Examination of the Association of Diet and Persistent Cancer-Related Fatigue: A Pilot Study

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Persistent cancer-related fatigue (PCRF), defined as an unusual, constant, subjective sense of tiredness not relieved by rest (Morrow, 2007), is one of the most common symptoms experienced by cancer survivors (Montazeri, 2008). Rates of significant PCRF in patients with cancer range from 30%–82% within the first five years after diagnosis, and are as high as 34% in the 5–10 years after diagnosis (Bower et al., 2006). PCRF is associated with decreased quality of life (Alexander, Minton, Andrews, & Stone, 2009; Kim et al., 2008; Reid-Arndt, Hsieh, & Perry, 2009), decreased sleep quality and/or quantity (Alexander et al., 2009; Kim et al., 2008), depression (Bower, 2005), and impaired cognition (Bower, 2008). Individualized nutritional counseling has been found to be beneficial for decreasing fatigue and improving quality of life in patients with cancer receiving treatment (Ravasco, Monteiro-Grillo, & Camilo, 2007; Ravasco, Monteiro-Grillo, Vidal, & Camilo, 2005) and has been recommended by the National Comprehensive Cancer Network ([NCCN], 2012) for patients with cancer in treatment and during their long-term follow-up.

In contrast, nutritional recommendations for fatigue in cancer survivors have not been examined and no clinical guidelines have been proposed. To date, few options exist for dietary treatment of PCRF. Recommended interventions include addressing anemia and encouraging adequate protein and caloric intake (Carroll, Kohli, Mustian, Roscoe, & Morrow, 2007; Mustian et al., 2007). Growing evidence, however, suggests an inflammatory basis for chronic fatigue in cancer survivors (Bower, Ganz, Irwin, Arevalo, & Cole, 2011; Collado-Hidalgo, Bower, Ganz, Cole, & Irwin, 2006; Collado-Hidalgo, Bower, Ganz, Irwin, & Cole, 2008; Ganz & Bower, 2007). Foods such as fruits, vegetables, and fatty fish, as well as nutrients such as carotenoids, omega 3 fatty acids, and antioxidant vitamins, have been shown to decrease inflammatory

Purpose/Objectives: To examine associations between diet and persistent cancer-related fatigue (PCRF) in cancer survivors.

Design: A cross-sectional pilot study.

Setting: A university cancer center in Michigan.

Sample: 40 adult cancer survivors who were recruited from July 2007 to August 2008 and had completed all cancer treatments at least 12 weeks prior to recording their dietary intakes and fatigue severity.

Methods: Participants' fatigue was assessed with the Brief Fatigue Inventory (BFI). Based on the BFI score, participants were placed into one of three fatigue levels: no fatigue, moderate fatigue, or severe fatigue. Dietary data were collected using a four-day food diary and analyzed using Nutrition Data System for Research software. Diet data were collected during the same week that fatigue was measured.

Main Research Variables: Fatigue and dietary intake.

Findings: Mean daily intake of whole grains, vegetables, and, in particular, green leafy vegetables and tomatoes were significantly higher in the nonfatigued group compared to fatigued cancer survivors. Also, cancer survivors reporting no fatigue had significantly higher intakes of certain anti-inflammatory and antioxidant nutrients.

Conclusions: Increased consumption of whole grains, vegetables, and foods rich in certain anti-inflammatory nutrients was associated with decreased levels of PCRF. Additional rigorous studies are required to investigate possible mechanisms and causal relationships regarding the benefits of particular diets on PCRF.

Implications for Nursing: Nurses, as one of the main providers of care to cancer survivors, should continue to follow National Comprehensive Cancer Network recommendations until additional data on diet and fatigue are evaluated.

Knowledge Translation: Nurses should be aware of national guidelines for nutritional recommendations for treating cancer-related fatigue. In addition, nurses should ask about and record the cancer survivor's typical dietary intake. Referrals to registered dietitians, in accordance with national guidelines for cancer survivors, should be considered when advising a fatigued patient.

biomarkers. Those foods and nutrients could have a positive impact on chronic inflammation and, therefore, persistent fatigue in cancer survivors (Helmersson, Arnlov, Larsson, & Basu, 2009; Holt et al., 2009; Oliveira, Rodriguez-Artalejo, & Lopes, 2009; Wall, Ross, Fitzgerald, & Stanton, 2010). Another possible biologic mechanism of PCRF is dysregulation of adenosine triphosphate (ATP) production, leading to diminished muscle strength and physical fatigue (Barsevick et al., 2010). As B vitamins play a key role in various aspects of ATP production and energy metabolism (Bourre, 2006; Malouf & Grimley Evans, 2003), the authors of the current article decided to also explore the possible associations between B vitamin intake and fatigue. The authors hypothesized that cancer survivors who ate foods and nutrients rich in anti-inflammatory components and/or B vitamins would be less likely to experience fatigue or have less severe fatigue. Therefore, the purpose of this study was to investigate the association between food categories, anti-inflammatory nutrients and B vitamins, and the severity of PCRF as measured by the Brief Fatigue Inventory (BFI) (Chang et al., 2007).

Methods

The University of Michigan Medical School's institutional review board approved the study protocol and all procedures. All participants provided written informed consent.

Participants and Design

Five hundred and five cancer survivors who were participants in a previously published longitudinal trial (Zick et al., 2011) were screened from July 2007 to August 2008. Forty-three met all eligibility criteria and were entered into the study. Three participants did not complete their food records, leaving a total of 40 participants. Therefore, data from 40 participants were analyzed in this cross-sectional pilot study. Eligible participants were aged 18 years and older with a histologically confirmed diagnosis of cancer and who had completed their cancer-related treatments at least 12 weeks prior. Participants had to maintain their typical dietary patterns and be apparently cancer free as assessed by their oncologist.

Potential participants were deemed ineligible if they were diagnosed with anemia; had any comorbidities likely to cause significant fatigue; had gross nutritional deficiencies (defined by albumin levels less than 3.5 mg/dl); had a diagnosis of depression; had a thyroid disorder; had an anticipated survival of less than six months; had an initiation, a cessation, or change of dose of any chronic medications or dietary supplements; or were pregnant or lactating.

Potential participants were identified and referred to the study by their oncologist or through the referral of a nurse practitioner who ran a gynecologic cancer support group. Participants presented for a screening visit at the University of Michigan Institute of Clinical Research where a history, physical, screening blood work (complete blood count, albumin, thyroid stimulating hormone, and T4), and a list of concomitant medications were obtained; screening questionnaires (BFI, Hospital Anxiety Depression Scale [HADS]) were conducted; and a diet diary was presented to participants. Other than the BFI, these measures were used to determine a potential participant's eligibility for the study by ruling out unstable medical conditions and other causes of fatigue.

Participants also were given a four-day food record during the screening visit to be completed on Tuesday, Thursday, Friday, and Sunday of the week before they entered the study. The food records were kept on forms that enumerated the food consumed, the time of day, and the amount. Instructions on how to complete the food records were provided by a registered dietitian. All completed food records were checked for completeness, and data were entered by one trained dietetic technician throughout the entire study. The completed food records were entered into Nutrition Data System (NDS) for Research, version 2009, software. Servings of foods consumed were determined for the NDS program using the U.S. Food and Drug Administration serving sizes, which are based on the gram weight of the food. For example, a usual serving size of fruits would be a medium sized apple or orange and are about 60 kcal per serving, whereas servings of vegetables that are 1/2 cup cooked and 1 cup raw are about 25 kcal per serving.

Similar to Ball, Benjamin, and Ward's (2008) study, food groups were constructed based on the NDS's classifications. For instance, the red meat group included beef, lean beef, lamb, cold cuts and sausage, fresh pork, lean fresh pork, cured pork, lean cured pork, and lean cold cuts and sausage. Other food groups were fruits, vegetables, nuts and seeds, fish and seafood, poultry, dairy products, eggs, sweeteners, fats and oils, legumes, and grains. The grains food group was further broken down into whole and refined grains, as defined by NDS. The vegetable group was split into four subgroups, also as defined by NDS. The four subgroups were made up of dark green vegetables, deep yellow vegetables, tomatoes, and other vegetables. The average daily servings were calculated for each participant based on the four-day food diary for each of the food groups.

Participants also were asked to complete the BFI at the end of the week they completed their food records. The BFI was developed to screen patients with cancer for fatigue. The BFI assesses the severity of fatigue and

the impact of fatigue on daily functioning in patients with fatigue from cancer and cancer treatment. It has been shown to have good reliability (Cronbach alpha = 0.96) and to correlate well with other measures of fatigue (Mendoza et al., 1999). The instrument consists of a one-page fatigue assessment tool that contains nine items, each measuring the severity of fatigue on a scale from 0–10, and is calculated from the mean of completed items. A BFI score of 0–3.99 indicates no or mild fatigue, a score of 4–5.99 is considered moderate fatigue, and a score of 6 or greater is considered severe fatigue (Chang et al., 2007). Cancer survivors with any BFI score were eligible to participate in the study. To ensure that a roughly equal number of severely fatigued and moderately fatigued participants were represented, as well as nonfatigued survivors, numerous cancer survivors were screened.

Statistical Analysis

Statistical analyses were conducted using SPSS®, version 17. For continuous variables, the assumption of normality was checked using the Shapiro-Wilks test. BFI was recoded into the levels of nonfatigued, moderately fatigued, and severely fatigued. Baseline characteristics by fatigue levels are reported using means and standard deviations (SDs) for continuous variables; counts and percentages for categorical variables. Differences of baseline characteristics between nonfatigued, moderately fatigued, and severely fatigued were calculated using one-way analyses of variance (ANOVAs) for continuous variables and Pearson chi-square for categorical measures. One-way ANOVAs were used to compare the difference in average food and nutrient intakes derived from the four-day food records between the three groups. Post-hoc comparisons of the pairs nonfatigued versus moderately fatigued and nonfatigued versus severely fatigued also were conducted. A two-sided alpha of 0.05 was considered significant. As this data analysis was not planned a priori, and, therefore, was hypothesis generating, the authors did not adjust the p value for multiple testing.

Because the authors did not plan the analysis a priori, a decision was made to conduct a post-hoc power analysis to determine if the study would have sufficient power to detect differences in fatigued and nonfatigued survivors. The sample size calculation is based on a two-sample Satterhwaite t test adjusting for unequal variances.

Results

The authors present demographic, nutritional, and clinical characteristics for all 40 participants by fatigue level in Table 1. No significant differences were noted

Table 1. Baseline Characteristics of Groups by Fatigue Severity as Measured by the Brief Fatigue Inventory (N = 40)

	Nonfatigued (n = 11)		Moderately Fatigued (n = 13)		Severely Fatigued (n = 16)	
Characteristic	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Age (years)	55.5	11.2	53.3	12	58.3	12.3
Body mass index (kg/m²)	29.5	9	28.4	8.5	29.6	5.1
Months since treatment completion	37.9	35.3	36.4	47.6	44.6	49.2
Macronutrients						
Energy (kcal per day)	1,618	464	1,453	201	1,792	425
Total fat[a]	34.5	9.2	39.9	7.2	37.9	7.6
Total carbohydrates[a]	131.6	21.6	118.5	18.8	121.9	21.3
Total protein[a]	46	11	42.8	6.2	40.2	8.6
Characteristic	**n**		**n**		**n**	
Female	10		13		16	
Race						
Caucasian	11		12		15	
Native American and African American	–		1		–	
Asian	–		–		1	
Type of cancer						
Breast	6		8		8	
Gynecologic[b]	4		4		8	
Other[c]	1		1		–	
Stage of cancer						
I	5		7		11	
II	2		4		4	
III	2		1		1	
IV	2		1		–	
Treatments received for cancer[d]						
Chemotherapy	7		9		7	
Radiation	7		9		10	
Surgery	10		13		16	

[a] Grams per 1,000 kcal
[b] Includes ovarian, uterine, endometrial, and cervical cancers
[c] Includes melanoma and rectal cancer
[d] Some participants received more than one treatment.

between participants reporting no fatigue compared to those with moderate or severe fatigue for any demographic, nutritional, or clinical characteristic.

Association Between Food Groups and Fatigue

Table 2 presents the results of the associations between food groups and fatigue levels. Cancer survivors with no fatigue ate significantly more fish ($p = 0.05$), whole grains ($p < 0.01$), and vegetables ($p < 0.01$) compared to moderately fatigued cancer survivors. Similar trends were observed when comparing nonfatigued to severely fatigued cancer survivors with survivors with no fatigue eating more fish, whole grains, and vegetables; however, only the difference in vegetable consumption reached statistical significance ($p < 0.01$). Severely fatigued survivors ate more nuts and seeds ($p = 0.04$) than did cancer survivors with no fatigue. In addition, when examining vegetable group subclasses, nonfatigued cancer survivors ingested more dark green vegetables ($p = 0.05$), tomatoes ($p < 0.01$), and other vegetables ($p = 0.05$) in contrast to either severely or moderately fatigued cancer survivors, although severely fatigued survivors did not reach significance

Table 2. Examination of the Association of Food Groups and Fatigue Status (N = 40)

	Food Servings Per Day								
	Nonfatigued (n = 11)		Moderately Fatigued (n = 13)		Severely Fatigued (n = 16)				
Food Group	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	p^a (ANOVA)	p^b (ANOVA)	p^c (ANOVA)
Alcohol	0.21	0.36	0.29	0.63	0.54	0.73	0.35	0.76	0.18
Dairy	1.69	1.17	1.69	0.93	1.55	1	0.92	0.99	0.73
Eggs	0.51	0.37	0.49	0.44	0.47	0.45	0.97	0.93	0.81
Fats and oils	2.74	2.17	2.63	1.4	2.32	1.27	0.78	0.87	0.51
Fish	1.2	1.02	0.47	0.76	0.63	0.83	0.11	0.05	0.1
Fruit	2.41	2.11	0.99	1.16	2.6	2.33	0.08	0.09	0.81
Grains	4.58	2	4.2	1.11	4.49	1.79	0.84	0.59	0.89
Refined grains	2.1	0.63	1.26	0.35	1.12	0.28	0.24	0.09	0.34
Whole grains	2.04	1.3	0.61	0.85	1.38	1.14	0.01	< 0.01	0.14
Legumes	0.2	0.34	0.05	0.11	0.18	0.24	0.28	0.16	0.85
Nuts and seeds	0.27	0.3	0.53	0.74	1.1	1.44	0.1	0.54	0.04
Poultry	1.38	1.05	1.2	1.21	1.39	1.31	0.91	0.72	0.99
Red meat	1.22	0.94	1.77	1.39	1.86	1.46	0.44	0.32	0.22
Sweeteners	0.74	1.32	0.58	0.92	0.39	0.41	0.61	0.68	0.33
Vegetables	4.35	2.82	1.95	0.97	2.33	1.25	< 0.01	< 0.01	< 0.01
Dark green vegetables	0.81	0.79	0.34	0.43	0.32	0.38	0.05	0.04	0.03
Deep yellow vegetables	0.42	0.54	0.1	0.12	0.32	0.46	0.16	0.07	0.5
Tomatoes	0.67	0.43	0.34	0.17	0.27	0.19	< 0.01	< 0.01	< 0.01
Other vegetables[d]	2.19	2.21	0.88	0.64	1.15	0.87	0.05	0.02	0.06

[a] p values are for between-groups ANOVA.
[b] p values are for post-hoc ANOVA comparing nonfatigued to moderately fatigued.
[c] p values are for post-hoc ANOVA comparing nonfatigued to severely fatigued.
[d] Includes vegetables in salads, soups, stews, stir fry, and similar mixed dishes (e.g., beets, cabbage, mung bean sprouts, summer squash)
ANOVA—analysis of variance

($p = 0.06$) for the other vegetable group when compared to nonfatigued survivors. No significant differences were noted in the other vegetable subclasses. No other food groups were significantly associated with BFI.

Associations Between Nutrients and Fatigue

Associations between anti-inflammatory nutrients, B vitamins, and fatigue levels are presented in Table 3. Cancer survivors who were not fatigued ate, in general, more carotenoids, including lycopene, lutein, zeaxanthin, and alpha and beta carotene, although only alpha and beta carotene were statistically significant ($p = 0.05$ and $p < 0.01$, respectively) when compared to cancer survivors with fatigue.

The ingestion of antioxidant vitamins and minerals displayed a different pattern. Nonfatigued cancer survivors consumed significantly more vitamin C and vitamin A ($p = 0.05$ and $p < 0.01$, respectively), but no significant difference was noted in vitamin E, zinc, or selenium among the fatigue levels. When examining key essential fatty acids, no significant differences were noted in the consumption of the omega 6 fatty acids among fatigue levels.

In contrast, cancer survivors who were not fatigued consumed significantly more of two omega 3 fatty acids, eicosapentaenoic acid (EPA) and docosapenaenoic acid (DHA) ($p = 0.05$), although no significant difference was found in alpha linolenic consumption between fatigue levels.

For B vitamins, cancer survivors who were not fatigued and those who were moderately fatigued ingested more B vitamins than survivors who were severely fatigued. However, these differences were only significant for vitamin B_1 ($p = 0.03$), vitamin B_2 ($p < 0.01$), and folate ($p = 0.02$).

Range and Average Amount of Consumption of Food Groups

Table 4 presents the range and average consumption of the food groups. Except for fish (n = 21, 53%) and legumes (n = 14, 35%), 27 participants (68%) reported eating any individual food group, with 100% of participants reporting eating dairy, fats and oils, grains, and vegetables. Fruit, fats and oils, grains, and vegetables were the food groups of which participants ate the most, averaging more than two servings per day.

Post-Hoc Power Analysis

The authors conducted a post-hoc power analysis to gauge the needed sample size to detect clinically meaningful differences; a measure that would be useful for planning a future study. The authors present here the summary of such an investigation, specific to finding the differences between the severely fatigued and the nonfatigued subgroups with respect to the food groups. Based on the sample of 40 participants, an alpha of 0.05, and an effect size of 80%, the study was underpowered to detect any differences in food groups with the exception of vegetables. Future studies will include larger sample sizes.

Discussion

The authors found that their hypothesis that cancer survivors who ate foods and nutrients rich in anti-inflammatory components or B vitamins would be less likely to experience fatigue or have less severe fatigue was partially supported. In particular, the authors determined that consuming fish, whole grains, and vegetables was associated with an absence or lower fatigue severity. Eating a wide variety of vegetables also appeared to be associated with lower levels or lack of fatigue, as all of the subgroups of vegetables were significantly associated with lack of fatigue except for deep yellow vegetables. Several anti-inflammatory or antioxidant nutrients were correlated with less fatigue, specifically beta and alpha carotene, vitamin C, vitamin A, and the omega 3 fatty acids DHA and EPA. Other anti-inflammatory nutrients had no association with fatigue level. Those nutrients included the other carotenoids, vitamin E, selenium, zinc, and the omega 6 fatty acids. Increased consumption of B vitamins also was noted in the nonfatigued and moderately fatigued groups, although only thiamine, riboflavin, and folate were significantly different between nonfatigued and severely fatigued survivors.

The results are in agreement with one other study that found self-reported increases in fruit and vegetable intake were significantly associated with reduced fatigue in breast cancer survivors (Alfano et al., 2009). In that study, however, survivors were simply asked "yes" or "no" if they had increased, decreased, or ate the same amount of fruits and vegetables since their cancer diagnosis (Alfano et al., 2009). Accordingly, the accuracy of any dietary changes in that study is questionable. Also lacking from Alfano et al. (2009) are details about the amount and types of fruits and vegetables associated with decreased fatigue and the effects of other food groups and/or nutrients on the presence or severity of fatigue. The current study's findings, indicating a significant association between fatigue and omega 3 fatty acid consumption, also was found in a study by Alfano et al. (2012) of 633 breast cancer survivors. Alfano et al. (2012) found a significant result between higher intakes of omega 3 polyunsaturated fatty acids (PUFAs) and decreased physical aspects of fatigue intake, as well as a significant association between a higher intake of omega 3 PUFAs and C-reactive protein, a serum marker of inflammation. In a study of 25 adult patients with melanoma by Porock et al. (2005), no association was observed between caloric or nutrient

intake and fatigue status. However, this patient sample was considerably different than the one used in the current study. Aside from being diagnosed with melanoma as compared to breast and gynecologic cancers, half of the participants were in active cancer treatment at the time of the survey and the other half were only 6–12 months post-treatment. In addition, more than 60% of the population was male and a different scale, the Schwartz Cancer Fatigue Scale, was used to collect participants' fatigue (Porock et al., 2005).

In contrast to the previous studies, the current study tested whether different types of vegetables and grains were more associated with fatigue than others. The results indicate that not all vegetables and grains were significantly associated with reductions in fatigue. In fact, only whole grains, tomatoes, miscellaneous vegetables, and dark green vegetables were associated with decreased fatigue. The preliminary results also indicate that the association between fatigue and vegetable consumption can be affected by relatively small increases in the consumption of vegetables and whole grains, with as little as one increased serving per day needed to change the association between diet and fatigue severity.

Limitations

Limitations of this study include its cross-sectional design and the small, mostly Caucasian female sample. Therefore, the design of the study only allows for a

Table 3. Nutrient Intake Per 1,000 kcal by Fatigue Severity (N = 40)

Nutrient	Nonfatigued (n = 11)		Moderately Fatigued (n = 13)		Severely Fatigued (n = 16)		p^a (ANOVA)	p^b (ANOVA)	p^c (ANOVA)
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD			
Carotenoids									
Beta carotene (mcg)	4,658.6	4,155.84	1,220.22	1,121.31	2,009.66	1,828.14	< 0.01	< 0.01	0.01
Alpha carotene (mcg)	982.01	1,159.53	183.5	210.74	525.72	706.34	0.05	0.02	0.14
Beta cryptoxanthin (mcg)	93.08	56.99	98.09	175.8	105.73	115.45	0.97	0.92	0.8
Lycopene (mcg)	3,622.68	2,354.56	2,564.58	1,479.22	2,162.34	2,318.97	0.21	0.23	0.08
Lutein and zeaxanthin (mcg)	2,640.3	2,591.98	1,447.53	2,644.07	1,047.31	860.24	0.16	0.17	0.06
Antioxidant vitamins and minerals									
Vitamin C (mg)	84.08	73.37	46.27	24.23	46.01	24.96	0.05	0.04	0.03
Vitamin E									
Alpha tocopherol (mg)	5.76	3.29	5.47	2.67	5.96	2.42	0.74	0.8	0.46
Beta tocopherol (mg)	0.24	0.1	0.26	0.19	0.32	0.25	0.58	0.82	0.34
Delta tocopherol (mg)	1.74	0.89	1.59	0.69	1.63	0.94	0.89	0.65	0.72
Gamma tocopherol (mg)	6.88	2.22	6.76	2.3	6.85	2.17	0.99	0.89	0.97
Vitamin A activity (IU)	9,994.54	7,818.95	3,360.96	1,985.46	4,566.36	3,638.37	< 0.01	< 0.01	< 0.01
Selenium (mcg)	64.23	12.21	58.61	12.07	55.25	11.67	0.17	0.26	0.06
Zinc (mg)	6.77	4.24	6.99	3.16	5.31	1.55	0.27	0.86	0.22
Fatty acids									
Omega 3 fatty acids									
Alpha linolenic (mg)	951.38	282.84	771.14	306.59	113.37	223.81	0.25	0.11	0.19
Eicosapentaenoic (mg)	91.11	136.92	20.32	31.57	30.47	37.16	0.05	0.03	0.05
Docosapenaenoic (mg)	28.84	30.73	9.33	91.93	13.45	146.52	0.05	0.02	0.05
Omega 6 fatty acids									
Linoleic (mg)	6,865.46	1,983.97	7,305.52	5,716.61	7,551.98	1,537.95	0.71	0.61	0.41
Arachidonic (mg)	87.59	39.6	81.07	24.77	68.43	27.94	0.27	0.61	0.12
B vitamins									
Thiamine (B_1) (mg)	1.07	0.54	1	0.29	0.78	0.14	0.07	0.59	0.03
Riboflavin (B_2) (mg)	1.38	0.42	1.32	0.35	1.03	0.19	0.01	0.64	< 0.01
Niacin (B_3) (mg)	14.92	6.9	14.09	5.57	11.57	2.93	0.22	0.69	0.1
Pantothenic acid (B_5) (mg)	4.11	2.4	3.62	2.08	2.8	0.63	0.16	0.49	0.06
Pyrodoxine (B_6) (mg)	1.32	0.6	1.28	0.57	1.01	0.33	0.21	0.85	0.12
Cobalamine (B_{12}) (mcg)	3.37	1.66	3.37	1.67	2.84	1.82	0.64	0.99	0.44
Folate (B_9) (mcg)	297.57	147.44	268.79	81.76	204.41	55.8	0.05	0.5	0.02

[a] p values are for between-groups ANOVA.
[b] p values are for post-hoc ANOVA comparing nonfatigued to moderately fatigued.
[c] p values are for post-hoc ANOVA comparing nonfatigued to severely fatigued.
ANOVA—analysis of variance

preliminary investigation into the association between diet and foods and PCRF, and does not allow the authors to confirm any causal relationship between diet and fatigue. However, despite the data being very preliminary, this investigation is the first to examine this population and the results could encourage others to more rigorously investigate dietary interventions for this population.

This study was limited by the study design and outcome measures collected as part of the longitudinal trial, which was not primarily designed to investigate an association between diet and fatigue. In particular, the lack of a measurement of physical activity among study participants was a limitation. Exercise has been shown to significantly decrease persistent fatigue in cancer survivors (Fong et al., 2012). Healthy behaviors such as exercising and eating a healthy diet are highly correlated with one another. Consequently, the association between decreased fatigue severity and components of a healthy diet could be explained by differing physical activity levels instead of differences in diet. Future studies would benefit from the addition of validated measures of physical activity. This study also measured diets using diet records as compared to food frequencies questionnaires (FFQs). That could be seen as a major limitation because FFQs generally are developed to capture typical eating patterns within a population through time. Whether four-day diet records reflect usual dietary intake is relatively unknown. However, data comparing the Block FFQs and four-day diet records in women at high risk for developing breast cancer found that mean energy, fat, fruit, and vegetable intakes by these two methods were similar in women both at baseline and after an intervention that increased fruit and vegetable consumption and decreased fat intakes (Radakovich et al., 2006). An underreporting of total calories in every fatigue level also may have occurred, with an average reported intake of 1,621 kcal per day, which is rather low, particularly with body mass index levels averaging about 29. An underreporting of energy intake in obese individuals often occurs when using four-day food records (Pietilainen et al., 2010). That would be of particular concern if differences across fatigue levels appeared. However, an underreporting across all three fatigue levels was apparent. Particular attention should be taken with any future studies to ensure that under- or over-reporting does not lead to inaccurate associations between diet and fatigue.

Conclusions

In summary, decreased PCRF in cancer survivors is associated with a modest daily increases in whole grains and vegetable consumption. Certain key nutrients involved in cellular energy production or having anti-inflammatory properties such as omega 3 fatty acids also are associated with lower levels of fatigue in the current study's sample of cancer survivors. Because the results are preliminary and not causal in nature, no dietary recommendations for treating fatigue should be drawn from them. Healthcare providers working with cancer survivors should instead continue to recommend the nutritional guidelines provided by the NCCN (2012) and the American Cancer Society (Kushi et al., 2012).

Future larger and more rigorous studies will be required to investigate possible mechanisms and causal relationships as well as to establish a solid scientific evidence base regarding the benefits of particular foods or diets on PCRF. In addition, studies in more diverse cancer populations will be needed to determine if foods and/or particular nutrients also may be associated with PCRF.

Implications for Nursing Practice

Intervention studies are needed to determine whether and what type of diet would be effective in treating chronically fatigued cancer survivors. That information is, to date, unavailable and makes dietary recommendations for these patients difficult. Studies also are needed to explore what population (i.e., men compared to women) would benefit from dietary interventions for

Table 4. Range and Average Amount of Consumption of Food Groups (N = 40)

Food Group	Participants Who Ate Food	Servings Per Day		
		$\bar{X}$	SD	Range
Dairy	40	1.63	1	0.29–4.34
Eggs	33	0.49	0.41	0–1.5
Fats and oil	40	2.53	1.57	0.71–8.39
Fish	21	0.73	0.9	0–2.72
Fruit	36	2.02	2.04	0–7.33
Grains	40	4.42	1.63	1.91–8.52
Whole grains	36	1.31	1.21	0–4.59
Refined grains	40	3.12	1.5	0.61–6.87
Legumes	14	0.14	0.25	0–0.88
Nuts and seeds	27	0.69	1.06	0–5.29
Poultry	33	1.33	1.18	0–4.03
Red meat	36	1.66	1.31	0–4.82
Sweeteners	36	0.55	0.89	0–4.39
All vegetables	40	2.76	1.99	0.42–11.36
Dark green vegetables	30	0.46	0.56	0–2.02
Deep yellow vegetables	30	0.28	0.42	0–1.64
Tomatoes	38	0.4	0.32	0–1.28
Other vegetables[a]	40	1.35	1.4	0.06–8.34

[a] Includes vegetables in salads, soups, stews, stir fry, and similar mixed dishes (e.g., beets, cabbage, mung bean sprouts, summer squash)

fatigue and when dietary recommendations are most needed. In addition, nurses should be aware of current national dietary guidelines for treating cancer-related fatigue and be aware if the guidelines apply to patients with cancer in active treatment, cancer survivors, or in patients in palliative care settings. Each of these groups has potentially unique dietary requirements and causes of fatigue.

Nurses also should be trained in several methods for collecting dietary information from cancer survivors and how to translate the dietary knowledge obtained from these methods into clinically relevant information. Communication with and appropriate referrals to dietitians also should be emphasized to facilitate successful dietary changes for cancer survivors, particularly those who have comorbidities such as diabetes or obesity.

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