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Vitamin D and Calcium Intakes of Participants with and without Cancer

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Abstract

Vitamin D and calcium play major roles in bone health in addition to other positive roles in tissues and cells. These roles in tissues and cells are associated with preventing some types of cancer. The purpose of this study was to determine attitudes of cancer patients towards their dietary intakes of vitamin D and calcium. A questionnaire was completed by 128 volunteers (mean age = 53.5 years ± 16.6, 94 women) from a cancer treatment center in Alabama. Participants with cancer (n = 59) were more likely to agree ($p = 0.048$) to the statement, "I try to eat healthy every day" compared to participants without cancer (n = 69); similar results occurred for the statement, "I have a healthy diet" ($p = 0.050$). Participants without cancer consumed more fish such as salmon, tuna, and halibut than participants with cancer ($p = 0.035$). Women and participants with cancer were more concerned with eating healthy and obtaining vitamin D and calcium than non-cancer participants and men. Overall, many participants did not appear to be consuming their dietary requirements for calcium and vitamin D. However, 69.1% of all participants reported they regularly exposed their skin to sunshine for 10–15 minutes without sunscreen.

INTRODUCTION

Cancer is characterized by uncontrolled growth and the spread of abnormal cells in the body. As the second leading cause of death among adults in the United States, cancer accounts for nearly one in every four deaths. Lung cancer is the leading cause of cancer death in both men and women followed by prostate cancer in men and breast cancer in women [1]. Breast cancer rates began to decline in 2002 [1] and decreased by 6.7% between 2002 and 2003 with little additional decrease in 2004 [2]. The decrease in breast cancer rates has been attributed to the decrease in the use of hormone-replacement therapy in postmenopausal women [2]. While genetics and age play major roles in one's risk of developing breast cancer [1], research has shown a relationship of breast cancer risk and inadequate nutrient intakes, specifically vitamin D and calcium [3]. The American Cancer Society [1] states that approximately one-quarter to one-third of all cancer deaths are related to poor nutrition, overweight or obesity, and physical inactivity and could be prevented.

Adequate amounts of vitamin D and calcium in the diet have been associated with reduced risk of cancer [4]. The recommended intake for people aged 0–50 years is 15 µg/day (600 IU) for vitamin D and the adequate intake for calcium is 1000 mg/day for adults aged 19–50 [5]. According to Neuhouser et al. [6], vitamin D influences important cellular events (apoptosis and cell cycle regulation) that are critical in cancer patients' prognosis and survival. Vitamin D and calcium can help inhibit the growth of mammary tumors and may also play a role in a breast cancer patient's stability during and after cancer treatments [3].

Peterlik and Cross [3] stated that evidence from clinical trials and observational studies support the hypothesis that calcium malnutrition and hypovitaminosis D increase the risk for malignancies, especially colon, breast, and prostate cancers. Holick [7] further summarized that studies revealed if serum vitamin D levels were 20ng/ml or higher, there was an approximate 30–50% decreased risk of developing and dying from colon, breast, and prostate cancers. Harris and Go [8] reported that calcium supplementation can reduce the recurrence of colon polyps but the effect was dependent on serum vitamin D levels. They concluded that with the apparent synergistic effect of calcium and vitamin D, supplementation of both nutrients in cancer prevention programs may be advisable [8].

The purpose of this study was to investigate intakes of

vitamin D and calcium and dietary attitudes of cancer patients. The objectives of this study were to conduct a survey with a group of people diagnosed with cancer and undergoing treatment and a control group (participants who had not been diagnosed with cancer) and compare differences between the two groups, specifically concerning intakes of foods high in vitamin D and calcium, use of supplements, and attitudes and perceptions of eating healthy.

MATERIALS AND METHODS

Questionnaire

A questionnaire was designed modeled from the National Cancer Institute's Diet History Questionnaire [9] to investigate vitamin D and calcium intakes. The National Cancer Institute [10] reported three separate studies assessed the validity of the questions on the Diet History Questionnaire [11,12,13]. The questionnaire used in the present study contained 54 items that included two subjective summary questions, "In general, please indicate how much you agree or disagree with the following statement: I have a healthy diet" and "… I try to eat healthy every day" with responses ranked as 1 = disagree very much, 3 = neither agree nor disagree, 5 = agree very much. The questionnaire also provided participants with four graphical serving size guidelines to help them estimate accurate responses to portion size questions. Adequacy of vitamin D and calcium intakes were estimated based on weekly intakes of supplements, sun exposure time without sunscreen, and monthly food frequencies and diet history, specifically foods high in calcium and/or vitamin D. Demographic (age, sex) data, menopausal status, and current personal cancer information (currently have or do not have cancer, type of cancer, and the stage of cancer) were also requested.

Research site, participants, data collection, and Institutional Review Board approval

A cancer treatment clinic in Alabama was used to recruit participants and collect data. A convenience sample of patients, employees, and friends and families of the patients that were in attendance at the cancer clinic were given the option of completing the questionnaire if they were 18 years or older. Both groups, participants diagnosed with cancer and participants who identified themselves as not having cancer, voluntarily chose to complete the anonymous questionnaire. Those who chose not to participate were not treated differently than those who participated.

Participants were allowed to complete questionnaires in the waiting rooms and while receiving cancer treatments. They were not required to answer all items on the questionnaire. Each questionnaire was enclosed in a large envelope and each participant was asked to return the completed questionnaire into the envelope to assure anonymity. When participants returned their questionnaires to the investigator, they were provided a handout from Harvard Pilgrim Health Care [14] that included calcium and vitamin D information.

This study did not interfere with the normal daily activities of the clinic and adhered to the privacy protocols in the United States' Health Insurance Portability and Accountability Act. The university's Institutional Review Board (IRB) approved all research protocol prior to beginning the study. Administrative services at the cancer treatment center also approved the study prior to starting the project and provided a letter of support to the university's IRB granting permission to use the center for data collection.

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 19.0 (SPSS Inc., Chicago, Illinois) with statistical significance determined at the 0.05 level ($p < 0.05$). Differences for dietary intakes, attitudes and perceptions about their overall diet, and intakes of vitamin D and calcium supplements were determined between participants who had cancer and those without cancer. Comparisons between the groups, those diagnosed with cancer and those that self reported they did not have cancer, were conducted using *t*-tests, and chi square tests were used for categorical items to compare differences between the two groups. Descriptive statistics were used to determine characteristics of the participants. Continuous variables are reported as means ± standard deviations (SD).

RESULTS AND DISCUSSION

This study included 128 participants (94 females, 34 males) who were 18–91 years of age. Fifty-nine participants (46.1%) had been diagnosed with cancer. The mean age of the participants with cancer was 60.9 years ± 13.4 and the mean age of the group without cancer was 47.1 years ± 16.6 (Table 1). Those with cancer reported breast (30.5%, n = 18), lung (18.6%, n = 11), colon or rectal (10.2%, n = 6), and other types of cancer such as prostate (n = 2), leukemia (n = 2), endometrial (n = 2), melanoma (n = 2), non-Hodgkin lymphoma (n = 1), and several participants indicated they had more than one type of cancer. Participants with cancer were asked if they knew what stage of cancer they were currently diagnosed with and 44.1% (n = 26) indicated they did not know, 20.3% (n = 12) reported they were in Stage IV (most severe stage), 11.9% (n = 7) reported Stage II,

Table 1: Characteristics of All Participants, Participants with Cancer, and Those without Cancer.

Characteristics of Participants	All Participants (N = 128)	Participants with Cancer (n = 59)	Participants without Cancer (n = 69)
Age (years)[a] (age range)	53.5 ± 16.6[b] (18–91)	60.9 ± 13.4 (27–90)	47.1 ± 16.6 (18–91)
Age Categories:[a]			
18 – 39	27[c]	5	22
40 – 49	21	5	16
50 – 59	27	14	13
60 – 69	28	9	19
70 – 91	20	14	6
Gender and Age:[a]			
Male (age range)	59.6 ± 14.7 (n = 34) (27–90)	62.5 ± 15.1 (n = 24) (27–90)	52.9 ± 11.9 (n = 10) (39–71)
Female (age range)	51.3 ± 16.8 (n = 94) (18–91)	59.9 ± 12.2 (n = 35) (30–83)	46.1 ± 17.2 (n = 59) (18–91)

[a]Five participants did not provide their age
[b]Mean ± standard deviation
[c]Number of participants

8.5% (n = 5) reported Stage III, 6.8% (n = 4) reported Stage I, and five participants did not respond.

The overall response to the question, "In general, how concerned are you about eating healthy?" resulted in a mean response of 4.4 ± 0.8 on a 5-point scale of 1 = very unconcerned to 5 = very concerned. When comparing responses between participants who had cancer and those without cancer, there was not a difference (p = 0.599, Table 2). A large majority (91.4%) of respondents with cancer indicated they were concerned or very concerned with eating healthy, which was similar to responses provided by those without cancer.

The results indicated that those with cancer were trying to eat healthy every day as the mean response for cancer participants responding to the item, "I try to eat healthy every day" was higher (3.7 ± 1.1) compared to participants without cancer (3.2 ± 1.3, p = 0.048, Table 2). Also, participants with cancer agreed more with the item, "I have a healthy diet" than those without cancer (p = 0.050) although the mean response of 3.4 ± 1.1 was between 3 = neither agree nor disagree to 4 = agree (Table 2). There was not a difference (p = 0.130) between the groups for the item that asked participants to choose the answer that best described "How healthy is your diet in general?" The responses ranged from 1 = my diet is very unhealthy to 5 = my diet is very healthy. Those with cancer had a mean score of 3.7 ± 1.1 and those without cancer had a mean response of 3.4 ± 1.1 (Table 2).

Participants were concerned about receiving their daily requirements for vitamin D and calcium; a score of 4.2 ± 1.1 was obtained for all participants with no difference (p = 0.642) between the two groups (Table 2).However, results comparing males and females discovered a difference (p = 0.042); women scored this item higher (4.4 ± 0.9) than men (3.9 ± 1.3). This could possibly be due to osteoporosis awareness, which usually aims to increase calcium and vitamin D intakes in women to prevent osteoporosis. However, cancer treatments such as chemotherapy, radiation, and some surgeries cause adverse nutritional effects, which can be severe, in both males and females [15]. There were no other differences (p > 0.05) between men and women. When examining menopausal status, 56 women identified themselves as postmenopausal and 36 women indicated they were premenopausal. Although more postmenopausal than premenopausal women reported taking a calcium supplement that contained vitamin D, it was not significant; no differences in responses to the questionnaire items were detected between these two groups of women (p > 0.05).

There was not a difference (p > 0.05) between participants with cancer and those without cancer in regards to overall consumption of dairy products (Table 3). Although 27.2% of

Table 2: Attitudes of All Participants, Participants with Cancer, and Those without Cancer.

Questionnaire Items	All Participants (N = 128)	Participants with Cancer (n = 59)	Participants without cancer (n = 69)	*P* value[a]
In general, how concerned are you about eating healthy?	4.4 ± 0.8[b]	4.4 ± 0.9	4.3 ± 0.7	0.599
In general, how concerned are you about receiving your daily requirements for vitamin D and calcium?	4.2 ± 1.1[b]	4.3 ± 1.2	4.2 ± 1.0	0.642
Indicate how much you agree or disagree with the following statement: I have a healthy diet.	3.1 ± 1.1[c]	3.4 ± 1.1	3.0 ± 1.1	0.050*
Indicate how much you agree or disagree with the statement: I try to eat healthy every day.	3.4 ± 1.2[c]	3.7 ± 1.1	3.2 ± 1.3	0.048*
How healthy is your diet in general?	3.5 ± 1.1[d]	3.7 ± 1.1	3.4 ± 1.1	0.130

[a]P value is comparison of participants with cancer and those without cancer (t-test).
[b]Mean ± standard deviation (1 = very unconcerned, 3 = neither concerned nor unconcerned, 5 = very concerned).
[c]Mean ± standard deviation (1 = disagree very much, 3 = neither agree nor disagree, 5 = agree very much).
[d]1 = my diet is very unhealthy, 2 = my diet is somewhat unhealthy, 3 = my diet is neither healthy nor unhealthy, 4 = my diet is somewhat healthy, 5 = my diet is very healthy. *Significant at $p \leq 0.05$.

Table 3: Selected Food Intakes by All Participants, Participants with Cancer, and Those without Cancer.

Questionnaire Items	All Participants (N=128)	Participants with Cancer (n=59)	Participants without Cancer (n=69)	*P* value[a]
Overall dairy product consumption[b]	2.3 ± 1.2[c]	2.2 ± 1.3	2.4 ± 1.1	0.412
Milk fortified with vitamin D[d]	3.0 ± 2.5	3.5 ± 2.7	2.6 ± 2.3	0.058
Yogurt fortified with Vitamin D[e]	2.3 ± 2.4	2.1 ± 2.3	2.4 ± 2.5	0.453
Juice fortified with vitamin D and/or calcium[d]	3.3 ± 2.4	3.8 ± 2.6	2.8 ± 2.1	0.012*
Soy, rice, almond, or other "milks" fortified with vitamin D and/or calcium[d]	0.8 ± 1.5	0.9 ± 1.7	0.7 ± 1.4	0.373
Tofu fortified with calcium[e]	0.1 ± 0.8	0.2 ± 1.2	0.03 ± 0.3	0.242
Macaroni and cheese[e]	1.7 ± 1.3	1.8 ± 1.4	1.7 ± 1.3	0.450
Cooked leafy greens, e.g., turnip, collard, mustard, kale, spinach, Swiss chard, or Bok choy[e]	1.9 ± 1.6	2.1 ± 1.6	1.7 ± 1.5	0.179
Broccoli[e]	2.1 ± 1.5	1.7 ± 1.3	2.3 ± 1.6	0.026*
Raw leafy greens (excluding lettuce)[e]	1.0 ± 1.4	0.7 ± 1.2	1.2 ± 1.6	0.081
Sardines, clams, or oysters[e]	0.5 ± 1.0	0.7 ± 1.2	0.3 ± 0.7	0.036*
Salmon, tuna, trout, halibut, or swordfish[e]	1.5 ± 1.3	1.5 ± 1.0	1.6 ± 1.5	0.574
Cereals, e.g., Total Raisin Bran, Total Corn Flakes, Whole Grain Total[e]	1.7 ± 2.0	1.8 ± 1.8	1.6 ± 2.2	0.521

[a]*P* value is comparison (t-tests) of participants with cancer and those without cancer.
[b]Responses: 0 = none, 1 = less than one serving a day but one or two servings a week, 2 = 1 serving a day, 3 = 2 servings a day, 4 = 3 servings a day, 5 = 4 or more serving a day.
[c]Mean ± standard deviation.
[d]Responses: 0 = never, 1 = 1 time in past month, 2 = 2-3 times in past month, 3 = 1-2 times per week, 4 = 3-4 times per week, 5 = 5-6 times per week, 6 = 1 time per day, 7 = 2-3 times per day, 8 = 4-5 times per day, 9 = 6 or more times per day.
[e]Responses: 0 = never, 1 = 1 time in past month, 2 = 2-3 times in past month, 3 = 1 time per week, 4 = 2 times per week, 5 = 3-4 times per week, 6 = 5-6 times per week, 7 = 1 time per day, 8 = 2 or more times per day.
*Significant at $p \leq 0.05$

all participants indicated they never drank milk in the past month, 24% drank milk at least one time per day. Almost 65% of participants consumed 1–3 servings of dairy products daily over the past month. Examples of dairy products and portions consumed included 1 cup of milk, 0.5 cup of ice cream, 1 cup of yogurt, and 1 ounce or slice of cheese. Almost 40% of participants never ate yogurt fortified with vitamin D. Only 15.2% consumed yogurt 2–3 times in the last month, while 12% reported eating yogurt 5–6 times each week. Of those who consumed fortified yogurt (n = 81), 65.4% ate less than one cup each time. Participants who never consumed dairy products (26.6%, n = 34) reported the reason was lactose intolerance (n = 14), another 14 indicated they did not think about drinking or eating dairy products, and six did not like dairy products. Due to the varied calcium content in these foods, the estimation is that approximately 65% of participants were consuming a minimum range of 224–452 mg/day calcium and a maximum range of 672–1,356 mg/day in the past month.

More participants with cancer drank fruit juice fortified with vitamin D and/or calcium compared to participants without cancer, 3.8 ± 2.6 and 2.8 ± 2.1, respectively (p = 0.012, Table 3). Approximately 26% of all participants drank fortified juice at least once a day, while 43% drank it less than three times per month. Participants were also asked if they consumed fortified beverages other than juice such as almond, rice, or soy milk. Approximately 71% of 121 respondents reported in the past month they had never consumed these types of beverages and less than 3% of participants consumed them daily. Additionally, a vast majority of participants (96.6%) did not eat tofu fortified with calcium in the past month as indicated by the low mean score of 0.1 ± 0.8 (Table 3). Approximately 83% of participants ate less than three servings of macaroni and cheese monthly, while almost 3% consumed it daily. Over 50% of the participants that reported eating macaroni and cheese (n = 105) reported they ate 1–1.5 cups as a serving.

While there was not a significant difference in consumption of cooked leafy greens between participants without cancer and those with cancer, those without cancer indicated they ate broccoli more often than those with cancer, 2.3 ± 1.6 and 1.7 ± 1.3, respectively (p = 0.026, Table 3). Overall, approximately 50% of 124 respondents ate a serving of broccoli 1–3 times in the past month and over 15% consumed broccoli 1–2 times a week. Almost 25% of participants reported they never ate cooked greens such as collard, turnip, mustard, spinach, Swiss chard, Bok choy or kale in the past month but 50% reported eating these vegetables 1–3 times in the past month. Over 50% of the participants stated they ate 1–1.5 cups as a serving size for broccoli and cooked greens. Broccoli, and other cruciferous vegetables, may be important to consume in relation to cancer. Cruciferous vegetables and broccoli in particular are known to contain anti-cancer agents such as sulforaphane, which can influence the initiation and progression of cancer [16], in fact, studies have identified the molecular mechanisms for the anti-carcinogenic action of broccoli [16].

The majority of participants ate sardines, clams, or oysters a maximum of one time per month, if at all, however, those with cancer indicated they ate sardines, clams, or oysters more often than those without cancer (p = 0.036, Table 3). Participants were also asked, "How many times in the past month did you consume salmon, swordfish, tuna, halibut or trout?" Almost 60% of 123 respondents reported they consumed these items one to three times in the past month. The majority of participants that reported they had consumed these items also reported they had eaten between 3–6 ounces each time.

Almost 75% of 122 participants consumed fortified General Mills Total cereal (i.e., Total Corn Flakes, Total, or Total Raisin Bran) less than three times in the past month. The vast majority (96.2%) added milk to their cereal with approximately 70% of those participants using 1–1.5 cups of milk in their cereal. There was not a significant difference (p = 0.521) between participants with cancer and those without cancer in the number of times in the past month Total cereal was consumed.

Twenty-five participants with cancer (42.4%) reported they took multivitamin supplements and 32 participants without cancer (46.4%) took multivitamins (Table 4). Of the 57 participants that took multivitamins, 78.9% took one every day. Almost 80% reported their multivitamin also contained minerals. Fifty-eight participants reported taking other supplements such as individual vitamins, minerals, and herbal supplements, with similar numbers of users reported for those with cancer and those without cancer (p = 0.622, Table 4). The majority of participants (60.1%) reported never taking a calcium supplement. Approximately 70% of those who indicated they took a calcium supplement reported that it contained vitamin D as well. Only four males reported taking a calcium supplement that contained vitamin D, while 37 females reported taking a calcium plus vitamin D supplement. Also, only 10 participants with cancer (16.9%) took a vitamin D supplement while more participants without cancer (33%, n = 23) took vitamin D (p =

Table 4: Supplement Intakes by All Participants, Participants with Cancer, and Those without Cancer.

Supplement	All Participants (N=128) Yes Responses (n)	Participants with Cancer (n=59) Yes Responses (n)	Participants without cancer (n=69) Yes Responses (n)	*P* value[a]
Multivitamin	57	25	32	0.750
Other (individual vitamins, minerals, herbal supplements)	58	28	30	0.622
Vitamin D supplement	33	10	23	0.001*
Calcium supplement[b]	1.2 ± 1.8[c]	1.2 ± 1.8	1.2 ± 1.8	0.973
Antacids, e.g., Tums, Rolaids[b]	0.7 ± 1.2	0.7 ± 1.2	0.8 ± 1.2	0.629

[a]Chi square tests determined differences between participants with cancer and those without cancer for yes responses; *t*-tests determined differences between means.

[b]Responses: 0 = never, 1 = 1-3 days per month, 2 = 1-3 days per week, 3 = 4-6 days per week, 4 = every day.

[c]Mean ± standard deviation.

*Significant at $p \leq 0.05$

.001, Table 4). Approximately 74% of all participants did not take an individual vitamin D supplement, but 69.1% reported they regularly exposed their skin to the sun for 10 to 15 minutes without sunscreen. Holick [7] reported casual sun exposure accounts for 90–95% of most people's vitamin D requirement.

The current study indicated that 25.8% of the participants took a vitamin D supplement which was similar to the results reported by Neuhouser et al. [6]. They reported 26.6% of participants used either a single vitamin D supplement or a vitamin D-specific supplement such as vitamin D plus calcium [6]. Additionally, Shin et al. [17] observed a reduced risk in breast cancer in premenopausal women who consumed more low-fat, fat-free dairy products containing vitamin D and calcium, which supports the importance of obtaining adequate amounts of vitamin D and calcium.

Approximately 50% of 123 respondents thought they usually obtained their daily requirements for vitamin D and calcium, although less than 43% of 124 respondents agreed or very much agreed to the statement, "I have a healthy diet." Participants' perceptions of a healthy diet may not be accurate as adequate amounts of several micronutrients including calcium are associated with a high quality diet [18]. Cohen and Babey [19] discussed contextual influences on eating behaviors and environmental factors that may overwhelm consumers and influence poor food choices. Additionally, consumers' food choices may be made without conscious awareness [19] which may influence diet quality perception.

Eating healthy during cancer treatment can be especially challenging. Cancer patients often experience changed eating behaviors from the side effects of cancer treatment such as changes in taste and smell, loss of appetite, nausea, sore mouth or throat, dry mouth, and dental and gum problems [20]. These side effects can lead to dislikes of food in general, less desire to eat and drink, and discomfort or difficulty eating and drinking. These factors could affect cancer patients' food choices and eating patterns.

CONCLUSION

The American Cancer Society [1] estimates that approximately one-fourth to one-third of cancer deaths are related to poor nutrition, physical inactivity, and overweight or obesity. The effect of poor nutrition may be only vaguely understood for cancer prevention, development, and treatment. Adequate amounts of vitamin D and calcium have been associated with reduced risk of cancer [4]. Vitamin D and calcium can play a positive role in inhibiting the growth of mammary tumors as well as increasing the cancer patient's bone recovery and stability during and after treatments [6]. Therefore, it is important for cancer patients to receive the recommended daily amounts of vitamin D and calcium.

Results from this study showed differences ($p < 0.05$) between the participants with cancer and those without cancer for consumption of broccoli; sardines, clams, or oysters; and juice fortified with vitamin D and/or calcium. Overall, many participants appeared to not obtain the recommended daily amounts of calcium and vitamin D; however, approximately 69% of all participants reported they regularly exposed their skin to sunshine for 10–15 minutes without sunscreen. The findings from this research can be beneficial for the development of nutrition education programs for cancer patients and/or cancer survivors. Participants with cancer and women were more concerned with eating healthy and obtaining the recommended amounts of vitamin D and calcium than non-cancer participants and the men. These findings could help build a nutrition component into a cancer-spouse/companion support program. However, further investigations with a national or regional representative sample should be conducted prior to incorporating these findings into nutrition education materials.

This study had limitations including the small sample size and the location of study participants. The study would have benefited by using a variety of cancer clinics from rural and urban locations throughout the southern United States. The results would be more applicable to generalize to the southern population's eating habits and dietary concerns for vitamin D and calcium. Another limitation of the study was a lack of questionnaire items that reflected interactions with vitamin D and calcium absorption such as how often participants took antiseizure medicines, glucocortoicoids, rifampin, or St. John's Wart. Also, perhaps participants should have been asked about other conditions such as Crohn's disease, whipple disease, celiac disease, or liver disease since these contribute to vitamin D deficiency [21]. These inquiries could have been used to determine if participants who took interacting medications and supplements, or who had a malabsorption disease, were more concerned about their intakes of vitamin D and calcium.

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