INTAKE OF PLANT FOODS, ALCOHOLIC BEVERAGES, 
AND NONNUTRITIVE SWEETENERS IN 
POSTMENOPAUSAL BREAST CANCER SURVIVORS 

by 

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(Under the Direction of Mary Ann Johnson) 

ABSTRACT 

Differences in consumption of selected plant based foods, nutrients, alcohol, and nonnutritive sweeteners in postmenopausal breast cancer survivors (survivors, n = 13) and postmenopausal women without breast cancer (controls, n = 71) were determined. Women were from northeast Georgia [n = 84, 95% white, mean (SD) age = 58.5 (3.8) y, BMI = 26.0 (4.6)]. Three-day diet records were analyzed (University of Minnesota’s Nutrition Data System for Research). Compared to controls, survivors consumed significantly more legumes, non-citrus fruit and fruit juices, carbohydrates (% of energy, g/1000 kcal/d, all P < 0.05), dietary folate equivalents (g/1000 kcal/d, P = 0.03), and fiber (g/1000 kcal, P = 0.06), but significantly less sucralose (a nonnutritive sweetener), wine, and alcohol (% of energy, all P < 0.05). Although there is no evidence that nonnutritive sweeteners are linked to cancer in humans, findings suggest these cancer survivors are attempting to follow evidence-based recommendations for cancer prevention such as a more plant based diet with less alcohol.
INDEX WORDS: Women; Breast cancer; Postmenopausal; Diet; Alcohol; Nonnutritive sweeteners; Plant foods
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DEDICATION

This work is dedicated to my mother and father, Gloria and Jerry, and my husband, Ty, for their love and their support throughout this process. I could not and would not be where I am today if it were not for them. Their love and guidance have made me the person that I am today and words could not express my gratitude and love that I have for them.
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CHAPTER 1
INTRODUCTION

Cancer is the second most common cause of death in the United States (American Cancer Society 2013). However, the number of cancer survivors in the US is steadily increasing, as is the number of years they are surviving after diagnosis (Tennant et al 2012). This increase in survivorship is thought to be due to earlier detection and diagnosis, as well as improvements in treatment (American Cancer Society 2013). Breast cancer is one of the most prevalent types of cancer diagnosed, especially for women (American Cancer Society 2013). Weight control, dietary choices, and level of physical activity are considered the most important modifiable risk factors for cancer (Kushi et al 2012). Over one-third of cancer deaths in the US are thought to be attributed to diet and physical activity habits (Kushi et al 2012).

Together, postmenopausal status and breast cancer survivorship create a unique situation, which increases the importance of maintaining a healthy body weight (Kushi et al 2012). Obesity has been linked with several types of cancer, including breast cancer, especially in postmenopausal women (Demark-Wahnefried et al 2012). There is an increased risk of breast cancer recurrence with being overweight or obese, which is likely because of the higher levels of estrogen that are produced with excess adipose tissue after menopause (Kushi et al 2012).

Some of the most recent recommendations for cancer prevention include increasing physical activity, being as lean as possible within the normal weight range, focusing on plant based foods, limiting consumption of red and processed meats, and increasing fruit and vegetable intake (Kushi et al 2012). While there has been a significant amount of evidence regarding the
relationship between plant based foods and their cancer preventing effects, attempts to isolate specific nutrients have been unsuccessful (Kushi et al 2012).

Certain fruits and vegetables, including dark green and orange vegetables, cruciferous vegetables, soy products, legumes, allium vegetables, and tomato products, are currently being researched to determine whether they have significant chemopreventive properties (Kushi et al 2012). While there are many known benefits of consuming higher quantities of fruits and vegetables, consumption remains low throughout the US, which is likely related to the lack of access to affordable produce, preparation time, and taste preferences (Kushi et al 2012).

The American Cancer Society (2012) recommends limiting consumption of alcoholic beverages in order to help prevent the development of cancer. This recommendation is a result of the findings that alcohol consumption, no matter the source, has been linked to an increased risk of developing breast cancer, particularly in postmenopausal women (Chen et al 2011). These recommendations conflict with some of the positive health effects of moderate alcohol consumption on heart health (Rock et al 2012).

There is currently no strong scientific evidence that nonnutritive sweeteners, such as saccharin, aspartame, sucralose, and acesulfame potassium, are a carcinogenic risk in humans (Weihrauch and Diehl 2003). This is partly attributed to the difficulty in determining not only whether nonnutritive sweeteners have an effect on cancer risk, but also which specific nonnutritive sweetener is attributed to the effect considering the fact that many nonnutritive sweeteners are combined in food products (Weihrauch and Diehl 2003).

Due to research findings that older adults, including breast cancer survivors, are not consuming the recommended amount of servings of fruits and vegetables per day, it should be explored further in order to better understand the nutrition education needed in this particular
population. Postmenopausal breast cancer survivors are a unique group that have many health risks that can be decreased through modifiable lifestyle factors, such as diet and physical activity. The purpose of this study was to determine the feasibility of recruiting postmenopausal breast cancer survivors to a research study in the northeast Georgia area and to determine the dietary differences between postmenopausal breast cancer survivors and their controls. The hypothesis was that postmenopausal breast cancer survivors would have a higher intake of plant based foods and lower intakes of alcohol and nonnutritive sweeteners. The specific aims were to determine the consumption of plant based food groups, alcohol, and nonnutritive sweeteners in postmenopausal breast cancer survivors and their controls.

This study explored the differences in the diets of breast cancer survivors and women with no history of breast cancer related to plant based foods, alcoholic beverages, and nonnutritive sweeteners. This study was part of a larger parent project that explored fatigue and physical function in postmenopausal breast cancer survivors (Ward 2013) and a related project that explored the differences in animal foods and nutrients related to animal foods (Lay 2014). Chapter 2 is a review of the literature about breast cancer, postmenopausal women, diet recommendations for cancer survivors and prevention, and dietary intake and the differences that have been observed in cancer survivors and their healthy counterparts. Chapter 3 includes the abstract, methods, results, discussion of the study outcomes regarding the differences in consumption of certain food groups, nutrients, alcoholic beverages, and nonnutritive sweeteners in postmenopausal breast cancer survivors in comparison to their controls. Chapter 4 is a summary of the major findings of the study. Appendix A and B include questionnaires, while Appendix C is a summary of the analyses regarding the relationships of fiber intake with fatigue, vigor, and vitality, which are related to the original hypotheses for this master’s thesis.
Menopause

Menopause is the time during a woman’s life, typically between the ages of 45 to 55 y, when menstruation ceases and other changes occur in the body (Col et al 2009). These physiological changes eventually make it no longer possible for a woman to become pregnant (Col et al 2009). During menopause, a woman’s ovaries no longer make eggs and there is a decrease in estrogen production (Col et al 2009). A woman is considered as ‘postmenopausal’ once she has not had a menstrual cycle for over a year (Col et al 2009).

There are several symptoms for a woman who is entering menopause; these include hot flashes, few or no menstrual cycles, night flashes, mood swings, and joint pain (Col et al 2009). In order to determine whether a woman is going through menopause or is postmenopausal, hormone levels, such as estradiol, follicle stimulating hormone, and luteinizing hormone, are assessed (Col et al 2009). A pelvic exam can also be used to help determine menopausal status (Col et al 2009).

Menopausal treatment includes hormone therapy, medications, and diet and lifestyle changes (Col et al 2009). Hormone therapy is accomplished through the use of estrogen and sometimes progesterone (North American Menopause Society 2010). However, there are risks that come along with the use of hormone therapy; therefore, it is not recommended for women to take part in hormone therapy for more than 5 y (North American Menopause Society 2010).
Treatment for menopausal symptoms through the use of medications include antidepressants, a blood pressure medicine known as Clonidine, and a seizure drug known as Gabapentin (Freeman et al 2011). These medications are thought to help reduce the occurrence of hot flashes and mood swings among other menopausal symptoms (Freeman et al 2011).

Diet and lifestyle changes that have been found to help alleviate menopausal symptoms include avoiding alcohol, caffeine, increasing consumption of soy-containing foods, daily exercise, kegel exercises, and yoga (Col et al 2009). The soy-containing foods are encouraged due to their phytoestrogen content (Col et al 2009).

Bone loss and osteoporosis is of great concern in women who experience menopause due to the decreased levels of estrogen (North American Menopause Society 2010). Decreased levels of estrogen are known to lead to an increased risk of fractures and bone loss (Krum and Brown 2008). This is due to estrogen’s ability to suppress production of osteoclastogenic cytokines in T-cells and osteoblasts (Krum and Brown 2008).

Breast cancer

It is estimated that in 2012 there were 13.7 million cancer survivors living in the US (de Moor et al 2013). This number is expected to increase to 18 million by the year 2022 (de Moor et al 2013). As of January 1, 2009 almost 2.8 million women have been diagnosed with breast cancer in the US (American Cancer Society 2012, National Cancer Institute 2012). In the US, over 70% of cancer deaths occur in adults who are 65 y of age and older (Currie et al 2009). Approximately 41% of cancer diagnoses in women in the year 2012 were due to breast cancer, making it the number one type of cancer in women of the US (de Moor et al 2013). Women who
have a family history of breast cancer are almost two times more likely to develop breast cancer than those who do not (American Cancer Society 2013).

According to the American Cancer Society (2012), cancer is a general name for over 100 diseases that are caused by abnormal cell growth. The cells that cause this abnormal growth become cancer cells due to the damage to their deoxyribonucleic acid or DNA (Kushi et al 2012). This damage to the DNA of the cell would be repaired in a normal cell or the cell would die, but in cancer cells, cell apoptosis does not occur and the cell continues to make new cells with the same damaged DNA (Kushi et al 2012). Cancer cells have also been found to have the ability to change the types of extracellular matrix receptors that are expressed in order to favor ones that transmit progrowth signals (Hanahan et al 2000). Metastasis occurs when cancer cells begin moving to and invading other parts of the body through the use of blood vessels and lymph vessels (Kushi et al 2012).

No matter where it metastasizes, cancer is always named for its place of origin in the body (Kushi et al 2012). The median age at the time of diagnosis for breast cancer is 61 y, with around 40% of breast cancers occurring in women over 65 y of age (de Moor et al 2013). Breast cancer is typically found through the use of routine mammograms, self-examination, or clinical examinations (Kushi et al 2012). Signs and symptoms of breast cancer include swelling in the breast, skin irritation, pain, nipple retraction, redness or thickening of the nipple, and nipple discharge that is not breast milk (Kushi et al 2012).

Stages of breast cancer

There are nine different stages of breast cancer (National Cancer Institute 2012). The first stage is Stage 0 and is carcinoma in situ, in this case there are abnormal cells present in the
breast, but they have not invaded surrounding breast tissue outside of the duct (National Cancer Institute 2012). In Stage IA, there is a breast tumor present, but it is no more than 2 cm in diameter and abnormal cell growth has not spread to the lymph nodes (National Cancer Institute 2012). In Stage IB, the tumor has not grown to be more than 2 cm in diameter, and abnormal cell growth is occurring in the lymph nodes (National Cancer Institute 2012). The tumor is no more than 2 cm in diameter and the cancer has spread to the underarm lymph nodes or the tumor is between 2 and 5 cm in diameter with no presence of abnormal cell growth in underarm lymph nodes in Stage IIA (National Cancer Institute 2012). In Stage IIB, the tumor is between 2 and 5 cm in diameter and abnormal cell growth is detected in the underarm lymph nodes or the tumor is greater than 5 cm in diameter and no abnormal cell growth is detected in the underarm lymph nodes (National Cancer Institute 2012). In Stage IIIA, the tumor in the breast is no more than 5 cm in diameter and there is abnormal cell growth in the underarm lymph nodes that are beginning to attach to surrounding tissue (National Cancer Institute 2012). The tumor can be any size, but it has grown into the chest wall, skin of the breast, or lymph nodes behind the breastbone in Stage IIIB (National Cancer Institute 2012). In Stage IIIC, the tumor is any size and it has traveled to lymph nodes located behind the breastbone and under the arm (National Cancer Institute 2012). The final stage of breast cancer is Stage IV and this is where the abnormal cell growth has metastasized to other parts of the body, such as the liver or brain (National Cancer Institute 2012).

*Breast cancer types and treatments*

The two most common types of breast cancer are ductal carcinoma and lobular carcinoma, with other types of breast cancer being a mixture of the two or a less common type
(National Cancer Institute 2012). After being diagnosed with breast cancer, there are other tests used to determine what type of treatment is appropriate, although surgery to remove part or the whole breast is the most common treatment and is typically followed by radiation (National Cancer Institute 2012). These tests include a hormone receptor test that determines whether the cancer requires estrogen, progesterone, or both to thrive (National Cancer Institute 2012). If the cancer cells are found to be receptive of these hormones, then hormone therapy will be the most likely treatment option (National Cancer Institute 2012). Another test, known as the HER2 test, determines whether the cancer cells need the protein, HER2, in order to thrive and if so, then targeted therapy is a treatment option (National Cancer Institute 2012). Targeted treatment helps to deter the action of the extra HER2 protein in cancer cells and can be given either intravenously or as a pill (National Cancer Institute 2012). Chemotherapy is another treatment option that can be given before or after surgery and it involves drugs that are given either intravenously or in a pill form that kills cancer cells (National Cancer Institute 2012). The side effects for these treatment options vary and it is important for the doctor and patient to determine the best course of action (National Cancer Institute 2012).

Cancer survivorship

Cancer survivorship is typically viewed in three different stages (Kushi et al 2012). The first stage is considered to be from diagnosis to the end of the initial treatment, the second stage is from treatment to extended survival, and the final stage is long-term survival (Kush et al 2012). Around 64% of cancer survivors were diagnosed more than 5 y ago and around 45% of cancer survivors are 70 y of age or older (Kushi et al 2012).
**Older adults and fiber intake**

Typical intakes of dietary fiber in women ages 50-59 y in the US was around 17 g/d and for women 60-69 y it was 15.6 g/d (USDA 2012). In a position paper by the American Academy of Nutrition and Dietetics (2012) it is stated that according to national surveys of dietary intake, older adults (> 60 y) consistently consume less than the recommended amount of daily dietary fiber. However, it is important that older adults stay within the carbohydrate recommendations and limit energy intake; therefore, it is recommended that in order to increase fiber intake, older adults should increase the variety of fruits, vegetables, and whole grains (American Academy of Nutrition and Dietetics 2012). It is also important to take into account the fact that some older adults can experience decreased appetites and increasing their fiber consumption can decrease their energy intake due to the feeling of satiety caused by increased fiber intake (American Academy of Nutrition and Dietetics 2012).

**Breast cancer and nutrition**

*General recommendations*

Weight control, dietary choices, and level of physical activity are considered the most important modifiable risk factors for cancer (Kushi et al 2012). Over one-third of cancer deaths in the US are thought to be due to diet and physical activity habits (Kushi et al 2012). Recommendations for improved survivorship and decreased recurrence include being as lean as possible within the normal weight range, focusing on plant based foods, limiting consumption of red and processed meats, and increasing fruit and vegetable intake (Kushi et al 2012). The American Cancer Society (2012) recommends methods such as including a variety of fruits and
vegetables at every meal and snack to help increase consumption of fruits and vegetables. (See Table 2.1 for USDA and ACS recommendations).

The American Cancer Society (2012) recommends at least 150 minutes of moderate to vigorous physical activity each week. Moderate to vigorous physical activity has been associated with a 25% decreased risk of breast cancer compared to women who are less active (Kushi et al 2012).

In a study conducted by Blanchard et al (2008), only 37.1% of the 2,885 breast cancer survivors in their study were meeting the weekly physical activity recommendation. They also found that only 18.2% of their breast cancer survivors were meeting the recommendation for fruit and vegetable consumption, which at that time, was 5 servings of fruits and vegetables per day (Blanchard et al 2008).

**Nutrition related side effects from cancer treatment**

Common side effects of cancer treatment include anorexia, early satiety, changes in taste and smell, and disturbances of the bowel (Rock et al 2012). Inadequate nutrition and malnutrition can occur due to these unwanted side effects (Rock et al 2012). This is due also in part to the fact that nutrition requirements for macro- and micronutrients are affected by the type of cancer and the stage at diagnosis due to the metabolic and physiological alterations that can occur (Rock et al 2012). Most forms of cancer treatment affect regular eating habits, nutritional needs, and how the body digests and absorbs foods (Rock et al 2012).

Because of these difficulties that occur during cancer treatment, it is recommended by the American Cancer Society that those undergoing cancer treatment and cancer survivors should consult with a Registered Dietitian (RD), who is preferably a certified specialist in oncology.
(CSO, Rock et al 2012). A RD can help ensure that the cancer patient, or survivor, prevents or resolves nutrient deficiencies, maintain a healthy weight, prevent cachexia, and increase their overall quality of life (Rock et al 2012).

Breast cancer and obesity

Another factor that is associated with the development of breast cancer is having excess adipose tissue from being overweight or obese (Pakiz et al 2011). In particular, postmenopausal women have an increased risk of breast cancer when they have increased weight gain during adulthood when compared to premenopausal women (Kushi et al 2012). Increased adipose tissue can cause higher levels of localized estrogen in tissues such as the breast in postmenopausal women, which can lead to increased risk of breast cancer (Kushi et al 2012).

A meta-analysis conducted by Protani et al (2010) found that obese women with breast cancer had a 33% increase in the rate of death. Obesity has been linked with several types of cancer, including breast cancer, especially in postmenopausal women (Demark-Wahnefried et al 2012). An annual review conducted by Makarem et al (2013) found that only one out of seven studies found an increased breast cancer specific mortality risk when comparing the highest tertile of total dietary fat consumption with the lowest tertile. However, a randomized clinical trial did find that relapse-free and recurrence-free survival was significantly higher in the group that consumed lower amounts of dietary fat (Makarem et al 2013).

Overweight or obesity are now classified as a medical condition because of the coinciding chronic inflammation (Festa et al 2001). This inflammation has also been linked to breast cancer (Marvie and Howell 2005). The inflammatory cytokine interleukin-6, IL-6, is mainly produced by visceral fat and can stimulate the production of C-reactive proteins (Marvie
and Howell 2005). TNF-alpha is mainly from macrophages that are located within visceral and subcutaneous fat and its presence may advance the development of tumors, while also inhibiting tumor cell proliferation and promoting cell apoptosis (Marvie and Howell 2005). Interleukin-8 (IL-8) and vascular endothelial growth factor (VEGF) have also been found to have a relationship with breast cancer development (Lithgow and Covington 2005). Research has found that when one loses weight and excess fat, these inflammatory factors decrease (Pakiz et al 2011).

*Breast cancer and plant based foods*

A study conducted by Campbell et al (1998), known as the Cornell China study, was one of the first to find a relationship between higher intakes of plant based foods and decreased risk of diseases, such as breast cancer. They also found that breast cancer mortality increased when consumption of dietary fat and blood cholesterol levels increased (Campbell et al 1998). There were fewer reports of cancer in participants who had higher blood levels of vitamin C and beta-carotene, which is most often found in plant based foods (Campbell et al 1998). While there were strong associations observed between breast cancer and animal fat intake, there were no relationships between plant based food intake and breast cancer (Campbell et al 1998). The American Cancer Society (2012) also states that according to twenty years of research, it has been shown that individuals who consume diets with low intakes of red and processed meat, as well as refined grain products, and have higher intakes of fruits and vegetables have a lower risk of developing certain cancer or dying from cancer.

While there has been a significant amount of evidence regarding the relationship between plant based foods and their cancer preventing effects, attempts to isolate specific nutrients have
been unsuccessful (Kushi et al 2012). These studies attempted to determine the effects of specific nutrients through the use of supplements, however, they found that in very high doses these nutrients may be harmful (Kushi et al 2012). Many studies have also found that there are no benefits observed between antioxidant supplements and cancer prevention (Kushi et al 2012). It is thought that fruits and vegetables may indirectly influence cancer risk via their effects on energy intake and body weight (Kushi et al 2012). Individuals who consume higher quantities of fruits and vegetables have a lower risk of developing obesity, which is related to increased cancer risk (Kushi et al 2012). This decreased risk for obesity may be related to the high fiber and water content, as well as low energy content, of many fruits and vegetables (Kushi et al 2012). Certain fruits and vegetables, such as dark green and orange vegetables, cruciferous vegetables, soy products, legumes, allium vegetables, and tomato products, are currently being researched to determine whether they have significant chemopreventive properties (Kushi et al 2012). Although there are many known benefits of consuming higher quantities of fruits and vegetables, consumption remains low throughout the US, which is likely due to lack of access to affordable produce, preparation time, and taste preferences (Kushi et al 2012).

A study conducted by Guest et al (2013) evaluated the dietary intake of a group of breast cancer survivors (n = 42) and found that the majority of the participants had mean intakes of daily dietary fiber and fruit and vegetable servings that were below the recommendations (16.5 g/d fiber, 2.7 cup equivalents/d of fruits and vegetables). Another study conducted by Milliron et al (2013) used National Health and Nutrition Examination Survey (NHANES) data to determine whether there were differences in dietary intake between female breast cancer survivors and female non breast cancer survivors (n = 102, survivors; n = 2,684 controls). In this sample, breast
cancer survivors consumed a diet similar to those without a history of breast cancer (Milliron et al 2013).

Antioxidants, which are found in fruits and vegetables and include vitamin C, vitamin E, carotenoids and other phytochemicals, have also been thought to be associated with decreased breast cancer risk due to their protection against tissue damage caused by oxidation (Kushi et al 2012). However, the many benefits of increased fruit and vegetable consumption have been previously discussed and their benefits do not lie solely on their antioxidant content, which has been examined through several randomized controlled trials (Kushi et al 2012). Beta-carotene is another carotenoid that was once thought to be associated with decreased breast cancer risk; however, after major clinical trials were conducted, high-dose supplementation of beta-carotene was found to either increase the risk of lung cancer in cigarette smokers or to have no effect on cancer risk (Kushi et al 2012).

One legume, the soybean, has been positively associated with the prevention of breast cancer (Thomson 2012). Soybeans are thought to have bioactive compounds that have positive effects on health through their antioxidant, anti-inflammatory, and estrogen-modulating effects (Thomson 2012). While many benefits have been observed when consumption of plant based foods are increased, there have not been successful relationships observed between related nutrients and chemo preventative relationships have not been observed for specific nutrients (American Cancer Society 2012).

Grains, specifically whole grains, are also recommended as part of a healthy diet for cancer prevention and cancer survivorship (Kushi et al 2012). The research is limited in this area due in part to the insufficient data on the specific types of whole grains consumed when listed on a questionnaire (Kushi et al 2012). However, it is important to note that whole grains are another
excellent source of fiber and diet patterns consisting of adequate whole grain intake have been related to better weight control, which is one of the main modifiable risk factors for developing breast cancer (Kushi et al 2012).

**Breast cancer and alcohol consumption**

The American Cancer Society (2012) recommends limiting consumption of alcoholic beverages in order to help prevent the development of cancer. For women, the recommendation for consumption of alcohol is limited to no more than one drink per day less due to their smaller body size and slower metabolism of alcohol in comparison to men (Kushi et al 2012).

This recommendation is due to the findings that alcohol consumption, no matter the source, has been linked to an increased risk of developing breast cancer, particularly in postmenopausal women (Chen et al 2011). It has been determined that, compared to nondrinkers, there is a 10% to 12% higher risk of developing female breast cancer associated with each drink per day (Kushi et al 2012).

However, the biological mechanism by which alcohol increases the risk of developing breast cancer has not been determined (Thomson 2012). Acetaldehyde, which is a product of alcohol metabolism, can cause damage to DNA and is thought to be one possible mechanism (Kushi et al 2012). The increased blood levels of estrogens and other hormones that occur with consumption of alcohol and can also increase the risk of breast cancer (Kushi et al 2012).

Just as high fruit and vegetable consumption is related to lower body weight through lower energy intake, high alcohol consumption is associated with higher body weight due to the related increase in energy intake (Kushi et al 2012). In the US, alcoholic beverages are one of the top five contributors to energy intake (Kushi et al 2012).
These recommendations conflict with some of the positive health effects of moderate alcohol consumption (Rock et al 2012). Some of these positive health effects include the reduction in risk of heart disease when consuming one drink per day for women, which is due to the small increase in high-density lipoprotein cholesterol that occurs with alcohol consumption (Rock et al 2012, Kushi et al 2012). However, it is important to note that increased consumption of alcohol does not offer any additional health benefits and the American Heart Association states that adult nondrinkers should not begin consuming alcoholic beverages because they can reduce their risk of heart disease through other methods (Rock et al 2012, Kushi et al 2012). Therefore, it is important for healthcare providers to provide tailored recommendations for each individual (Rock et al 2012).

Breast cancer and nonnutritive sweeteners

Some of the nonnutritive sweeteners include aspartame, sucralose, saccharin, and acesulfame potassium. Saccharin and aspartame are considered ‘first generation’ nonnutritive sweeteners and have been researched extensively; while sucralose and acesulfame potassium are considered ‘new generation’ nonnutritive sweeteners and some researchers suggested they do not have enough epidemiological evidence to determine any carcinogenic risks (Weihrauch and Diehl 2003).

Saccharin is the oldest of the nonnutritive sweeteners and the most researched (Weihrauch and Diehl 2003). Out of 20 animal studies that examined saccharin and its effects on rats, only 1 study found the presence of significantly more neoplasia in the animals fed saccharin (Weihrauch and Diehl 2003). The one study that did find a significant presence, found the
animals studied were a type that were frequently susceptible to cell proliferation (Weihrauch and Diehl 2003).

While there is no evidence that when consumed as part of a regular human diet nonnutritive sweeteners cause cancer, there have been some animal studies that have found an association between high consumption of aspartame and cancers of the bladder and brain, or of hematopoietic cancers (Lim et al 2014). However, a study conducted by Lim et al (2014) examined 285,079 men and 188,905 women during a 5 y period of time and did not find any significant associations between aspartame intake from aspartame containing drinks and increased risk of hematopoietic or brain cancer. Based on NHANES data from 2001-2002, it is estimated that aspartame consumption in the US was around 330.2 mg/d or 4.9 mg/kg bw/d (Magnuson et al 2007). This is in large part due to the consumption of diet sodas (Magnuson et al 2007).

It is difficult to determine directly in humans not only whether nonnutritive sweeteners have an effect on cancer risk, but also which specific nonnutritive sweetener would be causing the effect due to the fact that many nonnutritive sweeteners are combined in food products (Weihrauch and Diehl 2003). In summary, there is currently no strong scientific evidence that nonnutritive sweeteners are a carcinogenic risk in humans (Weihrauch and Diehl 2003).

Conclusion

Research has shown the importance of increased consumption of plant based foods and decreased consumption of alcohol to decrease risk of breast cancer (Kushi et al 2012). Due to these findings and the fact that other research and data collection have found that older adults, including breast cancer survivors, are not consuming the recommended amount of servings of fruits and vegetables per day, it should be explored further in order to better understand the need
for nutrition education in this particular population. Postmenopausal breast cancer survivors are a unique group that has many different health risks that can be decreased through modifiable lifestyle factors, such as diet and physical activity.

**Table 2.1** United States Department of Agriculture and American Cancer Society nutrition recommendations

<table>
<thead>
<tr>
<th>Food or nutrient</th>
<th>United States Department of Agriculture (1800 kcal food pattern)</th>
<th>American Cancer Society</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables</td>
<td>2.5 c/d&lt;sup&gt;1&lt;/sup&gt;</td>
<td>2.5 c/d</td>
</tr>
<tr>
<td>Fruits</td>
<td>1.5 c/d&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Grains</td>
<td>6 oz-eq/d, of which at least 3 oz-eq should be whole grains&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Chose whole grains instead of refined grain products</td>
</tr>
<tr>
<td>Alcohol</td>
<td>1 serving/d&lt;sup&gt;4&lt;/sup&gt;</td>
<td>1 serving/d&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>Nonnutritive sweeteners</td>
<td>n/a</td>
<td>Limit consumption</td>
</tr>
</tbody>
</table>

<sup>1</sup> USDA servings sizes: 1 cup of vegetables include dark green vegetables (1 c raw chopped broccoli, 1 c cooked greens, 2 c raw leafy greens), red and orange vegetables (1 c raw/cooked carrots, 1 c mashed pumpkin, 1 cup raw chopped pepper, 1 large tomato or 1 c raw chopped tomato, 1 c tomato juice, 1 large sweet potato, 1 c cubed winter squash), beans and peas (1 c cooked, whole or mashed), and other vegetables (1 c cooked bean sprouts, 1 c chopped raw/cooked cabbage, 1 c raw/cooked cauliflower, 1 c diced raw/cooked celery, 1 c raw cucumbers, 1 c cooked green beans, 1 c chopped raw/cooked green peppers, 2 c raw chopped lettuce, 1 c raw/cooked mushrooms, 1 c raw onions, 1 c raw squash)

<sup>2</sup> USDA serving sizes: 1 cup of fruit includes apple (½ large, 1 small, 1 c raw/cooked chopped), applesauce (1 c), banana (1 c, sliced or 1 large), cantaloupe (1 c diced/ball), grapes (1 c or 32 seedless), grapefruit (1 medium or 1 c sections), mixed fruit (1 c), orange (1 orange or 1 c sections), peach (1 large), pear (1 medium), pineapple (1 c chunks, sliced, crushed), plum (3 medium or 2 large), strawberries (8 large), watermelon (1 small wedge), dried fruit (½ c), 100% fruit juice (1 c or 8 fl oz)

<sup>3</sup> USDA serving sizes: 1 oz eq of grains includes bagels (1 mini), biscuits (1 small), breads (1 regular slice, small slice French, 4 snack size), bulgur (½ c cooked), cornbread (1 small piece), crackers (5 whole wheat, 2 rye crispbreads, 7 square or round), English muffins (1 small), oatmeal (½ c cooked, 1 packet instant, 1 oz dry), pancakes (1 pancake, 2 small pancakes), popcorn (3 c, popped), ready to eat cereal (1 c flakes, 1 ¼ c puffed), rice (½ c cooked, 1 oz dry), pasta (½ c cooked, 1 oz dry), tortillas (1 small flour tortilla, 1 corn tortilla)

<sup>4</sup> Includes beer and ales (1 serving = 12 fl oz), cordial and liqueur (1 serving = 1.5 fl oz), distilled liquor (1 serving = 1.5 fl oz), and wine (1 serving = 5 fl oz table wine, 3 fl oz dessert wine); these serving sizes are the same for NDSR and USDA
CHAPTER 3

INTAKE OF PLANT FOODS, ALCOHOLIC BEVERAGES, AND NONNUTRITIVE SWEETENERS IN POSTMENOPAUSAL BREAST CANCER SURVIVORS

Abstract

Differences in consumption of selected plant based foods, nutrients, alcohol, and nonnutritive sweeteners in postmenopausal breast cancer survivors (survivors, n = 13) and postmenopausal women without breast cancer (controls, n = 71) were determined. Women were from northeast Georgia [n = 84, 95% white, mean (SD) age = 58.5 (3.8) y, BMI = 26.0 (4.6)]. Three-day diet records were analyzed (University of Minnesota’s Nutrition Data System for Research). Compared to controls, survivors consumed significantly more legumes, non-citrus fruit and fruit juices, carbohydrates (% of energy, g/1000 kcal/d, all P < 0.05), dietary folate equivalents (g/1000 kcal/d, P = 0.03), and fiber (g/1000 kcal, P = 0.06), but significantly less sucralose (a nonnutritive sweetener), wine, and alcohol (% of energy) (all P < 0.05). Although there is no evidence that nonnutritive sweeteners are linked to cancer in humans, findings suggest these cancer survivors are attempting to follow evidence-based recommendations for cancer prevention such as a more plant based diet with less alcohol.

Introduction

It is estimated that in 2012 there were 13.7 million cancer survivors living in the US (de Moor et al 2013). This number is expected to increase to 18 million by the year 2022 (de Moor et al 2013). As of January 1, 2009 almost 2.8 million women have been diagnosed with breast cancer in the US (American Cancer Society 2012, National Cancer Institute 2012). Approximately 41% of cancer diagnoses in women in the year 2012 were because of breast cancer, making it the number one type of cancer in women of the US (de Moor et al 2013).

Weight control, dietary choices, and level of physical activity are considered the most important modifiable risk factors for cancer (Kushi et al 2012). Over one-third of cancer deaths
in the US are related to diet and physical activity habits (Kushi et al 2012). Some of the most recent recommendations include being as lean as possible within the normal weight range, focusing on plant based foods, limiting consumption of red and processed meats, and increasing fruit and vegetable intake (Kushi et al 2012).

One factor associated with the development of breast cancer is having excess adipose tissue from being overweight or obese (Pakiz et al 2011). Postmenopausal women with excess adipose tissue have an increased risk of breast cancer because of high levels of localized estrogen in the adipose tissue, which can lead to an increased risk of breast cancer (Kushi et al 2012).

Plant based foods may indirectly influence cancer risk through their effects on energy intake and body weight (Kushi et al 2012). Individuals who consume higher quantities of plant based foods may have a lower risk of developing obesity, largely due to the high fiber and water content, as well as low energy content, of many fruits and vegetables (Kushi et al 2012). Although there are many known benefits of consuming higher quantities of fruits and vegetables, consumption remains low in the US (Kushi et al 2012).

The American Cancer Society (2012) recommends limiting consumption of alcoholic beverages to decrease the risk of developing cancer, and they also recommend that cancer survivors limit alcohol intake. This recommendation is based on the findings that alcohol consumption, no matter the source, has been linked to an increased risk of developing breast cancer, particularly in postmenopausal women (Chen et al 2011). It has been determined that, compared to nondrinkers, there is a 10% to 12% higher risk of developing female breast cancer associated with each drink per day (Kushi et al 2012).

There is currently no strong scientific evidence that nonnutritive sweeteners, such as saccharin, aspartame, sucralose, and acesulfame potassium, are a carcinogenic risk in humans.
It is difficult to determine directly in humans not only whether nonnutritive sweeteners have an effect on cancer risk, but also which specific nonnutritive sweetener would be causing any carcinogenic effect considering many nonnutritive sweeteners are combined in food products (Weihrauch and Diehl 2003).

Little research has been done to examine the dietary differences between postmenopausal women with and without breast cancer. Therefore, the aim of this study was to determine whether dietary differences exist between postmenopausal breast cancer survivors and postmenopausal women who have not had breast cancer (controls). It was hypothesized that compared to controls, postmenopausal breast cancer survivors would have a higher intake of plant based foods and lower intakes of alcohol and nonnutritive sweeteners. Lay (2014) investigated the differences in animal foods and related nutrients in postmenopausal breast cancer survivors and women with no history of breast cancer.

Methods
This study was a part of a parent research project conducted by Christie L. Ward and this section was adapted from her doctoral dissertation and recent publication (Ward 2013, Ward et al 2013).

Participants
Women who were aged 45-65 y and postmenopausal were recruited for this study through various methods, including email, flyers, and community events. Women who were aged 45-65 y, postmenopausal, and breast cancer survivors were also recruited in a similar manner. In order to be included in this study, participants were required to have been non-smoking for at least two years prior to study participation, weight stable (within 2 kg) for the past three months,
medications stable for the past three months, free of uncontrolled pulmonary, cardiovascular or
metabolic disease, and free of symptomatic joint abnormalities, and symptomatic nervous
disorders. In order for postmenopausal breast cancer survivors to be included in this study, they
had to have completed any cancer related treatment more than six months, but less than 10 y
prior to screening. These criteria were required since the parent research project examined
physical functioning as well as physical activity and, therefore, the participants had to be able to
perform these functions. Participants were also asked to wear an activity monitor for seven days
and undergo body composition analysis with DXA. A total of 92 women completed the study (15
breast cancer survivors, 77 controls) and of these 2 survivors and 6 controls were excluded for
these reasons: 1 survivor due to being > 10 y from breast cancer diagnosis, 1 survivor due to
incomplete questionnaires, 5 controls due to incomplete diet records, and 1 control due to only
having a diet record and no other data.

All of the procedures for the current and parent research project were approved by the
Institutional Review Board of the University and prior to their enrollment, all participants signed
an IRB approved informed consent.

Procedures

This study had a cross sectional design that included two testing and data collection visits
held 7-10 d apart. Each visit was held in the Body Composition and Metabolism Lab,
Department of Kinesiology, University of Georgia and took approximately 2-3 hours to complete
and the majority of the visits occurred during January 2013 to August 2013. Participants who
expressed interest in the project were then screened via telephone, and eligible participants were
then scheduled for two appointments 7-10 days apart in order to allow proper time for physical
activity monitoring. Each participant was sent a copy of informed consent via email prior to visit 1. During visit 1, each participant completed consent forms, anthropometric measures, and a series of questionnaires. During the 7-10 d period between visit 1 and visit 2, participants completed a series of questionnaires in regard to their health history and each participant was asked to wear a physical activity monitor. During visit 2, questionnaires, which were completed at home, were reviewed by the research staff to determine whether they were complete.

Demographics

Participants completed a demographic questionnaire that included age, marriage status, race (Asian/Pacific Islander, Black, Hispanic, Native American/Alaskan, White), education level, employment information, income level, and household information.

Health History

All participants were requested to report whether they were experiencing the presence of a medical condition such as arthritis, asthma, chronic obstructive pulmonary disease, cardiovascular disease, diabetes, degenerative disc disease, osteoporosis, and peripheral arterial disease. Each participant was also asked to report all medications and supplements. Because the questions were open-ended regarding dietary supplements, the usage and frequency information appeared incomplete and inconsistent and, therefore, were not qualitatively or quantitatively assessed in this study.
**Anthropometrics**

Weight was measured using a calibrated digital scale (Tanita, Model WB-110A) and barefoot standing height was measured to the nearest 0.1 cm using a stadiometer (Seca, Model 242). Waist circumference was also measured three times for accuracy at the natural waist and the average measurement was used for data analysis.

**Physical Activity**

In order to objectively measure physical activity time, each participant wore an accelerometer (New Lifestyles – 1000, Barebones Pedometer, New Lifestyles, Inc., Lees Summit, MO), which assessed both steps per day and minutes spent engaged in moderate to vigorous physical activity (MVPA). MVPA was defined as activity completed above a moderate intensity threshold, which corresponds to approximately 3.6 METs (Metabolic Equivalents). Participants were instructed to wear the accelerometer on the non-dominant hip, fastened to their waistband, during all waking hours, except when bathing or swimming. Participants were then instructed to record the time spent wearing the accelerometer, the number of steps and the MVPA on a hand-written log at the end of each day during the 7 day period. A member of the research team using the memory feature of the NL-1000 then verified logs. A day of valid wear was considered when the participant had worn the accelerometer for ten hours and there were four valid days present. Step counts were calculated using the average step count from valid wear days (steps/d), and minutes in MVPA per day were calculated as average time spent in MVPA from valid wear days.
Diet Assessment

Participants were requested to keep a 3-day diet record during the 7-10 d period between visits 1 and 2. During visit 1, a member of the research team reviewed the process of maintaining a diet record with the participant. The participant recorded every meal and snack for 3 days, with 2 days being weekdays and 1 day being a weekend day (Friday, Saturday, and Sunday) in order to account for variances in eating patterns throughout the week. During visit 2, a member of the research team knowledgeable in nutrition reviewed the diet record with the participant in order to ensure clarity and preciseness by allowing the participant multiple opportunities to recall forgotten foods and details, such as the cooking method and brand name. The 3-day diet records were then entered by a nutrition graduate student and assessed using the University of Minnesota’s Nutrition Data System for Research (NDSR, 2013, Minneapolis, MN). NDSR is a computer-based software application developed at the University of Minnesota Nutrition Coordinating Center that facilitates the collection of recalls in a standardized fashion (Feskanich et al 1989).

All participants’ energy intake was ≥ 1145 kcal/d and ≤ 2204 kcal/d; therefore no exclusions were made based on unreliably low or high energy intakes (Willett 1998). The present study used food group variables that were created by NDSR, as well as unique variables that were created to be comparable to the USDA food groups and are indicated in Table 3.2. The most common substitutions needed to be made were for certain snack bars, certain types of Greek yogurt, and certain vegetarian products; this should have a minimal impact on the results, because the best possible match was chosen as a replacement in order to ensure the nutrient content was comparable.
Statistical Analyses

Descriptive statistics including means, standard deviations, medians, and percentages, as well as chi-square analyses were calculated and analyzed with SAS Statistical Analysis System for Windows Version 9.3 (Cary, NC). Differences between breast cancer survivors and their controls were assessed with a series of analyses including chi-square analyses, T-tests, and Wilcoxon exact tests (Table 3.1, 3.2, 3.3, 3.4). The Wilcoxon test, rather than the T-test, was determined to be the most appropriate test to compare survivors and controls, because of the small sample size, non-normal distribution of the variables, and the large number of participants who did not consume certain foods. To optimize computing time, the Monte Carlo option was used (alpha = 0.05) for the Wilcoxon tests. Although not used to interpret the results, T-tests were also computed. For the T-tests, the Folded F P-value for equality of variances was used to determine whether to use P-values for equal variances (if P > 0.05, then used Pooled P-value) or unequal variances (if P < 0.05, then used the Satterthwaite P-value).

For participant demographics and health characteristics (Table 3.1), Wilcoxon tests were used to interpret the results (2-sided P-values were used, because there was no hypothesis regarding the direction of the difference expected in this table).

For food group intake (Table 3.2), Wilcoxon tests were conducted for all variables and one-sided P-values were used because it was hypothesized that the survivors’ intake would generally be ‘healthier’ than the controls, with higher intakes of plant based foods. Only data is shown for all vegetables, all fruits and juices, all grains, and all snack bars, as well as any other subgroup of these major categories. Food groups with a P \leq 0.15 were also reported in order to examine any trends. Chi-square analyses were performed for each food group to compare the
percentage of participants consuming above and below the median distribution in the total sample.

For nutrient intake (Table 3.3), Wilcoxon tests were used to interpret the results, but P-values for T-tests were also computed. One-sided P-values were used because it was hypothesized that the survivors’ intake would generally be ‘healthier’ than the controls. Chi-square analyses were performed for each nutrient to compare the percentage of participants who met or exceeded the RDA or other recommendation for nutrient intake for women age 51-70 y. Because of the small sample size, procedures for calculating usual intakes and use of EAR rather than RDA as a measure of nutritional adequacy were not implemented.

For alcohol and nonnutritive sweetener intake (Table 3.4), chi-square analyses were performed and used to interpret the results for all alcoholic beverages and subgroups, as well as all nonnutritive sweeteners and subgroups in order to compare the percentage of participants consuming above and below the median distribution in the total sample. Wilcoxon tests could not be performed because of the large number of the participants who did not consume several of these items.

**Results**

**Participants**

The characteristics of the study participants are shown in Table 3.1 (total, n = 84; survivors, n = 13, controls, n = 71). The two groups did not have significantly differently demographics or characteristics. The mean (SD) for age for the total sample was 58.5 (3.8), all females, 95.2% were white, 2.4% were black, and 2.4% were Asian Pacific. The mean (SD) for BMI was 26.0 (4.6) for the total sample, 26.6 (4.5) for survivors, and 26.0 (4.7) for controls.
There were 2.41% of all participants who were underweight (BMI < 18.5 kg/m²), 45.7% of all participants were normal weight (BMI 18.5 – 24.9 kg/m²), and 34.9% of all participants were overweight (BMI 25-29.9 kg/m²). 100% of the participants reported a high school education or more. Although not statistically different, compared to controls, the survivors reported (medians) 1 more medication, 1 more comorbidity, 1,615 less steps per day, and 8.6 less minutes of moderate to vigorous physical activity per day. The top four comorbidities observed in this sample were depression, anxiety, degenerative disc disease, and obesity.

The mean (SD) age of breast cancer diagnosis for survivors was 53.7 (4.85) y, with the range of age at diagnosis being 43-61 y. The mean (SD) for time since breast cancer diagnosis was 41.8 (20.0) mo (range = 24-92 mo) and the mean (SD) for time since last breast cancer treatment was 28.5 (13.3) mo (range = 6-54 mo). There were 53.8% of the survivors who received chemotherapy and radiation treatment. There were 3 out of the 13 survivors who had undergone a total mastectomy on both the right and left sides, with 2 other survivors who had a total mastectomy on either the right or left side.

Food Group Intakes

Table 3.2 shows the differences in consumption of specified food groups in survivors and controls and the Wilcoxon and chi-square tests were used to interpret the results. Compared to controls, the survivors consumed more legumes (median: 0.08 servings/d vs 0.28 servings/d, P = 0.007) and were more likely to consume above the median intake of the total sample for legumes (median: 0.18 servings/d, P = 0.007). Compared to controls, survivors consumed more servings/d of fruits and juices, not including citrus fruit and juices (P = 0.04). Compared to controls, survivors consumed more some whole grain products, such as flours, breads, pastas, and cereals
(median: 0 servings/d vs 0.30 servings/d, $P = 0.08$) and were more likely to consume above the median intake of the total sample for some whole grain products (median: 0 servings/d, $P = 0.09$).

**Nutrient Intakes**

Table 3.3 shows the differences in specified nutrient intakes in survivors and controls. Compared to controls, survivors consumed a higher percentage of their energy intake from carbohydrates (47.7% vs 42.2%, $P = 0.01$). However, controls consumed a higher percentage of calories from alcohol (0.52% vs 4.37%, $P = 0.001$). Compared to controls, survivors consumed higher total dietary fiber per 1000 kcal per day (14.3 g/1000 kcal/d vs 12.8 g/1000 kcal/d, $P = 0.06$). Compared to controls, survivors were more likely to meet or exceed the Adequate Intake recommendation (AI) for grams of total dietary fiber per 1000 kcal per day (AI = 14 g/1000 kcal/d, $P = 0.07$). Compared to controls, survivors had a trend for a higher average daily intake of dietary folate equivalents (mean: 545 mcg/d DFE vs 501 mcg/d DFE, $P = 0.10$) and had significantly higher intakes of dietary folate equivalents/1000 kcal (mean: 319 mcg/1000 kcal/d vs 289 mcg/1000 kcal/d, $P = 0.03$). Compared to controls, survivors were more likely to meet or exceed the Recommended Dietary Allowance for daily potassium intake (RDA = 4700 mg/d, $P = 0.02$; based on 1 individual). Compared to controls, survivors had significantly higher intakes of carbohydrates/1000 kcal/d (mean: 123 g/1000 kcal/d vs 109 g/1000 kcal/d, $P = 0.02$). There were no significant differences seen in intake of energy (kcal/d), carbohydrates (g/d), total dietary fiber (g/d), soluble dietary fiber (g/d), insoluble dietary fiber (g/d), vitamin K (mcg/d), vitamin C (mg/d), vitamin A (RAE mcg/d), alpha-carotene (mcg/d), beta-carotene (mcg/d), beta-carotene equivalents (mcg/d), beta-cryptoxanthin (mcg/d), natural folate (mcg/d), synthetic folate (mcg/d),
potassium (mg/d), sodium (mg/d), sodium-potassium ratio, or magnesium (mg/d). However, for the total sample, 88% exceeded the RDA for carbohydrates (130 g/d), 98.8% exceeded the RDA for sodium (1300 mg/d), 1.19% met the RDA for potassium, and 39.3% - 77.4% met the RDAs for total dietary fiber, vitamin K, vitamin C, vitamin A, dietary folate equivalents, and magnesium. There are not RDAs for the carotenoids.

Alcohol and Nonnutritive Sweetener Intakes

Table 3.4 shows the differences in consumption of alcohol and nonnutritive sweeteners between survivors and controls. Many participants did not consume any alcoholic beverages or nonnutritive sweeteners. Compared to controls, survivors were less likely to consume alcoholic beverages (P = 0.009), wine (P = 0.009), all nonnutritive sweeteners (P = 0.10) and sucralose (P = 0.05). There were no significant differences observed between the two groups in the specific consumption of saccharin, acesulfame potassium, or aspartame.

Discussion

The purpose of this study was to explore the differences in intake of plant based food groups, related nutrients, alcohol, and nonnutritive sweeteners in postmenopausal breast cancer survivors and their controls. In partial support of the hypotheses, compared to controls, survivors consumed significantly more of some plant foods, such as legumes and non-citrus fruits and juices, as well as significantly less alcohol and some nonnutritive sweeteners (sucralose). These findings build on previous research among breast cancer survivors that focused on only a few plant foods, included a broader age range, and may have included women who were pre-menopausal (Guest et al 2013, Milliron et al 2013). Milliron et al (2013) found no significant
differences in their sample of survivors versus controls, except that the survivors reported greater intakes of whole grains. Milliron et al (2013) also found that more than 90% of their sample did not meet the recommendations for fruits, vegetables, and whole grains. However, it is important to note that while the Milliron et al (2013) study used NHANES data, their sample did not focus on postmenopausal breast cancer survivors. Their sample included all women who had reported a history of breast cancer and had completed a 24-hour dietary recall (Milliron et al 2013). The present study examined not only postmenopausal breast cancer survivors, but also required participants to keep a 3-day diet record, which allowed for more typical consumption and there were also more subgroup of foods analyzed.

The nutritional significance of these differences in dietary patterns between these breast cancer survivors and their controls were not related to energy intake, which was the same in survivors (mean: 1729 kcal/d) and controls (mean: 1789 kcal/d). In order to rule out bias, the current sample’s intakes were compared to nationally representative NHANES data. In comparison to NHANES data, the current sample had similar intakes to women 50-59 y in the US who reported a mean energy intake of 1759 kcals/d and women 60-69 y reported a mean energy intake of 1717 kcals/d (USDA 2012).

*Legumes, fruit, and fiber*

Compared to controls, survivors had higher intakes of legumes, as well as non-citrus fruit and juice intake, which may have contributed to the higher intake among controls of carbohydrates (% energy, g/1000 kcal/d, all P < 0.02), dietary folate equivalents (mcg/1000 kcal/d, P = 0.03), and total dietary fiber (g/1000 kcal/d, P = 0.06). Legumes are an excellent source of fiber as ½ cup cooked contains approximately 8 g of fiber (USDA 2013). USDA
(2014) recommends that women over the age of 51 y of age consume 1 cup of beans and peas ("legumes") per week. Fruit is another source of fiber; for example, a medium apple (161 g) has about 2 g of fiber (USDA 2013).

Most categories of fruit and vegetables did not differ between survivors and controls. In the total sample, the daily intake of all vegetables (about 2 cup-equivalents), all fruits and juice (about 1 cup-equivalent), and all whole grains (about 1.4 ounce-equivalents) were less than the recommended for moderately active older women consuming 1,800 kcal/d (2.5 cup-equivalents, 1.5 cup equivalents, and 3 ounce-equivalents, Dietary Guidelines for Americans 2010), which explains why only 51% met the RDA for fiber (21 g/d) and 32% met the AI for fiber (14 g/1000 kcal). Thus, all women in this study should attempt to increase their intakes of fiber by increasing the intake of these foods, but not through the use of supplements, because the benefits of fiber containing foods and decreased cancer risk are not solely based on the fiber (Kushi et al 2013). A more plant based diet increases overall intake of fiber, other essential nutrients, and phytochemicals, and these foods help to lower energy intake because they are lower in energy (low fat typically) and can be satiating – all of which make fiber-containing foods beneficial for postmenopausal breast cancer survivors (Kushi et al 2012).

Milliron et al (2013) also reported that both controls and breast cancer survivors from 2003-2006 NHANES did not meet dietary recommendations for fruit, vegetables, and whole grains, even though cancer survivors are encouraged to maintain a diet that is high in consumption of fruits and vegetables (Kushi et al 2012). Cancer survivors are also encouraged to limit their consumption of meat, which may explain why survivors had higher consumption of legumes – a good plant based source of protein (Kushi et al 2012). It is recommended that cancer survivors avoid processed meats in particular, due to the production of heterocyclic amines that
occur when meat is cooked at higher temperatures, which causes the formation of N-nitroso compounds (Milliron et al. 2013). Another area of concern is the high prevalence of both overweight (35%) and obesity (17%) in the total sample, because a higher intake of fruit and vegetables has been linked to a lower weight, which is known to decrease the risk of developing breast cancer or having a recurrence (Milliron et al. 2013). Diets with higher intakes of fruits and vegetables have higher fiber content, which has been linked to lower body weights (American Academy of Nutrition and Dietetics 2008). Although, it should be noted that while there is a link between higher fiber intake and lower body weight, there is further research needed on whether fiber decreases risk of cancer (American Academy of Nutrition and Dietetics 2008). Maintaining a healthy body weight is important for both postmenopausal survivors and controls because the risk of breast cancer is higher in postmenopausal women (Kushi et al. 2012). This is probably due to the higher levels of estrogen that are produced locally in excess adipose tissue, such as breast tissue, after menopause as opposed to being produced in the ovaries and spread throughout the body (Kushi et al. 2012).

Postmenopausal breast cancer survivors, cancer survivors, and older women in general are at high risk for cardiovascular diseases (American Heart Association 2013), which is another area of concern regarding the low intakes of fruit, vegetables, and whole grains in the total sample. High sodium, low potassium, and/or high sodium to potassium ratios may also be risk factors for some cardiovascular diseases, such as stroke (Appel et al. 2011, Weaver 2013). In the total sample, 98.8% (all but 1) met or exceeded the RDA for sodium intake (RDA = 1300 mg/d), while only 1.2% (n = 1) of participants met the RDA for potassium (RDA = 4700 mg/d). Consuming additional low-sodium fruits and vegetables could markedly contribute to healthier intakes of sodium and potassium. The problem of high sodium and low potassium intakes in this
sample is consistent with intakes among nationally representative samples of older women (e.g., potassium intakes among women ages 50-50 y and 60-69 y were 2592 mg/d and 2488 mg/d, respectively, in 2009-2010, USDA 2012).

**Alcohol**

Survivors consumed less alcohol than controls. The USDA (2013) and the American Cancer Society (2013) recommend that women consume one or less servings of alcoholic beverages per day. This recommendation was met by all survivors and about two-thirds of the controls. Perhaps the survivors are aware of and follow the American Cancer Society recommendations in regard to alcohol.

The importance of low alcohol intake should continue to be emphasized in survivors because alcohol is a known risk factor for increased breast cancer risk (Kushi et al 2012). Even though the message from the American Heart Association is contradictory, it is emphasized that although there are small advantages to low daily consumption of alcohol, adults who currently do not consume alcohol should not start due to the fact that they can receive the small health benefits found in alcohol in other ways, such as physical activity and a healthy diet (Kushi et al 2012).

**Nonnutritive Sweeteners**

Nonnutritive sweetener intake was lower in survivors compared to controls (P = 0.10), with survivors consuming some aspartame and avoiding the three other sweeteners assessed. This could be due to the American Cancer Society’s recommendation to limit consumption of nonnutritive sweeteners and it could also be due to the media, which portrays nonnutritive
sweeteners as having a carcinogenic effect, even though there is no scientific evidence of this in humans (Kushi et al 2012, Magnuson et al 2007). The percentage of survivors with consumption of more than 0 servings of artificially sweetened soft drinks was about 15% (2 of 13 participants), so perhaps the consumption of aspartame-sweetened soft drinks was the source of aspartame among the survivors.

Strengths and Limitations

Both a strength and limitation were the use of the 3-day dietary records, which can capture usual intakes, but the one-week time period might not reflect the seasonal variations in dietary patterns. Strengths were that the diet record keeping process was thoroughly explained to each participant and each record was reviewed with each participant to ensure preciseness and clarity regarding details about consumption. The computer-based software that was utilized to assess the diet records facilitated a standardized method that required the researcher entering each diet record to answer specific questions, such as preparation methods, specific ingredients, and specific brands (University of Minnesota 2014). The NDSR database, which is based from the University of Minnesota Nutrition Coordinating Center (NCC), includes over 18,000 different foods and more than 7,000 brand name products (Sievert et al 1989, University of Minnesota 2014). Ingredient choices and preparation methods provide more than 160,000 food variants (University of Minnesota 2014). Values for 163 nutrient, nutrient ratios and other food components are generated from the database (University of Minnesota 2014). The USDA Nutrient Data Laboratory is the primary source of nutrient values and nutrient composition (Schakel et al 1988). The physical activity data collection method is a strength since a hybrid accelerometer was used in order to not only determine the participants’ number of steps per day,
but also their minutes of moderate to vigorous physical activity per day. This allowed the researchers to get a clearer picture of the lifestyle habits of the participants.

Caan et al (2000) reported that an estimated 25% of type I, type II, and type IIIA breast cancer survivors underreport energy intake. If a breast cancer survivor is categorized as obese, they are twice as likely to underreport energy intake (Caan et al 2000). However, it is important to note that this underreporting that occurs in breast cancer survivors also occurs in the women who have no history of breast cancer (Caan et al 2000). The most common type of underreporting is in regard to the consumption of higher fat foods (Rock and Demark-Wahnefried 2002).

One of the goals of this study was to determine the feasibility of recruiting postmenopausal breast cancer survivors to a research study to assess several domains, including physical function, fatigue, physical activity, and dietary habits (Ward 2013). Given that only 13 (of the 15 enrolled) postmenopausal breast cancer survivors provided complete data for the dietary part of this study, it may not be feasible to conduct large studies in the northeast Georgia and Athens area with this population. Limitations of the study include the small sample size and inability to generalize these results beyond the northeast Georgia area. Another limitation is the cross-sectional design, which only captures a snapshot of the dietary habits of postmenopausal breast cancer survivors and controls. However, this study does add valuable knowledge about the dietary habits of postmenopausal breast cancer survivors and postmenopausal women without a history of breast cancer.
Future research

Given that in the US the number of cancer survivors is estimated to increase to almost 18 million by the year 2022 and the number of women aged 60 y and older is estimated to increase to 41 million by the year 2020, future research may be able to capture a more representative sample of postmenopausal breast cancer survivors for the entire country (US Census Bureau, de Moor et al 2013). NHANES data has shown a trend in the increasing obesity rates throughout the years, which is of concern for those hoping to prevent a breast cancer diagnosis or recurrence (Ogden et al 2013). Future studies may also be able to conduct additional longitudinal analyses of postmenopausal survivors to see how their dietary patterns, physical activity, and BMI change over time, with or without lifestyle interventions, and how these affect their risk for recurrence of cancer.

Conclusions

The results of this study add to the small, but growing body of literature concerning diet in female breast cancer survivors. Previous studies have examined dietary differences in women who are breast cancer survivors compared to women with no history of cancer and breast cancer survivors in general (Milliron et al 2013, Guest 2013), while the present study expands the knowledge of dietary differences specifically in postmenopausal women with and without a history of breast cancer. Finally, the results of this study generate a better understanding of the dietary habits of postmenopausal breast cancer survivors and their controls, as well as allowing health professionals to understand whether further nutrition education is needed within this population.
Table 3.1 Demographic and health characteristics of postmenopausal breast cancer survivors and their controls

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total Mean (SD), median or %, [95% CI]</th>
<th>Survivors Mean (SD), median or %, [95% CI]</th>
<th>Controls Mean (SD), median or %; [95% CI]</th>
<th>Folded F test, p-value</th>
<th>T-test, p-value</th>
<th>Wilcoxon p-value</th>
<th>Chi-square p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>84</td>
<td>13</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
<td>0.34</td>
</tr>
<tr>
<td>Age (year)</td>
<td>58.5 (3.8), 59.0, [58.0, 60.0]</td>
<td>57.4 (4.33), 58.0, [53.0, 61.0]</td>
<td>58.7 (3.75), 59.0, [58.0, 60.0]</td>
<td>0.44</td>
<td>0.25</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Non-Hispanic White (%)</td>
<td>95.2</td>
<td>92.3</td>
<td>95.7</td>
<td></td>
<td></td>
<td></td>
<td>0.34</td>
</tr>
<tr>
<td>Black (%)</td>
<td>2.41</td>
<td>7.69</td>
<td>1.43</td>
<td></td>
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</tr>
<tr>
<td>Asian Pacific (%)</td>
<td>2.41</td>
<td>0</td>
<td>2.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education, high school diploma or higher (%)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>69.8 (13.9), 67.2, [63.3, 71.2]</td>
<td>71.6 (16.4), 66.0, [59.4, 88.7]</td>
<td>69.5 (13.5), 67.3, [64.0, 71.7]</td>
<td>0.30</td>
<td>0.61</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>Body mass index (kg/m^2)</td>
<td>26.0 (4.6), 25.6, [24.2, 26.6]</td>
<td>26.6 (4.5), 26.7, [21.7, 29.9]</td>
<td>26.0 (4.7), 25.5, [24.2, 26.5]</td>
<td>0.96</td>
<td>0.67</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>Underweight, &lt; 18.5 (%)</td>
<td>2.41</td>
<td>0</td>
<td>2.86</td>
<td></td>
<td></td>
<td></td>
<td>0.93</td>
</tr>
<tr>
<td>Normal weight, 18.5-24.9</td>
<td>45.7</td>
<td>46.2</td>
<td>45.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characteristic</td>
<td>Total Mean (SD), median or %, [95% CI]</td>
<td>Survivors Mean (SD), median or %, [95% CI]</td>
<td>Controls Mean (SD), median or %, [95% CI]</td>
<td>Folded F test, p-value</td>
<td>T-test, p-value</td>
<td>Wilcoxon p-value</td>
<td>Chi-square p-value</td>
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<tr>
<td>Overweight, 25-29.9 (%)</td>
<td>34.9 (38.5)</td>
<td>34.3 (34.9)</td>
<td>38.5 (34.9)</td>
<td>0.55</td>
<td>0.63</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>Obese, &gt;30 (%)</td>
<td>16.9 (15.4)</td>
<td>17.1 (15.4)</td>
<td>15.4 (17.1)</td>
<td>0.71</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Natural waist (cm)</td>
<td>82.7 (12.3), 80.0, [78.5, 84.2]</td>
<td>84.2 (13.5), 84.1, [74.4, 89.5]</td>
<td>82.4 (12.2), 80.0, [78.5, 84.8]</td>
<td>0.04</td>
<td>0.25</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Low risk ≤ 88 cm (%)³</td>
<td>72.6 (76.9)</td>
<td>71.8 (76.9)</td>
<td>76.9 (71.8)</td>
<td>0.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High risk &gt; 88 cm (%)⁴</td>
<td>27.4 (23.1)</td>
<td>28.2 (23.1)</td>
<td>23.1 (28.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age at breast cancer diagnosis (y)</td>
<td>53.7 (4.85), 55.0, [51.0, 58.0]</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time since breast cancer diagnosis (mo)</td>
<td>41.8 (20.0), 34.0, [27.0, 59.0]</td>
<td>Range: 43-61 y</td>
<td></td>
<td></td>
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<tr>
<td>Time since last breast cancer treatment (mo)</td>
<td>28.5 (13.3), 26.0, [19.0, 34.0]</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Total comorbidities⁵</td>
<td>2.06 (2.00), 2.00,</td>
<td>2.85 (2.70), 1.00,</td>
<td>1.91 (1.82), 2.00,</td>
<td>0.04</td>
<td>0.25</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Characteristic</td>
<td>Total Mean (SD), median or %, [95% CI]</td>
<td>Survivors Mean (SD), median or %, [95% CI]</td>
<td>Controls Mean (SD), median or %; [95% CI]</td>
<td>Folded F test, p-value</td>
<td>T-test, p-value</td>
<td>Wilcoxon p-value</td>
<td>Chi-square p-value</td>
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</tr>
<tr>
<td>Total medications and supplements(^5)</td>
<td>3.60 (3.34), 3.00, [2.00, 3.00]</td>
<td>5.15 (4.79), 4.00, [1.00, 7.00]</td>
<td>3.30 (2.95), 3.00, [2.00, 3.00]</td>
<td>0.01</td>
<td>0.20</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Step counts (steps/d)(^6)</td>
<td>8853 (3884), 8624, [7490, 9753]</td>
<td>7545 (3688), 6830, [4383, 12840]</td>
<td>9106 (3897), 9142, [7823, 9790]</td>
<td>0.89</td>
<td>0.19</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Moderate to vigorous physical activity (min/d)(^6)</td>
<td>28.4 (21.1), 22.9, [18.9, 32.0]</td>
<td>21.2 (19.5), 13.5, [5.05, 44.8]</td>
<td>29.8 (21.3), 23.3, [20.0, 33.2]</td>
<td>0.77</td>
<td>0.18</td>
<td>0.14</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)T-test p-value is pooled value if F value for equality of variances if \(p > 0.05\), and is Satterthwaite value if \(p \leq 0.05\); Wilcoxon exact p-value (two-sided) with alpha set at 0.05 using the Monte Carlo option to optimize computational time

\(^2\)Total, \(n = 83\), controls, \(n = 70\)

\(^3\)Decreased disease risk for type 2 diabetes, hypertension, CVD

\(^4\)Increased disease risk for type 2 diabetes, hypertension, CVD

\(^5\)Total, \(n = 81\), controls, \(n = 69\)

\(^6\)Total, \(n = 80\), controls, \(n = 67\)
<table>
<thead>
<tr>
<th>Food group</th>
<th>Nutrition Data System for Research (NDSR), servings per day</th>
<th>Total Mean (SD), median, [95% CI]</th>
<th>Survivors Mean (SD), median, [95% CI]</th>
<th>Controls Mean (SD), median, [95% CI]</th>
<th>Folded F test, p-value</th>
<th>T-test, p-value</th>
<th>Wilcoxon p-value</th>
<th>Chi-square, p-value</th>
<th>USDA food pattern for 1800 kcal</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>84</td>
<td>13</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All vegetables&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3.82 (1.81), 3.33, [3.02, 4.03], 50.0</td>
<td>3.97 (2.07), 3.43, [2.33, 4.24], 46.2</td>
<td>3.79 (1.77), 3.28, [3.02, 4.24], 50.7</td>
<td>0.40</td>
<td>0.75</td>
<td>0.49</td>
<td>0.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non starchy vegetables&lt;sup&gt;3&lt;/sup&gt;</td>
<td>1.85 (1.34), 1.60, [1.30, 1.96], 50.0</td>
<td>1.78 (1.70), 1.14, [0.46, 2.68], 38.5</td>
<td>1.86 (1.28), 1.66, [1.43, 1.98], 52.1</td>
<td>0.14</td>
<td>0.85</td>
<td>0.19</td>
<td>0.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starchy vegetables&lt;sup&gt;4&lt;/sup&gt;</td>
<td>0.42 (0.46), 0.28, [0.09, 0.41], 50.0</td>
<td>0.29 (0.27), 0.25, [0.04, 0.47], 38.5</td>
<td>0.44 (0.48), 1.66, [0.08, 0.59], 52.1</td>
<td>0.03</td>
<td>0.11</td>
<td>0.26</td>
<td>0.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legumes</td>
<td>0.23 (0.26), 0.18, [0.09, 0.29], 50.0</td>
<td>0.39 (0.28), 0.28, [0.19, 0.63], 84.6</td>
<td>0.20, (0.25), 0.08, [0, 0.26], 43.66</td>
<td>0.39</td>
<td>0.04</td>
<td>0.007</td>
<td>0.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All fruits and juice&lt;sup&gt;5&lt;/sup&gt;</td>
<td>2.11 (1.58), 1.75, [1.33, 2.42], 50.0</td>
<td>2.50 (1.68), 2.72, [0.86, 3.85], 61.5</td>
<td>2.03 (1.57), 1.72, [1.31, 2.40], 47.9</td>
<td>0.70</td>
<td>0.31</td>
<td>0.14</td>
<td>0.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All fruit juice&lt;sup&gt;6&lt;/sup&gt;</td>
<td>0.33 (0.56), 0.01, [0.08, 0.12], 51.2</td>
<td>0.17 (0.36), 0.01, [0.03, 0.36], 38.5</td>
<td>0.35 (0.59), 0.01, [0.01, 0.12], 53.5</td>
<td>0.06</td>
<td>0.28</td>
<td>0.27</td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citrus fruit and citrus juice&lt;sup&gt;7&lt;/sup&gt;</td>
<td>0.61 (0.74), 0.28, [0.08, 0.39], 50.0</td>
<td>0.51 (0.58), 0.29, [0, 1.39], 26.0</td>
<td>0.62 (0.77), 0.26, [0.08, 0.26]</td>
<td>0.28</td>
<td>0.60</td>
<td>0.45</td>
<td>0.76</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> Which is 2.5 c/d<sup>20</sup>, which is 5 NDSR servings

<sup>2</sup> Which is 1.5 c/d<sup>21</sup>, which is 3 NDSR servings
<table>
<thead>
<tr>
<th>Food group</th>
<th>Nutrition Data System for Research (NDSR), servings per day</th>
<th>Total Mean (SD), median, [95% CI] % above median</th>
<th>Survivors Mean (SD), median, [95% CI] % above total median</th>
<th>Controls Mean (SD), median, [95% CI] % above total median</th>
<th>Folded F test, p-value</th>
<th>T-test, p-value</th>
<th>Wilcoxon p-value</th>
<th>Chi-square, p-value</th>
<th>USDA food pattern for 1800 kcal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-citrus fruit and fruit juice(^8)</td>
<td></td>
<td>0.67, 50.0</td>
<td>53.9</td>
<td>0.67, 49.3</td>
<td>0.30</td>
<td>0.07</td>
<td>0.04</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>All grains(^9)</td>
<td></td>
<td>4.27 (1.97), 4.06, [3.43, 4.49], 50.0</td>
<td>4.65 (1.63), 5.23, [3.30, 5.70], 61.5</td>
<td>4.20 (2.03), 3.84, [3.35, 4.31], 47.9</td>
<td>0.42</td>
<td>0.45</td>
<td>0.13</td>
<td>0.37</td>
<td>6 oz-eq, of which at least 3 oz-eq should be WG (^{22})</td>
</tr>
<tr>
<td>All whole grains (WG)(^{10})</td>
<td></td>
<td>1.36 (1.12), 1.17, [0.92, 1.52], 47.6</td>
<td>1.29 (0.88), 1.29, [0.28, 2.06], 53.9</td>
<td>1.38 (1.16), 1.16, [0.89, 1.68], 46.5</td>
<td>0.28</td>
<td>0.81</td>
<td>0.49</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>WG flours, breads, pastas, cereals(^{11})</td>
<td></td>
<td>1.05 (0.99), 0.84, [0.50, 1.17], 50.0</td>
<td>0.88 (0.62), 0.94, [0.28, 1.39], 61.5</td>
<td>1.08 (1.05), 0.75, [0.47, 1.33], 52.1</td>
<td>0.05</td>
<td>0.35</td>
<td>0.43</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>WG crackers, chips, popcor ns(^{12})</td>
<td></td>
<td>0.29 (0.46), 0, [0, 0], 45.2</td>
<td>0.40 (0.57), 0, [0, 0.54], 0.33, 61.5</td>
<td>0.27 (0.44), 0, [0, 0.16], 42.3</td>
<td>0.18</td>
<td>0.36</td>
<td>0.16</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>All some whole grains (SWG)(^{13})</td>
<td></td>
<td>0.51 (0.61), 0.23, [0, 0.55], 50.0</td>
<td>0.59 (0.63), 0, [0, 1.33], 0.38, 61.5</td>
<td>0.49 (0.61), 0.23, [0, 0.59], 47.9</td>
<td>0.78</td>
<td>0.58</td>
<td>0.22</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>SWG flours, breads,</td>
<td></td>
<td>0.35 (0.57), 0, 0.49 (0.58), 0, 0.33 (0.57), 0, 0.30, [0, 1.10],</td>
<td>0.86</td>
<td>0.37</td>
<td>0.08</td>
<td>0.09</td>
<td></td>
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</tr>
<tr>
<td>Food group</td>
<td>Total Mean (SD), median, [95% CI]</td>
<td>Survivors Mean (SD), median, [95% CI]</td>
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<td></td>
</tr>
<tr>
<td>pastas, cereals[^14]</td>
<td>[0, 0], 33.3</td>
<td>53.9</td>
<td>[0, 0], 29.6</td>
<td>0.01</td>
<td>0.27</td>
<td>0.33</td>
<td>0.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWG crackers, chips[^15]</td>
<td>0.05 (0.14), 0, [0, 0], 17.9</td>
<td>0.03 (0.07), 0, [0, 0], 15.4</td>
<td>0.06 (0.14), 0, [0, 0], 18.3</td>
<td>0.01</td>
<td>0.27</td>
<td>0.33</td>
<td>0.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All refined grains (RG)[^16]</td>
<td>2.39 (1.83), 2.11, [1.60, 2.58], 50.0</td>
<td>2.76 (1.81), 2.82, [0.78, 4.35], 61.5</td>
<td>2.33 (1.83), 2.09, [1.60, 2.42], 47.9</td>
<td>1.00</td>
<td>0.43</td>
<td>0.19</td>
<td>0.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RG flours, breads, pastas, cereals[^17]</td>
<td>2.25 (1.82), 1.96, [1.50, 2.40], 50.0</td>
<td>2.66 (1.79), 2.82, [0.64, 4.18], 61.5</td>
<td>2.18 (1.83), 1.83, [1.50, 2.27], 47.9</td>
<td>1.00</td>
<td>0.39</td>
<td>0.15</td>
<td>0.37</td>
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<tr>
<td>RG crackers, chips[^18]</td>
<td>0.14 (0.32), 0, [0, 0], 31.0</td>
<td>0.10 (0.16), 0, [0, 0.23], 38.5</td>
<td>0.15 (0.34), 0, [0, 0], 29.6</td>
<td>0.01</td>
<td>0.50</td>
<td>0.34</td>
<td>0.52</td>
<td></td>
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</tr>
<tr>
<td>All snack bars (WG, SWG, RG)[^19]</td>
<td>0.13 (0.26), 0, [0, 0], 25.0</td>
<td>0.09 (0.20), 0, [0, 0], 23.1</td>
<td>0.13 (0.27), 0, [0, 0], 25.4</td>
<td>0.29</td>
<td>0.64</td>
<td>0.42</td>
<td>0.86</td>
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</tr>
</tbody>
</table>

[^1]: T-test p-value is pooled value if F value for equality of variances if p > 0.05, and is Satterthwaite value if p ≤ 0.05; Wilcoxon exact p-value (one-sided) with alpha set at 0.05 using the Monte Carlo option to optimize computational time

[^2]: Includes vegetable based snack (1 serving = 1 oz), dark green vegetables (1 serving = ½ c raw, cooked, or canned; 1c raw leafy), deep yellow vegetables (1 serving = ½ c raw, cooked, or canned), tomatoes (1 serving = ½ c chopped or default form, ½ c tomato sauce , ¼ c tomato puree, ¼ c tomato paste ), white potatoes (1 serving = ½ c chopped or default form, 1 medium baked potato), other starchy vegetables (1 serving = ½ c raw, cooked, or canned; 1 c raw leafy vegetables), vegetable juice (100% vegetable juice; 1 serving = 4 fl oz), other vegetables (1 serving = ½ c raw, cooked, or canned; 1 c raw leafy vegetables), legumes (cooked dried beans; 1 serving = ½ c cooked dry beans; ½ c refried beans; ½ c beans in sauce)

[^3]: Includes dark green vegetables, deep yellow vegetables, and tomato (serving sizes as in footnote 2)
4 Includes white potatoes and other starchy vegetables (serving sizes as in footnote 2)
5 Includes citrus juice (100% juice; 1 serving = 4 fl oz), fruit juice excluding citrus juice (100% juice; 1 serving = 4 fl oz), citrus fruit (1 serving = ½ c chopped or default form of fresh, frozen, or canned; 1 medium piece; ½ fresh grapefruit; ¼ c dried), fruit excluding citrus fruit (1 serving = ½ c chopped or default form of fresh, frozen, or canned; 1 medium piece; ¼ c dried), avocado and similar (1 serving = ½ c chopped or default form), fruit based snack (1 serving = 1 oz)
6 Includes citrus juice and fruit juice excluding citrus juice (serving sizes as in footnote 5)
7 Includes citrus fruit and citrus juice (serving sizes as in footnote 5)
8 Includes fruit juice excluding citrus juice and fruit excluding citrus fruit (serving sizes as in footnote 5)
9 Includes WG/SWG/RG grains, flour and dry mixes (1 serving = ½ c cooked grain/cereal; 16 g flour or cornmeal; 16 g bran or wheat germ; ½ c rice), WG/SWG/RG loaf-type bread and plain rolls (1 serving = 1 slice bread; ½ medium hamburger bun; ½ small bagel; ½ medium English muffin; 1 small roll; 1 medium bread stick), WG/SWG/RG quick breads, corn muffins, tortillas (1 serving = 45 g muffins and quick breads; 38 g French toast, pancake, waffle, biscuit; 45 g cornbread, popovers, Yorkshire pudding; 1 oz croissant; 1 oz tortilla), WG/SWG/RG pasta (1 serving = ½ c), WG/SWG/RG ready to eat cereal (presweetened or not presweetened; 1 serving = 1 oz), WG/SWG/RG crackers (1 serving = 1 oz), WG/SWG/RG snack chips (1 serving = 1 oz), popcorn (1 serving = 1 oz)
10 Includes WG grains, flour and dry mixes, loaf-type bread and plain rolls, quick breads, corn muffins, tortillas, pasta, ready to eat cereal, crackers, snack chips, popcorn (serving sizes as in footnote 9)
11 Includes WG grains, flour and dry mixes, loaf-type bread and plain rolls, quick breads, corn muffins, tortillas, pasta, ready to eat cereal.
12 Includes WG crackers, snack chips, and popcorn (serving sizes as in footnote 9)
13 Includes SWG grains, flour and dry mixes, loaf-type bread and plain rolls, quick breads, corn muffins, tortillas, pasta, ready to eat cereal, crackers, and snack chips (serving sizes as in footnote 9)
14 Includes SWG grains, flour and dry mixes, loaf-type bread and plain rolls, quick breads, corn muffins, tortillas, pasta, ready to eat cereal
15 Includes SWG crackers, and snack chips (serving sizes as in footnote 9)
16 Includes SWG grains, flour and dry mixes, loaf-type bread and plain rolls, quick breads, corn muffins, tortillas, pasta, ready to eat cereal, crackers, snack chips, and popcorn (serving sizes as in footnote 9)
17 Includes SWG grains, flour and dry mixes, loaf-type bread and plain rolls, quick breads, corn muffins, tortillas, pasta, ready to eat cereal
18 Includes SWG crackers, snack chips, and popcorn (serving sizes as in footnote 9)
19 Includes WG/SWG/RG snack bars (granola bar, energy bar, meal replacement bar; 1 serving = 40 g)
20 USDA servings sizes: 1 cup of vegetables include dark green vegetables (1 c raw chopped broccoli, 1 c cooked greens, 2 c raw leafy greens), red and orange vegetables (1 c raw/cooked carrots, 1 c mashed pumpkin, 1 cup raw chopped pepper, 1 large tomato or 1 c raw chopped tomato, 1 c tomato juice, 1 large sweet potato, 1 c cubed winter squash), beans and peas (1 c cooked, whole or mashed), and
other vegetables (1 c cooked bean sprouts, 1 c chopped raw/cooked cabbage, 1 c raw/cooked cauliflower, 1 c diced raw/cooked celery, 1 c raw cucumbers, 1 c cooked green beans, 1 c chopped raw/cooked green peppers, 2 c raw chopped lettuce, 1 c raw/cooked mushrooms, 1 c raw onions, 1 c raw squash)

21 USDA serving sizes: 1 cup of fruit includes apple (½ large, 1 small, 1 c raw/cooked chopped), applesauce (1 c), banana (1 c, sliced or 1 large), cantaloupe (1 c diced/ball), grapes (1 c or 32 seedless), grapefruit (1 medium or 1 c sections), mixed fruit (1 c), orange (1 orange or 1 c sections), peach (1 large), pear (1 medium), pineapple (1 c chunks, sliced, crushed), plum (3 medium or 2 large), strawberries (8 large), watermelon (1 small wedge), dried fruit (½ c), 100% fruit juice (1 c or 8 fl oz)

22 USDA serving sizes: 1 oz eq of grains includes bagels (1 mini), biscuits (1 small), breads (1 regular slice, small slice French, 4 snack size), bulgur (½ c cooked), cornbread (1 small piece), crackers (5 whole wheat, 2 rye crispbreads, 7 square or round), English muffins (1 small), oatmeal (½ c cooked, 1 packet instant, 1 oz dry), pancakes (1 pancake, 2 small pancakes), popcorn (3 c, popped), ready to eat cereal (1 c flakes, 1 ¼ c puffed), rice (½ c cooked, 1 oz dry), pasta (½ c cooked, 1 oz dry), tortillas (1 small flour tortilla, 1 corn tortilla)
Table 3.3 Nutrient intakes in postmenopausal breast cancer survivors and their controls

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Total Mean (SD), median or %, [95% CI]</th>
<th>Survivors Mean (SD), median or %, [95% CI]</th>
<th>Controls Mean (SD), median or %, [95% CI]</th>
<th>Folded F test, p-value</th>
<th>T-test, p-value</th>
<th>Wilcoxon, p-value</th>
<th>Chi-Sq, p-value (RDA)</th>
<th>RDA women 51-70 y</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>84</td>
<td>13</td>
<td>71</td>
<td></td>
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<tr>
<td>Energy (kcal/d)</td>
<td>1787 (426), 1717, [1600, 1869]</td>
<td>1729 (333), 1745, [1363, 2133]</td>
<td>1798 (442), 1690, [1592, 1906]</td>
<td>0.28</td>
<td>0.60</td>
<td>0.43</td>
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<tr>
<td>Carbohydrates (g/d)</td>
<td>198 (59.0), 191, [18, 211]</td>
<td>213 (56.7), 190, [186, 260]</td>
<td>195 (59.3), 191, [166, 213]</td>
<td>0.92</td>
<td>0.31</td>
<td>0.13</td>
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<tr>
<td>Carbohydrates (g/1000 kcal/d)</td>
<td>111 (21.8), 110, [105, 117]</td>
<td>123 (20.0), 116, [107, 158]</td>
<td>109 (21.5), 108, [103, 115]</td>
<td>0.82</td>
<td>0.03</td>
<td>0.02</td>
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</tr>
<tr>
<td>Carbohydrates (% met or exceeded RDA)</td>
<td>88.1</td>
<td>92.3</td>
<td>87.3</td>
<td>0.61</td>
<td>130 g/d</td>
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<tr>
<td>Calories from carbohydrates (%)</td>
<td>43.0 (8.32), 42.7, [40.8, 44.0]</td>
<td>47.7 (7.69), 45.1, [41.1, 58.0]</td>
<td>42.2 (8.2), 42.3, [40.0, 44.0]</td>
<td>0.86</td>
<td>0.03</td>
<td>0.01</td>
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<tr>
<td>Calories from alcohol (%)</td>
<td>3.78 (4.68), 1.86, [0.04, 3.43]</td>
<td>0.52 (0.82), 0, [0, 1.42]</td>
<td>4.37 (4.85), 3.03, [0.27, 5.44]</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td></td>
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<tr>
<td>Total dietary fiber (g/d)</td>
<td>22.4 (7.40), 21.3, [19.7, 23.3]</td>
<td>24.5 (8.38), 20.6, [19.2, 31.5]</td>
<td>22.0 (7.21), 21.5, [19.1, 23.8]</td>
<td>0.42</td>
<td>0.26</td>
<td>0.22</td>
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</tr>
<tr>
<td>Total dietary fiber (g/1000 kcal/d)</td>
<td>13.02 (4.9), 11.6, [11.1, 13.5]</td>
<td>14.3 (3.78), 14.1, [11.3, 16.8]</td>
<td>12.8 (5.07), 11.5, [11.3, 16.8]</td>
<td>0.26</td>
<td>0.32</td>
<td>0.06</td>
<td></td>
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</tr>
<tr>
<td>Nutrient</td>
<td>Total Mean (SD), median or %, [95% CI]</td>
<td>Survivors Mean (SD), median or %, [95% CI]</td>
<td>Controls Mean (SD), median or %, [95% CI]</td>
<td>Folded F test, p-value</td>
<td>T-test, p-value</td>
<td>Wilcoxon, p-value</td>
<td>Chi-Sq, p-value (% RDA)</td>
<td>RDA women 51-70 y</td>
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</tr>
<tr>
<td>Total dietary fiber (% met or exceeded RDA)</td>
<td>51.2 [11.1, 13.2]</td>
<td>46.2</td>
<td>52.1</td>
<td>0.69</td>
<td>21 g/d</td>
<td></td>
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</tr>
<tr>
<td>Total dietary fiber (g/1000 kcal/d, % met or exceeded AI)</td>
<td>32.1</td>
<td>53.9</td>
<td>28.2</td>
<td>0.07</td>
<td>14 g/1000 kcal/d</td>
<td></td>
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<tr>
<td>Soluble dietary fiber (g/d)</td>
<td>6.72 (2.33), 6.32, [5.74, 7.06]</td>
<td>7.14 (3.27), 6.28, [4.63, 11.3]</td>
<td>6.64 (2.13), 6.34, [2.00, 7.30]</td>
<td>0.03</td>
<td>0.60</td>
<td>0.43</td>
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<tr>
<td>Insoluble dietary fiber (g/d)</td>
<td>15.6 (5.71), 14.5, [13.3, 16.4]</td>
<td>17.3 (6.20), 14.4, [13.4, 22.0]</td>
<td>15.3 (5.61), 14.6, [12.9, 16.4]</td>
<td>0.57</td>
<td>0.24</td>
<td>0.14</td>
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</tr>
<tr>
<td>Vitamin K (mcg/d)</td>
<td>241 (287), 152, [136, 178]</td>
<td>215 (154), 173, [70.0, 323]</td>
<td>245 (306), 149, [135, 178]</td>
<td>0.01</td>
<td>0.59</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin K (mcg/1000 kcal/d)</td>
<td>141 (185), 95.1, [76.9, 121]</td>
<td>124 (79.4), 123, [41.4, 173]</td>
<td>144 (199), 90.9, [77.0, 117]</td>
<td>0.001</td>
<td>0.54</td>
<td>0.34</td>
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</tr>
<tr>
<td>Vitamin K (% met or exceeded AI)</td>
<td>77.4</td>
<td>77.0</td>
<td>77.5</td>
<td>0.97</td>
<td>90 mcg/d²</td>
<td></td>
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<tr>
<td>Vitamin C (mg/d)</td>
<td>104 (59.1), 94.0, [47.3, 62.2]</td>
<td>109 (63.5), 102, [58.0, 147]</td>
<td>104 (58.7), 92.5, [92.5, 147]</td>
<td>0.64</td>
<td>0.75</td>
<td>0.39</td>
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<tr>
<td>Nutrient</td>
<td>Total Mean (SD), median or %, [95% CI]</td>
<td>Survivors Mean (SD), median or %, [95% CI]</td>
<td>Controls Mean (SD), median or %, [95% CI]</td>
<td>Folded F test, p-value</td>
<td>T-test, p-value</td>
<td>Wilcoxon, p-value</td>
<td>Chi-Sq, p-value (% RDA)</td>
<td>RDA women 51-70 y</td>
</tr>
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<tr>
<td>Vitamin C (mg/1000 kcal/d)</td>
<td>61.0 (36.4), 52.1, [78.7, 106]</td>
<td>65.3 (36.3), 59.9, [33.2, 108]</td>
<td>60.1 (36.6), 51.7, [47.3, 62.2]</td>
<td>1.00</td>
<td>0.63</td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin C (% met or exceeded RDA)</td>
<td>65.5</td>
<td>61.5</td>
<td>66.2</td>
<td>0.75</td>
<td></td>
<td></td>
<td>75 mg/d</td>
<td></td>
</tr>
<tr>
<td>Vitamin A (RAE mcg/d)</td>
<td>981 (724), 780, [672, 981]</td>
<td>1119 (1440), 772, [389, 1232]</td>
<td>956 (512), 788, [697, 1040]</td>
<td>0.0001</td>
<td>0.69</td>
<td>0.15</td>
<td></td>
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</tr>
<tr>
<td>Vitamin A (RAE mcg/1000 kcal/d)</td>
<td>577 (520), 474, [397, 536]</td>
<td>730 (1155), 411, [197, 577]</td>
<td>549 (295), 480, [417, 553]</td>
<td>0.0001</td>
<td>0.59</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A (% met or exceeded RDA)</td>
<td>59.5</td>
<td>53.9</td>
<td>60.6</td>
<td>0.65</td>
<td></td>
<td></td>
<td>700 mcg/d</td>
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<tr>
<td>Alpha-carotene (mcg/d)</td>
<td>846 (1152), 392, [184, 520]</td>
<td>578 (522), 448, [141, 933]</td>
<td>895 (604), 381, [162, 685]</td>
<td>0.002</td>
<td>0.13</td>
<td>0.41</td>
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<tr>
<td>Beta-carotene (mcg/d)</td>
<td>6083 (5312), 4677, [3300, 6300]</td>
<td>5218 (3974), 3769, [1734, 9576]</td>
<td>6241 (5531), 4796, [3300, 6337]</td>
<td>0.21</td>
<td>0.53</td>
<td>0.37</td>
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<tr>
<td>Beta-carotene equivalents (mcg/d)</td>
<td>6584 (5690), 5032, [3674, 6801]</td>
<td>5582 (4210), 4186, [2016, 10085]</td>
<td>6767 (5927), 5167, [3674, 7288]</td>
<td>0.19</td>
<td>0.49</td>
<td>0.35</td>
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<tr>
<td>Nutrient</td>
<td>Total Mean (SD), median or %, [95% CI]</td>
<td>Survivors Mean (SD), median or %, [95% CI]</td>
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<td>Folded F test, p-value</td>
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<td>RDA women 51-70 y</td>
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<tr>
<td>Beta-cryptoxanthin (mcg/d)</td>
<td>156 (287), 71.6, [53.7, 91.0]</td>
<td>148 (144), 113, [27.7, 235]</td>
<td>157 (307), 71, [53.7, 87.5]</td>
<td>0.006</td>
<td>0.89</td>
<td>0.24</td>
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<tr>
<td>Dietary folate equivalents (mcg/d)</td>
<td>508 (216), 451, [406, 534]</td>
<td>545 (157), 575, [338, 687]</td>
<td>501 (225), 447, [402, 505]</td>
<td>0.17</td>
<td>0.51</td>
<td>0.10</td>
<td></td>
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</tr>
<tr>
<td>Dietary folate equivalents (mcg/1000 kcal/d)</td>
<td>294 (137), 264, [240, 280]</td>
<td>319 (89.4), 329, [240, 407]</td>
<td>289 (144), 256, [253, 277]</td>
<td>0.07</td>
<td>0.47</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dietary folate equivalents (% met or exceeded RDA)</td>
<td>64.3</td>
<td>77.0</td>
<td>62.0</td>
<td></td>
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<tr>
<td>Natural folate (mcg/d)</td>
<td>275 (94.0), 258, [228, 278]</td>
<td>301 (138), 276, [181, 445]</td>
<td>270 (84.2), 257, [228, 278]</td>
<td>0.01</td>
<td>0.44</td>
<td>0.38</td>
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<tr>
<td>Synthetic folate (mcg/d)</td>
<td>137 (122), 109, [93.0, 134]</td>
<td>143 (79.1), 116, [92.7, 226]</td>
<td>135 (129), 105, [86.8, 134]</td>
<td>0.07</td>
<td>0.77</td>
<td>0.17</td>
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<tr>
<td>Potassium (mg/d)</td>
<td>2793 (726), 2664, [2422, 2844]</td>
<td>2725 (919), 2386, [2142, 3766]</td>
<td>2806 (692), 2800, [2544, 2865]</td>
<td>0.14</td>
<td>0.71</td>
<td>0.17</td>
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</tr>
<tr>
<td>Potassium (mg/1000 kcal/d)</td>
<td>1610 (429), 1576, [1404, 1654]</td>
<td>1589 (457), 1515, [1151, 2097]</td>
<td>1614 (426), 1593, [1417,1674]</td>
<td>0.67</td>
<td>0.85</td>
<td>0.31</td>
<td></td>
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<tr>
<td>Potassium (% met or exceeded RDA)</td>
<td>1.19</td>
<td>7.69</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td>0.02</td>
<td>4700 mg/d</td>
</tr>
<tr>
<td>Nutrient</td>
<td>Total Mean (SD), median or %, [95% CI]</td>
<td>Survivors Mean (SD), median or %, [95% CI]</td>
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<tr>
<td>Sodium (mg/d)</td>
<td>2917 (820), 2844, [2648, 3082]</td>
<td>2809 (724), 2893, [2124, 3957]</td>
<td>2937 (839), 2834, [2652, 3119]</td>
<td>0.59</td>
<td>0.61</td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium (mg/1000 kcal/d)</td>
<td>1648 (349), 1660, [1476, 1720]</td>
<td>1625 (290), 1589, [1331, 2214]</td>
<td>1653 (360), 1667, [1463, 1740]</td>
<td>0.41</td>
<td>0.80</td>
<td>0.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium (% met or exceeded RDA)</td>
<td>98.8</td>
<td>100</td>
<td>98.6</td>
<td>0.67</td>
<td></td>
<td></td>
<td>1300 mg/d</td>
<td></td>
</tr>
<tr>
<td>Sodium/potassium ratio</td>
<td>1.09 (0.36), 1.05, [0.98, 1.17]</td>
<td>1.09 (0.31), 1.09, [0.73, 1.41]</td>
<td>1.10 (0.37), 1.05, [0.98, 1.17]</td>
<td>0.48</td>
<td>0.94</td>
<td>0.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium (mg/d)</td>
<td>313 (91.9), 293, [270, 321]</td>
<td>317 (109), 289, [223, 390]</td>
<td>312 (89.3), 294, [270, 323]</td>
<td>0.29</td>
<td>0.87</td>
<td>0.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium (mg/1000 kcal/d)</td>
<td>179 (46.3), 172.0, [160, 191]</td>
<td>185 (50.8), 183, [144, 232]</td>
<td>178 (45.7), 171, [156, 191]</td>
<td>0.55</td>
<td>0.61</td>
<td>0.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium (% met or exceeded RDA)</td>
<td>39.3</td>
<td>30.8</td>
<td>40.9</td>
<td>0.49</td>
<td></td>
<td></td>
<td>320 mg/d</td>
<td></td>
</tr>
</tbody>
</table>

1 T-test p-value is pooled value if F value for equality of variances if p > 0.05, and is Satterthwaite value if p ≤ 0.05; Wilcoxon p-value is from the Wilcoxon exact test (one-sided)
2 Adequate Intake, not Recommended Dietary Allowance
<table>
<thead>
<tr>
<th>Alcoholic beverage or nonnutritive sweeteners</th>
<th>Total mean (SD), median, [95% CI], % above median</th>
<th>Survivors mean (SD), median, [95% CI], % above median</th>
<th>Controls mean (SD), median, [95% CI], % above median</th>
<th>Chi-square, p-value</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcoholic beverages or nonnutritive sweeteners Nutrition Data System for Research (NDSR), servings per day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>84</td>
<td>13</td>
<td>71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All alcoholic beverages (servings/d)</td>
<td>0.66 (0.82), 0.40, [0, 0.67]</td>
<td>0.11 (0.18), 0, [0, 0.33]</td>
<td>0.76 (0.85), 0.53, [0.01, 0.81]</td>
<td>0.09</td>
<td>USDA and American Cancer Society recommends ≤ 1 serving/d</td>
</tr>
<tr>
<td>Alcoholic beverages recommendation (% exceeded)</td>
<td>27.4</td>
<td>0</td>
<td>32.4</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Wine</td>
<td>0.45 (0.70), 0, [0, 0.36]</td>
<td>0.01 (0.02), 0, [0, 0]</td>
<td>0.53 (0.73), 0.02, [0, 0.53]</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>Beer</td>
<td>0.09 (0.26), 0, [0, 0]</td>
<td>0.05 (0.13), 0, [0, 0]</td>
<td>0.10 (0.27), 0, [0, 0]</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>Liquors</td>
<td>0.12 (0.39), 0, [0, 0]</td>
<td>0.06 (0.14), 0, [0, 0]</td>
<td>0.13 (0.42), 0, [0, 0]</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>All nonnutritive sweeteners (mg/d)</td>
<td>87.3 (199), 0, [0, 18.0]</td>
<td>18.7 (40.0), 0, [0, 30.4]</td>
<td>99.8 (214), 0, [0, 24.2]</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Sucralose</td>
<td>56.5 (194), 0, [0, 20.2]</td>
<td>0 (0), 0, [0, 0]</td>
<td>67.0 (210), 0, [0, 0]</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Saccharin</td>
<td>2.10 (8.86), 0, [0, 5.95]</td>
<td>0 (0), 0, [0, 0]</td>
<td>2.49 (9.60), 0, [0, 0]</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>Acesulfame potassium</td>
<td>1.11 (3.68), 0, [0, 13.1]</td>
<td>0 (0), 0, [0, 0]</td>
<td>1.31 (3.98), 0, [0, 0]</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>Aspartame</td>
<td>27.4 (65.4), 0, [0, 27.4]</td>
<td>18.7 (40.0), 0, [0, 23.1]</td>
<td>29.0 (69.1), 0, [0, 0]</td>
<td>0.71</td>
<td></td>
</tr>
</tbody>
</table>
1 Many of the participants did not consume these alcoholic beverage or nonnutritive sweeteners so differences between survivors and controls were assessed by Chi-square analyses, rather than T-tests or Wilcoxon tests

2 Includes beer and ales (1 serving = 12 fl oz), cordial and liqueur (1 serving = 1.5 fl oz), distilled liquor (1 serving = 1.5 fl oz), and wine (1 serving = 5 fl oz table wine, 3 fl oz dessert wine); these serving sizes are the same for NDSR and USDA

3 Includes table wine (5 fl oz) and dessert wine (3 fl oz)

4 Includes beer and ales (12 fl oz)

5 Includes liquors, cordials, and liqueurs (1.5 fl oz)

6 Includes aspartame, sucralose, saccharin, and acesulfame potassium (all mg)
CHAPTER 4

SUMMARY

The purpose of this study was to determine the differences in consumption of plant based foods, alcohol, and nonnutritive sweeteners in postmenopausal breast cancer survivors and their controls in the northeast Georgia area. The findings of this study support that there are some significant differences in consumption of these foods. Specifically, the Wilcoxon exact tests and chi-square analyses indicate significant differences in consumption of legumes, non-citrus fruits and juices, wine, and sucralose, with survivors consuming more legumes and non-citrus fruits and juices, and less wine and sucralose. These differences in food patterns also resulted in some differences in intakes of fiber, dietary folate, and carbohydrates. These findings also indicate that many of the breast cancer survivors are attempting to follow the recommendations set forth by the American Cancer Society; however, the average fruit and vegetable intake for both groups was less than the recommended amount. This suggests a need for nutrition education or nutrition interventions in order to increase fruit and vegetable consumption in this population. Results indicate that many postmenopausal women who have no history of cancer are possibly at higher risk of developing breast cancer based on their higher consumption of alcohol with around one-third of the participants consuming more than the recommendation of one or less alcoholic beverages per day (USDA, American Cancer Society 2012).

This study also brings to light the increased need for further research in regard to nonnutritive sweeteners and their possible carcinogenic risk. None of the survivors reported consuming sucralose, saccharin, or acesulfame potassium; however, the survivors report small
amounts of aspartame and the controls reported consumption of all four nonnutritive sweeteners examined. While there is no scientific evidence that nonnutritive sweeteners cause an increase carcinogenic risk in humans, the American Cancer Society recommends limiting consumption of these products in order to prevent diagnosis or recurrence of cancer (American Cancer Society 2012). This is an area of research that needs further expansion and explanation in order to determine their relationship with cancer. The results of this study are important because they add to the growing understanding of the need for further nutrition education and intervention in postmenopausal women with and without a history of breast cancer in the northeast Georgia area.

This feasibility study indicated it is difficult to recruit postmenopausal breast cancer survivors from the Athens and northeast Georgia area. Thus, any future studies may need to utilize additional recruitment strategies, expand the recruitment region, and/or develop study designs that can be employed in relatively small samples. For example, well-designed lifestyle intervention studies of nutrition and exercise that followed women longitudinally might be able to show improved dietary patterns and physical function over time. Given the interest in pursuing a healthy lifestyle among older women and among cancer survivors (Kushi et al 2012), perhaps lifestyle interventions might be able to attract a larger number of postmenopausal breast cancer survivors.

Additional analyses other than those conducted in this project and the related project by Lay (2014) could be done with this existing data set. Although the initial aim was to explore whether higher fiber intake was related to lower feelings of fatigue, vigor, vitality, preliminary analyses indicated that fiber was either not related to these measures or was related in the opposite direction of the hypotheses (Appendix C). Given the strong relationships of physical
activity with physical function in a subgroup of these women uncovered by Ward-Ritacco et al (2013), perhaps future analyses could explore the relationships of dietary patterns with physical activity and physical function in these women.
REFERENCES


Pakiz Effects of weight loss intervention on body mass, fitness, and inflammatory biomarkers in overweight or obese breast cancer survivors.


APPENDICES

Appendix A – 3 Day diet record instructions and log
1. Record everything you ate or drank during the 24-hour time periods indicated (12:01 a.m. to midnight). **Repeat this for a total of 3 days (2 week days, 1 weekend day).**

2. To the best of your ability, describe combination or mixed dishes that were eaten. For example, what ingredients were included on that piece of pizza? Was it thick or thin crust? Did it have toppings? What kind and how much? Did you add red pepper or grated cheese? Include brand names if known.

3. Describe the amounts consumed in terms appropriate for that item. For example: ounces (cups) of milk, tablespoons of French dressing, slices of bread, pieces of fruit, etc. If you had a piece of pizza, how big was it in inches or sections, etc.? Record exact amounts to the best of your ability.

   **Sample Breakfast**
   
<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raisin bran cereal</td>
<td>1 cup.</td>
</tr>
<tr>
<td>2% milk</td>
<td>6 oz.</td>
</tr>
<tr>
<td>Orange</td>
<td>1 medium size, 3” diameter</td>
</tr>
<tr>
<td>Toast (whole wheat)</td>
<td>1 slice</td>
</tr>
<tr>
<td>with butter</td>
<td>1 teaspoon</td>
</tr>
<tr>
<td>with strawberry jam</td>
<td>1 tablespoon</td>
</tr>
<tr>
<td>Coffee</td>
<td>1 cup (8 oz.)</td>
</tr>
<tr>
<td>with sugar</td>
<td>2 teaspoons</td>
</tr>
</tbody>
</table>

4. Remember to include beverages and anything you may add to them, such as milk or sweetener.

5. Remember to include anything added to a food after it is prepared, such as margarine, salt, ketchup, mustard and the estimated amount.

6. If you need additional space, please feel free to attach additional sheets.

7. Please answer the question at the bottom of the day’s record. (Does this day’s record represent your usual food intake? ___ Yes ___ No). If your answer is no, explain why it wasn’t representative. Were you ill or are you on a special diet? Did you have unexpected guests and you took them out to dinner?

8. If you have any other questions concerning the food diary, please call the Body Composition and Metabolism Laboratory at (706) 389-4272 or email our team at uga.beml@gmail.com.
<table>
<thead>
<tr>
<th>Day of the Week: MON</th>
<th>TUES</th>
<th>WED</th>
<th>THURS</th>
<th>FRI</th>
<th>SAT</th>
<th>SUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time/Meal</td>
<td>Food, Beverage, Condiments</td>
<td>Amount Eaten (grams, cups, tsp, Tbsp, oz, etc)</td>
<td>Brand/Name How prepared</td>
<td>Home/Out</td>
<td></td>
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</tr>
</tbody>
</table>

Does this day’s record represent your usual days’ intake? _____ yes _____ no

If no, explain why not ___________________________
Appendix B – Accelerometer instructions and log

UGA Body Composition and Metabolism Laboratory
Activity Monitor (Hybrid Pedometer): Instructions for Use

Our Thanks to You!

Thank you for agreeing to wear a hybrid pedometer (ACTIVITY MONITOR) as part of our study. These instructions are intended to help you get started. An e-mail address is provided at the end of these instructions should you need to contact us. Thanks again!

Checklist (Your “To Do” List)

1. Read these instructions carefully. They contain important information regarding the proper use of your Activity Monitor.

2. Record the serial number of the monitor you have been given in the space provided. It is etched on the side of the device. DO NOT exchange this monitor for that of a friend. BE SURE TO WEAR ONLY THIS MONITOR FOR THE 7 DAY PERIOD.

3. Begin wearing your activity monitor on the Requested Start Date.

4. Record the date and time when you begin wearing it next to Actual Start Date on the Activity Monitor: Record of Use form.

5. Record the number of steps and the activity minutes that are displayed on your monitor each night before you go to bed on the form provided to you.

6. Stop wearing the monitor on the Requested End Date.

7. Record the date and time when you stop wearing it next to Actual End Date on the Activity Monitor: Record of Use form.

8. Please return the Activity Monitor and Record of Use form when you return for Visit Two.

When to Wear the Activity Monitor

- First, consult the Activity Monitor: Record of Use form for the specific dates you should be wearing your Activity Monitor.
- The total time you will be wearing the Activity Monitor will be seven days.
- You should wear it throughout the day. The only times you should NOT wear the monitor are:
  - While you are sleeping
  - When you shower, bathe or swim

How to Wear the Activity Monitor

You will wear the activity monitor at your waist, clipped to the waistband of your pants or clipped to a belt, if you do not generally wear garments with a waistband.

Hybrid Pedometer Instructions
The activity monitor should be worn on your **non-dominant hip**. In other words, if you are right-handed, the monitor should be on your left hip. (The opposite is true if you are left-handed.) Notice in the picture on the next page how our right-handed model is waving her right hand in the air while wearing the activity monitor on her left hip.

![Image of a woman waving with the activity monitor on her left hip]

*Steri is right handed and is waving that hand.*

*She is wearing the Activity Monitor on her left hip with the arrow pointing up.*

**Caring for the Activity Monitor**

- You will probably not need to clean the Activity Monitor. If it gets dirty, however, simply wiping it with a damp (not wet) rag should be sufficient.

**Returning the Activity Monitor**

After you have worn the Activity Monitor for 7 days, we ask that you return it to us. When returning the Activity Monitor to us, you should:

- Remove it from your waist.
- Remember to record your actual end date on the **Activity Monitor: Record of Use** form.
- Wrap the belt around the Activity Monitor and hold secure with a rubber band.
- Please return your **Activity Monitor: Record of Use** form as well.

If you are experiencing problems with your activity monitor or have questions, please call or e-mail:

Christie L. Ward  
ugabcml@gmail.com  
Body Composition and Metabolism Laboratory  
706-389-4272
## UGA Body Composition and Metabolism Laboratory Activity Monitor (Hybrid Pedometer) Record of Use Form

As a participant in this program, we ask that you wear your Activity Monitor (accelerometer) for a period of 7 days. Please begin wearing the monitor on the **Requested Start Date**. If you start late or skip a day for any reason, please wear the monitor for an extra day so that you wear it for a full seven days.

**Requested Start Date:**
**Actual Start Date:**
**Requested End Date:**
**Actual End Date:**

Please record the actual dates/times you wore the accelerometer in the table below.

<table>
<thead>
<tr>
<th>Date</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of day you put on the unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steps per day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>For research use only</td>
<td></td>
<td></td>
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<tr>
<td>Activity minutes per day</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>For research use only</td>
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</tr>
<tr>
<td>Time of day you took off the unit</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record any time you did not wear the unit? Please list the activity and how many minutes you did not wear the activity monitor (e.g., naps, swimming, showering)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
In the space provided, please provide comments about problems that occurred while you were wearing the unit.

<table>
<thead>
<tr>
<th></th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
</tr>
</thead>
</table>

Please contact the Body Composition and Metabolism Laboratory at 706-389-4272 or ugabcm1@gmail.com if you have any questions about your pedometer.
Appendix C - Dietary fiber and feelings of fatigue, vigor, and vitality in postmenopausal breast cancer survivors literature and analyses

Introduction

My original hypothesis for my masters’ thesis was that higher fiber would be associated with lower fatigue and more vitality and vigor. This Appendix C summarizes the literature review and preliminary analyses to assess a possible relationship of fiber with fatigue, vitality and vigor. Since these preliminary analyses did not support this hypothesis, I devoted my thesis to the hypothesis that postmenopausal breast cancer survivors and their controls would differ in their intake of certain plant foods, alcohol and nonnutritive sweeteners.

Feelings of fatigue, vigor, vitality

Fatigue, vigor, and vitality are considered moods and moods are often difficult to conceptualize and measure (O’Connor 2012). There is no consensus on how to categorize these feelings or moods, but, in general, they can be conceptualized into two categories, which are feelings of energy and feelings of fatigue (O’Connor 2012). Feelings or moods of energy are present when one feels that they have the ability to accomplish a mental or physical activity (O’Connor 2012). The feeling or mood of fatigue is present when this ability diminishes (O’Connor 2012).

Feelings of fatigue in post-menopausal breast cancer survivors and controls

With over 47% of otherwise healthy adults reporting increased feelings of fatigue, it is pertinent to note that there is a higher prevalence of feelings of fatigue in post-menopausal women versus men of similar ages (29.1% vs 15.3%, Vestergaard et al 2009). Over 60-70% of breast cancer survivors report feelings of fatigue between moderate and severe, and it is an
important concern for their quality of life (Sprangers et al 1996, Bower et al 2000). Estrogen production has ceased in post-menopausal women and this can be associated with negative health effects (Gold et al 2001, Messier et al 2011). Negative health effects include increased visceral adiposity, diabetes mellitus, decreased physical activity, decreased physical functioning, decreased muscle mass, and decreased muscle strength (Carr 2003, Aloia et al 1991). These changes can lead to greater feelings of fatigue and lower feelings of energy (Puetz 2006). It is estimated that around 50% of women younger than 50 y who have been treated with medications and adjuvant chemotherapy after being diagnosed with breast cancer have experience early ovarian failure (Gross et al 2002). Due to the combination of the aging process and the treatment of breast cancer, there may be greater feelings of fatigue that occurs from systemic inflammation in women who are PM-BCS, than those who are simply post-menopausal (Bower et al 2002).

**Fiber**

Plants and plant products contain a substance known as fiber (Institute of Medicine 2002). The edible form of fiber is known as dietary fiber and it can be find in fruits, vegetables, and grains (Institute of Medicine 2002). The two types of dietary fiber are known as soluble and insoluble (Institute of Medicine 2002). Fiber has been found to be helpful with weight loss due to its ability to create bulk in one’s diet, which leads to longer feelings of satiety (Institute of Medicine 2002). Fiber is also helpful with digestion and can relieve constipation and help treat diverticulitis (Institute of Medicine 2002).

Soluble fiber is the type of fiber that helps slow digestion due to its ability to attract water and become a gel-like substance in the gastrointestinal tract (Institute of Medicine 2002). This
type of fiber can be found in food products such as barley, oat bran, nuts, seeds, lentils, peas and some fruits and vegetables (Institute of Medicine 2002). Insoluble fiber helps speed the passage of food through the digestive tract and adds bulk to stool (Institute of Medicine 2002). Insoluble fiber is found in food products such as wheat bran, vegetables, and whole grains (Institute of Medicine 2002).

The recommended amount of dietary fiber intake can be beneficial, but higher intakes can lead to negative side effects, such as flatulence, bloating, and abdominal cramping (Institute of Medicine 2002). Increasing fiber intake above the recommended amount can also cause the absorption of certain minerals, such as iron, zinc, and magnesium, to be hindered (Institute of Medicine 2002).

Inadequate dietary fiber intake

The overall average dietary fiber intake for Americans is between 10-15 g per day (USDA 2010). The fiber recommendation for women over the age of 50 y is 21 g/d (Institute of Medicine 2002). In women over 18 y of age in 1999-2008, average fiber intake was 8.1 g/d/1000 kcal (King et al 2012). Due to previous evidence of inadequate fiber intake in the US population, efforts in public health have been put forth to increase fiber intake over the past 10 y (King et al 2012). It has been found that dietary fiber absorption is preferred over fiber supplements; therefore, the source of the fiber being consumed is important in older adult women (King and Player 2010, King et al 2012). Fruits, vegetables, and whole grains are whole food sources that are high in fiber and have been associated with positive health effects (King and Player 2010). Hsiao et al (2013) found that regardless of whether an older adult was consuming a healthy diet
according to the Healthy Eating Index, less than 10% of their participants exceeded the 2005 daily recommendation for fiber ($n = 416$). Thus, there is evidence that older adults are not consuming adequate amounts of dietary fiber.

**Feelings of fatigue and dietary fiber intake**

Higher dietary fiber intake was associated with decreased feelings of fatigue in female breast cancer survivors (18-70 y, $n = 42$, $P < 0.05$, Guest et al 2013). Smith et al (2001) reported that higher fiber intake correlated with decreased feelings of fatigue in a sample of men and women (mean age = 52 y, $r = -0.20$, $n = 142$). There are some possible reasons why inadequate dietary fiber intake might be a causal factor in increased feelings of fatigue: 1) poor overall diet quality, including low intakes of fruits and vegetables could affect feelings of fatigue (Guest et al 2013), and 2) dietary fiber has been found to be inversely related to circulating inflammatory markers interleukin 6 and tumor necrosis factor α receptor 2 in post-menopausal women, which are believed to “influence a central nervous system-mediated syndrome of sickness behavior that induces fatigue through decreased glucocorticoid signaling and under regulation of nuclear factor-κB activity” (Ma et al 2008, Alfano et al 2012).

**Significance of research on dietary fiber intake and feelings of fatigue, vigor, and vitality**

Decreased feelings of energy in post-menopausal breast cancer survivors is a common complaint; however, little is known about modifiable risk factors for decreased feelings of energy and increased feelings of fatigue beyond suggesting a healthy and active lifestyle (Guest et al 2013). The proposed research is significant because identification of modifiable risk factors
has the potential to decrease the perceived feelings of fatigue and increase feelings of energy experienced in post-menopausal years for women. Evidence is emerging from recent studies that health-related factors and chronic diseases such as type 2 diabetes, coronary heart disease, metabolic disease, and cancer may be related to an increase in inflammation markers, which may in turn be related to feelings of fatigue (Ma et al 2008). Evidence is also emerging that nutrition-related factors, such as inadequate fiber intake, might be a possible risk factor for high feelings of fatigue (Guest et al 2013).

**Methods**

Elsewhere in this thesis is a description of the sample of women (N = 84) and the dietary methodology for assessing the intake of fiber and related foods (3-day dietary records analyzed with the University of Minnesota’s Nutrition Data System for Research, 2013). Feelings of vitality were measured using the Vitality Scale of the SF-36, which is used to obtain perceptions of energy and lack of fatigue over the previous four weeks (Ware JE et al 1992). The fatigue and vigor sections of the Profile of Mood States Brief (POMS-B) were used to determine feelings of fatigue and feelings of vigor during the past week (McNair DM et al 1971).

**Statistical analyses**

Correlations (Table C.1, C.2) were conducted to examine the relationships between total fiber (g/d), soluble fiber (g/d), insoluble fiber (g/d), energy (kcal/d), POMS vigor, POMS fatigue, and SF36 vitality. Correlations were also conducted to examine relationships between the all vegetables food group, all grains food group, all fruits and juices food group, all alcoholic beverages, all nonnutritive sweeteners, POMS vigor, POMS fatigue, and SF36 vitality. However,
there were no significant correlations observed or the correlations were in the opposite direction of the hypotheses.

The strong correlation of some measures of fiber intake with energy intake indicated that regression analyses were needed that controlled for the intake of energy from food. In a series of regression models where the independent variables were group (control or survivor), one of the fiber variables (e.g., total, soluble, or insoluble fiber, or g/d as continuous measures), and food energy (calories/day), there was no significant relationship of fiber with fatigue, vigor, or vitality (as continuous measures), because the F for all of these models was not statistically significant (all P > 0.20).

Summary and conclusions

In this sample of postmenopausal breast cancer survivors (n = 13) and their controls, these preliminary analyses do not support the expected relationship of fiber intake with fatigue, vigor, or vitality (e.g., higher fiber intake associated with lower scores of fatigue and higher scores in vitality and vigor). Possible reasons include the small sample size and/or the relatively small variability in the intake of fiber. Therefore, future studies in this area should use a larger sample size with more variability in their intake of fiber.
Table C.1 Correlations between types of fiber and feelings of energy measures

<table>
<thead>
<tr>
<th></th>
<th>Total fiber (g/d)</th>
<th>Soluble fiber (g/d)</th>
<th>Insoluble fiber (g/d)</th>
<th>Energy (kcal/d)</th>
<th>POMS Vigor(^2)</th>
<th>POMS Fatigue(^3)</th>
<th>SF36 Vitality(^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fiber (g/d)</td>
<td>1</td>
<td>0.79</td>
<td>0.97</td>
<td>0.29</td>
<td>-0.22</td>
<td>0.08</td>
<td>-0.01</td>
</tr>
<tr>
<td>Soluble fiber (g/d)</td>
<td>1</td>
<td>0.62</td>
<td>0.07</td>
<td>-0.11</td>
<td>-0.03</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td>Insoluble fiber (g/d)</td>
<td>1</td>
<td></td>
<td>0.34</td>
<td>-0.23</td>
<td>0.11</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal/d)</td>
<td>1</td>
<td>-0.08</td>
<td>0.08</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

POMS Vigor

\[<\] -0.49 0.38

POMS Fatigue

\[<\] -0.52

SF36 Vitality

\[<\] 

\(^1\)N = 84, for 1-sided p-value for Pearson correlation coefficients, \(r \geq 0.19\) is \(P < 0.05\); \(r \geq 0.26\) is \(P < 0.01\); \(r \geq 0.36\) is \(P < 0.001\); the significant P values are marked in bold.

\(^2\)Profile of Mood States Vigor questionnaire

\(^3\)Profile of Mood States Fatigue questionnaire

\(^4\)Short Form (36) Vitality questionnaire
Table C.2 Correlations between food groups and feelings of energy measures

<table>
<thead>
<tr>
<th></th>
<th>All grain foods¹</th>
<th>All vegetables²</th>
<th>All fruits and fruit juices³</th>
<th>All alcoholic beverages⁴</th>
<th>All nonnutritive sweeteners⁵</th>
<th>POMS Vigor⁶</th>
<th>POMS Fatigue⁷</th>
<th>SF36 Vitality⁸</th>
</tr>
</thead>
<tbody>
<tr>
<td>All grain foods¹</td>
<td>1</td>
<td>-0.26</td>
<td>-0.03</td>
<td>-0.19</td>
<td>-0.04</td>
<td>0.02</td>
<td>-0.05</td>
<td>0.11</td>
</tr>
<tr>
<td>All vegetables²</td>
<td>1</td>
<td>0.09</td>
<td>0.15</td>
<td>-0.03</td>
<td>-0.08</td>
<td>0.17</td>
<td>-0.14</td>
<td></td>
</tr>
<tr>
<td>All fruits and fruit juices³</td>
<td>1</td>
<td>-0.21</td>
<td>-0.05</td>
<td>-0.17</td>
<td>0.07</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All alcoholic beverages⁴</td>
<td></td>
<td>1</td>
<td>0.10</td>
<td>-0.12</td>
<td>0.08</td>
<td>0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All nonnutritive sweeteners⁵</td>
<td></td>
<td></td>
<td>1</td>
<td>-0.01</td>
<td>-0.08</td>
<td>-0.0006</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

POMS Vigor⁶                  |                   |                   | 1                           | -0.49                    | 0.38                           |              |                |                |

POMS Fatigue⁷                |                   |                   |                             |                          |                               |              | -0.52         |                |

SF36 Vitality⁸               |                   |                   |                             |                          |                               |              |                | 1              |

See footnote in Table C.1.

¹ Includes WG/SWG/RG grains, flour and dry mixes (1 serving = ½ c cooked grain/cereal; 16 g flour or cornmeal; 16 g bran or wheat germ; ½ c rice), WG/SWG/RG loaf-type bread and plain rolls (1 serving = 1 slice bread; ½ medium hamburger bun; ½ small bagel; ½ medium English muffin; 1 small roll; 1 medium bread stick), WG/SWG/RG quick breads, corn muffins, tortillas (1 serving = 45 g muffins and quick breads; 38 g French toast, pancake, waffle, biscuit; 45 g cornbread, popovers, Yorkshire pudding; 1 oz croissant; 1 oz tortilla), WG/SWG/RG pasta (1 serving = ½ c), WG/SWG/RG ready to eat cereal (presweetened or not presweetened; 1 serving = 1 oz), WG/SWG/RG crackers (1 serving = 1 oz), WG/SWG/RG snack chips (1 serving = 1 oz), popcorn (1 serving = 1 oz)

² Includes vegetable based snack (1 serving = 1 oz), dark green vegetables (1 serving = ½ c raw, cooked, or canned; 1 c raw leafy), deep yellow vegetables (1 serving = ½ c raw, cooked, or canned), tomatoes (1 serving = ½ c chopped or default form, ½ c tomato sauce, ¼ c tomato puree, ¼ c tomato paste), white potatoes (1 serving = ½ c chopped or default form, 1 medium
baked potato), other starchy vegetables (1 serving = ½ c raw, cooked, or canned; 1 c raw leafy vegetables), vegetable juice (100% vegetable juice; 1 serving = 4 fl oz), other vegetables (1 serving = ½ c raw, cooked, or canned; 1 c raw leafy vegetables), legumes (cooked dried beans; 1 serving = ½ c cooked dry beans; ½ c refried beans; ½ c beans in sauce)

3 Includes citrus juice (100% juice; 1 serving = 4 fl oz), fruit juice excluding citrus juice (100% juice; 1 serving = 4 fl oz), citrus fruit (1 serving = ½ c chopped or default form of fresh, frozen, or canned; 1 medium piece; ½ fresh grapefruit; ¼ c dried), fruit excluding citrus fruit (1 serving = ½ c chopped or default form of fresh, frozen, or canned; 1 medium piece; ¼ c dried), avocado and similar (1 serving = ½ c chopped or default form), fruit based snack (1 serving = 1 oz)

4 Includes beer and ales (1 serving = 12 fl oz), cordial and liqueur (1 serving = 1.5 fl oz), distilled liquor (1 serving = 1.5 fl oz), and wine (1 serving = 5 fl oz table wine, 3 fl oz dessert wine); these serving sizes are the same for NDSR and USDA

5 Includes aspartame, sucralose, saccharin, and acesulfame potassium (all mg)

6 Profile of Mood States Vigor questionnaire

7 Profile of Mood States Fatigue questionnaire

8 Short Form (36) Vitality questionnaire
References for Appendix C


