

Dietary Supplement Use in Adult Cancer Survivors

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During the post-acute care stage, cancer survivors may initiate diet, physical activity, and other lifestyle changes in an attempt to prevent recurrence or chronic disease or to improve overall health and quality of life (Demark-Wahnefried, Aziz, Rowland, & Pinto, 2005). Complications or consequences related to cancer treatment also may provide the impetus for health-related behavior change. Despite limited scientific data available regarding the role of dietary supplements in promoting health and preventing cancer recurrence or secondary cancers (Brown et al., 2003), one of the most common behavior changes among survivors is the use of dietary supplements.

According to the U.S. Dietary Supplement and Health Education Act (DSHEA) (1994), dietary supplements include products containing vitamins and minerals as well as herbs or other botanicals, amino acids, glandular extracts, or other non-nutrient ingredients. Under the DSHEA, dietary supplements are not required to undergo prescreening or safety and efficacy studies prior to production and marketing by manufacturers (Larsen & Berry, 2003). In addition, since the passage of the DSHEA, the use of dietary supplements has increased, with the sharpest growths noted in the non-nutrient and antioxidant sectors (Wold et al., 2005). The rise in dietary supplement use is of particular concern because cancer survivors appear more likely to use dietary supplements compared to the general U.S. adult population. In contrast to a prevalence rate of approximately 50% in the general population, prevalence rates range from 64%–81% among cancer survivors (Velicer & Ulrich, 2008).

Several potentially beneficial roles for dietary supplements have been suggested. A daily multivitamin or multimineral supplement supplying nutrient doses at or below recommended intake levels (Institute of Medicine [IOM], 1997, 2000, 2001, 2004) generally is considered safe by physicians, other healthcare professionals, and the research community (Norman et al., 2003). Furthermore, guidelines recently issued by the World Cancer Research Fund and the American Institute for Cancer Research (2007) suggested that select vitamins and minerals from dietary supplements, such as calcium

Purpose/Objectives: To assess dietary supplement use and its association with demographic and health-related characteristics among cancer survivors and to investigate differences in supplement use patterns by cancer site.

Design: A cross-sectional survey.

Setting: Computer-assisted telephone survey.

Sample: 1,233 adult (ages 30–69) survivors participating in the Penn State Cancer Survivor Study who underwent an interviewer-administered questionnaire.

Methods: Descriptive statistics with multivariate logistic regression to determine demographic, disease, and health-related predictors of supplement use.

Main Research Variables: Use of dietary supplements and types of supplements taken.

Findings: Supplement use ranged from 50% among blood cancer survivors to 85% among melanoma skin cancer survivors, with an overall prevalence rate of 73%. Multivariate logistic regression revealed statistically significant associations (p values < 0.05) between supplement use and older age ($\geq$ age 50), higher levels of education and physical activity, female gender, lower body mass index, and white ethnicity.

Conclusions: Overall, a wide variety of supplements were reported, although multivitamins, calcium and vitamin D combinations, and antioxidant vitamin combinations were the most prevalent. Seventy-eight percent of supplement users took more than one supplement.

Implications for Nursing: The findings support continued efforts by oncology nurses to identify the types of supplements cancer survivors are using. Nurses should caution against the use of individual supplements as well as combinations of different supplements containing nutrient quantities above recommended daily intake levels. Furthermore, oncology nurses and other healthcare professionals should be receptive to questions and prepared to initiate conversations with patients about their use of dietary supplements.

and selenium, may decrease risk of certain cancers. On the other hand, a growing body of evidence suggests that the use of antioxidant supplements, namely beta-carotene and vitamins A and E, may pose health-related risks (Bjelakovic, Nikolova, Gluud, Simonetti, & Gluud, 2007). Coupled with the increasing prevalence of fortified foods, supplemental intake of vitamins and minerals could result in nutrient intake surpassing

the tolerable upper-intake levels established by IOM. Overall, very little is known concerning the efficacy and safety of most dietary supplements (Mulholland & Benford, 2007).

Characterizing supplement use patterns is an important step in accurately evaluating the associated health benefits and risks. The specific aims of the current study were to assess dietary supplement use and its association with demographic and health-related characteristics among cancer survivors and to investigate differences in supplement use patterns by cancer site. A clear understanding of supplement use by cancer site is essential for the guidance of scientific research and the development of firm guidelines for cancer survivors concerning the use of various dietary supplements. The findings will highlight the types of supplements most commonly used by survivors of various cancer types as well as the characteristics of survivors more likely to use them. The information may be particularly valuable to oncology nurses, who are in an excellent position to initiate conversations with patients and provide education related to dietary supplement use (Lengacher et al., 2002).

Methods

Study Sample and Design

All cases diagnosed with a first cancer from 1997–1999 were identified from tumor registries in central and northeastern Pennsylvania (Geisinger Medical Center, Hershey Medical Center, and Lehigh Valley Hospital) and Baltimore, MD (Johns Hopkins Medical Center). Detailed descriptions of the Penn State Cancer Survivor Study have been published previously (Short, Vasey, & Belue, 2008). Because a main focus of the Penn State Cancer Survivor Study was employment and disability, selected cases were between the ages of 25–62 at the time of diagnosis with primary cancer other than nonmelanoma skin cancer. Cases with stage IV tumors were excluded, with the exception of stage IV leukemia, lymphoma, and plasma cell cancer because of the relatively favorable survival rates associated with those cancer sites. Men with urologic cancers (e.g., prostate cancer, testicular cancer) at Johns Hopkins were outside the administrative control of the tumor registry and, thus, were not available for contact using the recruitment tactics.

The institutional review boards at Pennsylvania State University and at each respective hospital approved the research protocol. Hospital employees were responsible for mailing recruitment packages to potential respondents ($n = 5,150$) and obtaining formal consent, verbally at three sites and in writing at one site. Potential subjects were not identified to the research team until verbal or written consent was obtained. All consenting cases ($n = 2,076$) were sent to the Survey and Epidemiology Services Division of Social and Scientific Systems, Inc., of Silver Springs, MD,

where trained interviewers conducted computer-assisted telephone interviews. Eighty-eight percent of those who consented and were eligible ($n = 1,763$) completed the first interview, and 1,233 of those participants completed all four interviews through 2004. To address the low participation rate, extensive analyses were conducted to identify characteristics that were significantly different between participants and nonparticipants. The analyses are described in greater detail in a previous publication (Short et al., 2008) and included bivariate chi-square tests and a logistic regression model predicting participation from characteristics provided by the tumor registries for eligible cases ($n = 5,150$).

Demographic, Disease, and Health-Related Characteristics

Demographic and disease-related data, including age, race, gender, date of diagnosis, cancer site, and cancer stage, were obtained from the cancer registries. Data concerning each subject at the time of interview, such as current employment, health status, health insurance, and quality of life, as well as retrospective questions ascertaining information prior to cancer diagnosis (e.g., employment, health), were collected. Body mass index (BMI) was calculated from self-reported height and weight. Participants were re-interviewed annually for three years. The fourth and final survey was administered in 2004 and included physical activity questions adapted from the National Health Information Survey (National Center for Health Statistics, 2008b). Data pertaining to frequency, intensity, and length of time spent performing various subcategories of exercise were collected. Light or moderate activities were described to participants as those resulting in light sweating or a slight to moderate increase in breathing or heart rate, whereas vigorous activities produced heavy sweating or large increases in breathing or heart rate.

Dietary Supplements

Questions pertaining to the use of dietary supplements were administered during the final survey in 2004 with a questionnaire adapted from the National Health and Nutrition Examination Survey (National Center for Health Statistics, 2008a). The questionnaire captured information on the use of 34 specific dietary supplements, with additional open-ended questions regarding the use of other combination vitamin or mineral supplements, single-ingredient vitamin or mineral supplements, or alternative preparation or herbal remedy not mentioned specifically in the questionnaire. Data pertaining to frequency of supplement use (e.g., at least once per week during the prior month), duration of use (e.g., more or less than one year) and initiation of use (e.g., before or after cancer diagnosis) were obtained. For the analyses, certain individual supplements were collapsed

into broader categories after the supplement data were collected. The category of antioxidants included any supplement containing one or more of the following antioxidant nutrients taken either in combination or alone: beta-carotene; vitamins A, C, or E; and any antioxidant vitamin combination supplements. The category of calcium and vitamin D included single calcium, calcium-containing antacids, calcium combination supplements, and single vitamin D.

Data Analysis

Participants who reported the use of one or more dietary supplements at least once per week during the prior month were defined as supplement users. Differences between supplement users and nonusers with respect to demographic, disease, and health-related characteristics first were evaluated using bivariate chi-square analyses. Characteristics significantly associated with supplement use ($p < 0.05$) from bivariate chi-square analyses then were entered as candidate predictor variables in multivariate logistic regression analysis to determine significant predictors of use among cancer survivors. Logistic regression analysis was chosen because the outcome variable of supplement use was dichotomous (use or nonuse). Independent variables included in the final logistic regression model were age, BMI, education, ethnicity, gender, and physical activity level ($p < 0.05$). All data were analyzed using the Statistical Analysis Software Package 9.1.3; a two-tailed alpha level of 0.05 was employed for all statistical tests.

Results

Sample Characteristics

A total of 1,233 cancer survivors completed the final survey that included dietary supplement and physical activity questions. Results from bivariate chi-square analyses revealed a greater proportion of the remaining sample to be Caucasian and to have higher reported incomes compared to the 530 individuals who did not complete the entire study. No other significant differences were found with respect to the demographic, disease, and health-related characteristics investigated. Findings from the logistic regression model predicting participation revealed significant differences in cancer site, facility, gender, and race between participants and nonparticipants (Short & Mallonee, 2006; Short et al., 2008). For example, female Caucasian breast cancer survivors comprised approximately one-third of the total sample.

The following cancer sites were represented in the final sample: blood ($n = 58$), breast ($n = 406$), central nervous system ($n = 35$), colorectal ($n = 70$), head and neck ($n = 41$), lymphoma ($n = 31$), prostate ($n = 115$), respiratory ($n = 42$), melanoma skin ($n = 42$), thyroid ($n =$

94), urinary ($n = 42$), uterus ($n = 84$), other ($n = 135$), and unknown ($n = 38$). Age at the last interview in 2004 ranged from 30–69, with a mean respondent age of 55. Study participants were predominately Caucasian (94%) and female (67%). Time since primary cancer diagnosis ranged from four to eight years, with a mean of six years. Within the sample, 44% had stage I tumors at diagnosis, 32% stage II tumors, 13% stage III tumors, and 7% stage IV tumors; the remaining 3% of cases had an unknown or unrecorded tumor stage at diagnosis.

Although 90% of survivors reported performing at least 10 minutes of light, moderate, or vigorous activity each week, slightly more than half reported no activity resulting in heavy sweating or large increases in breathing or heart rate. More than two-thirds of the sample was overweight ($\text{BMI} \geq 25 \text{ kg/m}^2$), and 28% were obese ($\text{BMI} \geq 30 \text{ kg/m}^2$). Additional demographic, disease, and health-related characteristics of the sample are provided in Table 1.

Supplement Use

Dietary supplement use was common in the current study, with 900 cancer survivors (73%) reporting the use of at least one supplement once per week during the previous month. Almost half of participants began the use of a new supplement after cancer diagnosis. Prevalence of use ranged greatly by cancer site, from a low of 50% among blood cancer survivors to a high of 85% among melanoma skin cancer survivors. Among individuals who reported the use of dietary supplements, 78% took more than 1 supplement, and 20% used more than 5, with a range of 1–17 different supplements taken at least once or more each week.

Specific Dietary Supplements Reported

Participants in the current study reported a wide variety of dietary supplements. Figure 1 shows the frequency of use of specific dietary supplements according to cancer site. The most prevalent supplements were multivitamin or multimineral products (62%), antioxidants (40%), calcium or vitamin D (40%), and herbal preparations (21%). Prevalence rates of specific supplements reported varied greatly by cancer site; for instance, 22% of blood cancer survivors reported the use of an antioxidant supplement compared to 51% of colorectal cancer survivors, whereas prevalence of calcium and vitamin D use ranged from 17% of blood cancer survivors to 56% of breast cancer survivors. Use of any herbal preparation ranged from 9% among central nervous system cancer survivors to 33% of urinary cancer survivors, with an overall prevalence rate of 21% among all survivors. The most commonly reported single mineral, vitamin, and herbal supplements were calcium (20%), vitamin E (22%), and glucosamine (8%), respectively.

Table 1. Demographic Characteristics, Disease Stage, and Health-Related Indicators of Supplement Users Compared to Total Sample

Characteristic	All Respondents (N = 1,233)		Participants Reporting Supplement Use (N = 900)	
	$\bar{X}$	SD	$\bar{X}$	SD
Years since diagnosis	6.03	0.97	6.06	0.99
Characteristic	n	%	n	%
Age (years)				
≤ 50	339	27	219	65*
> 50	894	73	681	76*
Gender				
Female	822	67	631	77*
Male	411	33	269	65*
Ethnicity				
Caucasian	1,148	94	848	74**
Non-Caucasian	82	6	49	60**
Education				
Less than high school	58	5	31	53*
High school	384	31	271	71*
Some college or bachelor's degree	528	43	390	74*
Graduate or professional degree	261	21	206	79*
Annual household income				
< 100% federal poverty level	36	3	17	47**
> 100%–400% federal poverty level	257	21	179	70**
> 400% federal poverty level	690	56	518	75**
Unreported	250	20	186	74**
Tumor stage				
I	545	44	406	75***
II	400	32	296	74***
III	163	13	126	77***
IV ^a	87	7	53	60***
Unknown	36	3	19	53***
Body mass index (kg/m²)				
< 25	424	34	332	78**
25–30	454	37	327	72**
≥ 30	355	29	241	68**
Perceived health				
Excellent or good	1,050	85	783	75**
Fair or poor	180	15	114	63**
Exercise				
No weekly exercise	115	9	74	64***
0–1 hour per week ^b	751	61	542	72***
> 1 hour per week ^b	367	30	284	77***

* $p < 0.001$; ** $p < 0.01$; *** $p < 0.05$

^a Includes stage IV leukemias, lymphomas, and plasma cell cancers only

^b Refers to exercise producing heavy sweating or large increases in breathing or heart rate

Note. Because of rounding, not all percentages total 100. Because of missing data, not all n values total the sample size.

Characteristics Associated With Supplement Use

Bivariate chi-square analyses revealed statistically significant differences between dietary supplement users and nonusers with regard to age, BMI, cancer site, education, ethnicity, gender, measures of income, perceived health, physical activity level, and tumor stage. Subjects with higher levels of educational attainment, income, and vigorous physical activity were progressively more

likely to use dietary supplements, as were those with a lower BMI. Older age (> 50 years), female gender, and Caucasian ethnicity were positively associated with dietary supplement use. A total of 79% of cancer survivors with a professional or graduate degree used dietary supplements compared to 53% of individuals with less than a high school education ($p < 0.001$).

As shown in Table 2, multivariate logistic regression revealed older age, lower BMI, Caucasian ethnicity, female gender, higher levels of educational attainment,

and higher levels of physical activity as statistically significant positive predictors of dietary supplement use. The study found survivors ages 50 or older to be almost twice as likely to use supplements compared to younger survivors (95%, confidence interval [CI] = 1.48–2.61). Women were 1.87 times (95%, CI = 1.41–2.47) as likely to use supplements, and non-Caucasians compared with Caucasians were 40% less likely (95%, CI = 1.11–2.87). Individuals who were obese were 35% less likely to take supplements compared to those who were at a healthy weight (95%, CI = 0.46–0.91). With less than a high school education as the reference, a high school degree (odds ratio [OR] = 1.81, 95%, CI = 1.00–3.25), some college education, or a bachelor's degree (OR = 2.11, 95%, CI = 1.18–3.77) or graduate or professional education (OR = 2.68, 95%, CI = 1.43–5.03) were statistically significant predictors of supplement use. Additionally, individuals reporting greater than one hour of vigorous physical activity each week were 1.73 times more likely to use supplements compared to individuals reporting no weekly physical activity (95%, CI = 1.07–2.80).

Discussion

In the sample of 1,233 cancer survivors, a majority (73%) reported taking dietary supplements, ranging from 50% among blood cancer survivors to 85% among melanoma skin cancer survivors. The prevalence rate

observed is comparable to other estimates of supplement use among cancer survivors (Velicer & Ulrich, 2008) but considerably higher than estimates of supplement use among the general population. Radimer et al. (2004) reported that only 52% of healthy adults ages 20 and older reported the use of dietary supplements. The observation of greater prevalence of use among cancer survivors has been reported previously (Rock, 2007); however, few studies have investigated supplement use within a large cohort of survivors of various cancer sites.

The volume of supplements taken by participants in the current study was highly variable, ranging from 1–17 formulations, with a mean value of three. Seventy-eight percent of supplement users reported taking more than one formulation, which is considerably greater than estimates among healthy adult supplement users ages 20 and older (47%) (Radimer et al., 2004). Furthermore, 28% of supplement users in the current study reported the regular use of at least five dietary supplements.

Similar to findings from other surveys and studies (Velicer & Ulrich, 2008), data from the current study suggest that supplement use is associated with several demographic, disease, and health-related characteristics. Therefore, supplement use may serve as a marker for other health-related behaviors evidenced by higher levels of physical activity and lower prevalence rates of obesity among supplement users. The clustering of healthier lifestyle behaviors observed in the current

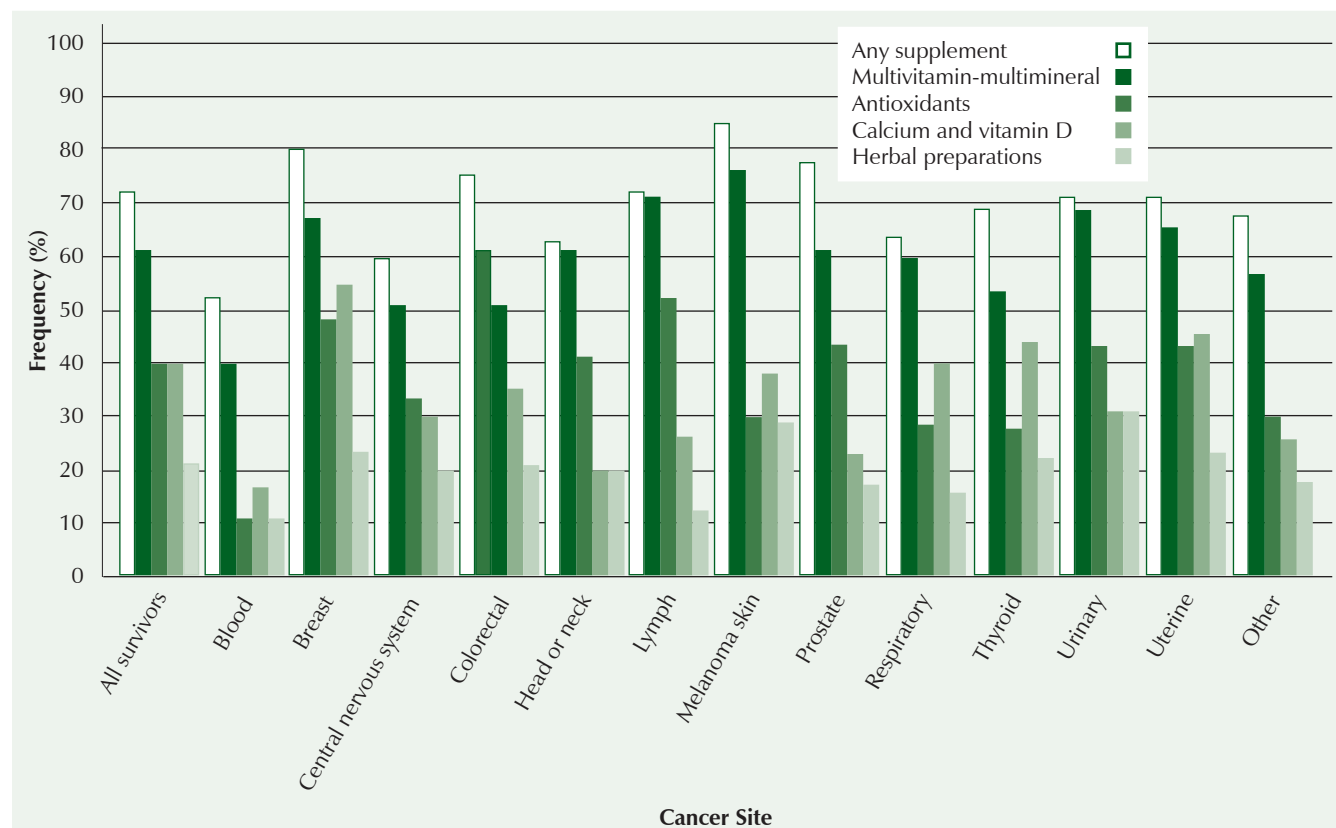


Figure 1. Most Commonly Reported Dietary Supplements According to Specific Cancer Site

Table 2. Factors Predicting Dietary Supplement Use in Multivariate Logistic Regression

Characteristic	Odds Ratio ^a	95% Confidence Interval
Age (years)		
≤ 50	1.000	
> 50	1.970	1.48, 2.61
Gender		
Male	1.000	
Female	1.870	1.41, 2.47
Ethnicity		
Caucasian	1.000	
Non-Caucasian	0.600	0.40, 0.98
Education		
< High school	1.000	
High school	1.810	1.00, 3.21
Some college or bachelor's degree	2.110	1.18, 3.77
Graduate or professional degree	2.680	1.43, 5.03
Body mass index (kg/m²)		
< 25	1.000	
25–30	0.840	0.60, 1.16
≥ 30	0.650	0.45, 0.91
Exercise		
No weekly exercise	1.000	
0–1 hour per week ^b	1.350	0.87, 2.08
> 1 hour per week ^b	0.026	

^a Risk estimates adjust for all other covariates presented in table.

^b Refers to exercise producing heavy sweating or large increases in breathing or heart rate

study and others should be considered in future studies because it may confound findings supporting a beneficial role of dietary supplements in promoting health and preventing cancer recurrence, secondary cancers, and other chronic disease. The observed associations between demographic and lifestyle characteristics and dietary supplement use highlight the need to use caution when interpreting results of observational studies relating dietary supplement use to health outcomes.

In the sample, multivitamin and multimineral supplements were the most prevalent dietary supplements, whereas calcium, vitamin E, and glucosamine were the most common single mineral, vitamin, and herbal products reported, respectively. The findings parallel those from prior investigations (Kishiyama et al., 2005; McDavid, Breslow, & Radimer, 2001; Radimer et al., 2004). In addition, the prevalence rate of herb or other botanical supplement use in the current study (21%) is comparable to other reports (Marinac et al., 2007; Norred, 2002). Despite the many differences in supplement use assessment tools as well as study samples, a consistently high and increasing prevalence of supplement use over time remains clear.

Potential health-related risks associated with dietary supplement use must be considered. Coupled with the increasing prevalence of fortified foods, supplement use may result in nutrient intakes surpassing the tolerable

upper-intake levels established by IOM. Findings from a recent meta-analysis suggest that supplementation with antioxidant vitamin and minerals, namely beta-carotene and vitamins A and E, may increase mortality (Bjelakovic et al., 2007). Although a clearer understanding of the association between antioxidant supplement use and increased mortality is needed, a few mechanisms of action have been suggested. Antioxidant supplements are synthetic, similar to pharmaceutical agents, yet are not subjected to comparably rigorous toxicity studies; furthermore, the use of antioxidant supplements may interfere with natural defense mechanisms (e.g., apoptosis, phagocytosis) (Bjelakovic et al.). The use of multiple supplements containing some of the same vitamins and minerals is of particular concern; 28% of supplement users in the sample reported the regular use of at least five different supplements, and more than 47% reported the use of both a multivitamin and multimineral supplement and at least one of the following antioxidant supplements: beta-carotene; vitamins A, C, or E; or any antioxidant vitamin combination supplement. Notably, almost 80% of cancer survivors in the study who reported taking single vitamin E also reported the use of a multivitamin and multimineral supplement.

The current study has several strengths. The size of the sample and the distribution of survivors among multiple cancer types are two notable strengths compared to previous investigations of supplement use patterns among survivors that tended to be limited to breast cancer survivors or were comprised of smaller samples (Boon et al., 2000; Fleischauer, Simonsen, & Arab, 2003; Newman et al., 1998; Patterson et al., 2002, 2003; Rock et al., 1997; Stolzenberg-Solomon et al., 2006). The use of cancer registry data is an additional strength of the study because self-reported data may underestimate cancer prevalence (McDavid et al., 2001). Furthermore, the survey contained a broad range of questions aimed at capturing the use of a variety of dietary supplements, including supplements recently suggested as having potentially adverse effects on health outcomes, such as beta-carotene and vitamins A and E.

As in all studies, the current investigation has several limitations. Subjects were asked questions pertaining to dietary supplement use and physical activity during the last of four annual interviews. Therefore, change in health behavior cannot be assessed because dietary supplement and physical activity data are not available for all 1,753 subjects who completed the baseline survey. Results from bivariate chi-square tests revealed that a greater proportion of the remaining sample was Caucasian, with higher reported annual incomes compared to the 530 individuals who did not complete the entire study. No significant gender difference in attrition rate was observed. Findings from the logistic regression model predicting participation in the study revealed significant differences in cancer site, facility, gender, and race between participants and

nonparticipants (Short & Mallonee, 2006; Short et al., 2008); therefore, female Caucasian breast cancer survivors comprised approximately a third of the total sample. As a recent review of the literature highlights (Velicer & Ulrich, 2008), female gender is one of the most consistent factors associated with supplement use; a more even distribution of participants by gender may have resulted in a lower overall prevalence rate of supplement use in the study or possibly different patterns of use. Twenty percent of the 1,233 participants who completed the final interview reported a cancer recurrence or secondary cancer ($n = 250$). Individuals with recurrent or secondary cancer were similar to cancer-free survivors with regard to age, education, ethnicity, and gender but were less likely to exercise vigorously more than one hour per week and were more likely to use dietary supplements. Lastly, caution should be used in the interpretation of the results because the current study was not designed to assess benefits or risks of dietary supplement use or the potential association of supplements and cancer recurrence or secondary cancer.

Conclusions and Implications for Nursing Practice

Dietary supplement use is prevalent among cancer survivors. Furthermore, nearly half of participants began the use of a new supplement after cancer diagnosis and a vast majority of supplement users took more than one supplement. Therefore, oncology nurses should be receptive to questions and prepared to initiate conversations with patients about their use of dietary supplements. In addition, findings from the study suggest that supplement

use may serve as a marker for a range of other health-related behaviors evidenced by higher levels of physical activity and lower levels of being overweight and obese among supplement users in the sample. Future researchers need to consider the potential confounding effects of the observed clustering of behaviors when investigating the effect of dietary supplement use on various health outcomes, including cancer recurrence among survivors. Similar to findings from other studies, supplement use was more prevalent among females, individuals with higher levels of educational attainment, and those further removed from diagnosis. Lastly, continued efforts to evaluate potentially adverse effects associated with chronically high intake of vitamins and minerals from dietary supplements among cancer survivor populations are warranted. Oncology nurses and other healthcare professionals should strongly caution against the use of individual supplements, as well as combinations of different supplements, containing nutrient quantities above daily recommended intake levels.

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