In addition, excess saturated fat intake is a known risk factor for cardiovascular diseases, which are 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>49,306</sup> their relationship to cancer incidence or survival has not been observed. Regardless, due to the relationship with increased cardiovascular disease risk, survivors should consume as few trans fats as possible. Major sources of trans fats are some margarines, baked goods, 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" (such as oat bran) or "insoluble" (such as

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, nuts, and fruits. Consumption of these foods is recommended because they contain other nutrients that may help reduce cancer risk and provide other health benefits, such as a reduced risk of coronary heart disease.<sup>46</sup>

### Flaxseed

Flaxseed is an excellent source of vitamins, minerals, and fiber, and also is an exceedingly rich source of phytoestrogenic lignans and omega-3 fatty acids.<sup>307</sup> While further work in humans is necessary, cell culture and animal studies suggest that flaxseed or its isolated compounds reduces tumor growth and also may potentiate the effects of some treatments, such as tamoxifen. Two randomized controlled clinical trials in cancer survivors, one conducted in 32 women with breast cancer and another performed in 161 men with prostate cancer, showed that patients who were assigned to flaxseed-supplemented diets prior to cancer surgery had significantly lower tumor proliferation rates than those who were assigned to other diets.<sup>271,308</sup> More research, however, is needed to corroborate these findings.

### 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>178</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 guidance regarding food safety, as outlined in Table 5.

### *Meat: Cooking and Preserving*

#### *Should I Avoid Meats?*

Several epidemiologic studies have linked high consumption of red and processed meats with an increased risk of colorectal, prostate, and stomach cancers.<sup>305,309-311</sup> Some research suggests that frying, broiling, or grilling meats, particularly meats that are higher in fat and poultry with skin, at very high temperatures creates chemicals called heterocyclic amines that have been shown to be carcinogenic. For these reasons, the ACS guidelines on nutrition and physical activity for cancer prevention recommend limiting the consumption of processed and red meats and

discourage the practice of cooking these and other higher fat sources of protein at high temperatures. This recommendation may also be applied to cancer survivors for the promotion of general good health, although currently, there is no evidence available regarding the effect of processed meat, meat cooked at high temperatures, or meat in general on cancer recurrence or progression.

### Obesity

#### *Does Being Overweight Increase the Risk of Cancer Recurrence and Second Primary Cancers?*

Increasing evidence indicates that being overweight or obese increases the risk of recurrence and reduces the likelihood of survival for many cancers.<sup>63,76</sup> Overweight and obesity are also associated with increased death rates for all cancers combined.<sup>55,234</sup> Because of other proven health benefits to losing weight, people who are overweight should be encouraged to achieve and maintain a healthy weight. 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>49,51,52</sup>

### Organic Foods

#### *Are Foods Labeled Organic Recommended for Cancer Survivors?*

The term *organic* is used to describe foods grown without pesticides and genetic modifications or meat, poultry, eggs, and dairy products obtained from animals that are given no antibiotics or growth hormones. The use of the term *organic* on food labels and packaging is regulated by the US Department of Agriculture to meet these and other criteria. It has been suggested 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 that of their conventionally grown counterparts. Whether this translates into health benefits from the consumption of organic foods is unknown. At present, no epidemiologic studies in humans exist to demonstrate whether such foods are more effective in reducing cancer 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 not only that exercise is safe and feasible during cancer treatment, but also that it can improve physical functioning and various aspects of quality of life. Moderate exercise has been shown to improve fatigue, anxiety, and self-esteem as well as cardiovascular fitness, muscle strength, and body composition.

Patients receiving chemotherapy and radiation therapy who already exercise may need to temporarily do so at a lower intensity and/or shorter duration compared with individuals who are not receiving cancer treatment. The principal goal should be to maintain activity as much as possible and increase levels after treatment has been completed.

#### ***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 of 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 gyms and other public places until their white blood cell counts return to safe levels, and survivors undergoing radiation should avoid swimming pools because chlorine exposure may irritate irradiated skin. For those individuals who were sedentary before diagnosis, light-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 of falls and injuries.

#### ***Can Regular Exercise Reduce the Risk of Cancer Recurrence?***

While not studied in every cancer type, over 20 observational studies have examined the impact of physical activity on cancer recurrence, cancer-related mortality, and overall mortality. The research to date has been primarily limited to survivors of breast, colorectal, prostate, and ovarian cancers. These studies demonstrate that higher levels of postdiagnosis physical activity are associated with a lower risk of disease recurrence and improved survival. While this research has demonstrated promise toward a direct effect of exercise on the progression of cancer, further research is needed, including randomized controlled trials. Nonetheless, physical activity has a beneficial effect on preventing cardiovascular disease, diabetes, and osteoporosis in the general population that presumably would translate to cancer survivors.<sup>55,114</sup> Therefore, cancer survivors should be encouraged to adopt a physically active lifestyle.

#### ***Is Yoga Beneficial to Cancer Patients and Survivors?***

Yoga has been studied in multiple intervention trials, primarily testing its impact on health-related outcomes in women with breast cancer. A recent meta-analysis demonstrated that yoga significantly improves psychological health outcomes, including anxiety, depression, distress, and stress.<sup>312</sup> While yoga appears to have an impact on psychosocial function, the benefits related to body composition, fitness, and muscle strength are less evident.

A combination of yoga with aerobic exercise and resistance training should be considered to maximize the benefit for cancer survivors, although more research still needs to be conducted.

### **Phytochemicals**

#### ***What Are Phytochemicals, and Do They Reduce Cancer Risk?***

The term *phytochemicals* refers to a wide variety of biologically active compounds in plants. Some have either antioxidant or hormone-like actions both in plants and in individuals who eat them.<sup>47</sup> Studies examining the effects of phytochemicals or selected 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. There is no evidence that phytochemicals taken as dietary 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 and soy-derived foods are an excellent source of protein and, for this reason, 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 in soy foods have antioxidant properties and may have anticancer activities. 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>313-316</sup>

For the breast cancer survivor, current evidence suggests no adverse effects on recurrence or survival from consuming soy and soy foods, and there is the potential for these foods to exert a positive synergistic effect with tamoxifen.<sup>208</sup>

### **Sugar**

#### ***Does Sugar “Feed” Cancer?***

No. Sugar intake has not been shown to directly increase the 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 added sugar do not contribute many nutrients to the diet and often replace more nutritious food choices. Therefore, limiting the consumption of foods and beverages with added sugar is recommended.



## Supplements

### *Would Survivors Benefit From Using Vitamin and Mineral Supplements?*

Survivors are strongly encouraged to obtain their needed nutrients through foods, as opposed to supplements. While dietary supplements are indicated in cases of nutrient deficiency (either that which is confirmed through laboratory testing or through the clinical presence of disease [eg, osteoporosis or osteopenia]), given the growing literature on the adverse effects of nutritional intake beyond normal levels,<sup>161,317</sup> a concern exists that supplements may do more harm than good.

### *Can Dietary Supplements Lower Cancer Incidence or the Risk of Recurrence?*

There is no evidence at this time that dietary supplements can reduce the risk of recurrence or improve the likelihood of survival.

## Vegetables and Fruits

### *Will Eating Vegetables and Fruits Lower the Risk of Cancer Recurrence?*

A 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 cancers.<sup>47,318</sup> Few studies exist, however, on whether a diet high in vegetables and fruits can reduce the risk of cancer recurrence or improve survival, although some recent studies suggest increasing the intake of vegetables may exert a beneficial effect on recurrence or survival for breast, prostate, and ovarian cancers.<sup>140,141</sup> Nonetheless, consistent with the *2010 Dietary Guidelines for Americans*,<sup>46</sup> cancer survivors should be encouraged to consume at least 2 to 3 cups of vegetables and 1.5 to 2 cups of fruits each day because of their health benefits. Because it is not known which of the many compounds in vegetables and fruits may be the most protective, the best advice is to consume plenty 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 depending on availability, economics, and ability to prepare food. Fresh foods are usually considered to have the most nutritional value. Often, however, 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 the 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>319</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. Frozen and canned food may cost less to consume at certain times of the year.

### *Does Cooking Affect the Nutritional Value of Vegetables?*

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 the absorption of others. For example, the carotenoids are better absorbed from cooked vegetables than from raw 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 individuals 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 those who may be immunocompromised, such as cancer patients undergoing chemotherapy.

## Vegetarian Diets

### *Do Vegetarian Diets Reduce the Risk of Cancer Recurrence?*

No studies have demonstrated that 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>320</sup> and are consistent with the ACS guidelines on nutrition and physical activity for the prevention of cancer.

## Water and Other Fluids

### *How Much Water and Other Fluids Should I Drink?*

Many symptoms of fatigue, lightheadedness, xerostomia, bad taste in the mouth, and nausea can be due to dehydration; survivors should therefore be encouraged to try to remain adequately hydrated. This is particularly important if they are experiencing unexpected losses through vomiting and diarrhea. Assuming no contraindications, a daily water intake of 3.7 liters for men and 2.7 liters for women meets the needs of most adults.<sup>321</sup> Notably, about 80% of that water is typically obtained from foods. If achieving adequate hydration is difficult, survivors should speak to their medical doctor regarding intravenous hydration.

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