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Diet and predictors of dietary intakes in women with family history of breast and/or ovarian cancer

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Abstract

Background—Dietary intakes of vegetable, fruit, fiber, folate, and B vitamins have been associated with reduced breast and/or ovarian cancer risk. However, few studies have assessed dietary intakes and factors associated with diet in women with family history of breast and/or ovarian cancer (FHBOC). We examined dietary intakes and predictors of diet in women with FHBOC (n = 211) enrolled in a population-based cancer family registry.

Methods—We assessed diet via a food frequency questionnaire, family history by telephone and demographic variables by questionnaire. Descriptive statistics were performed, and multivariate linear regression analyses were conducted to examine variables [body mass index (BMI), age, parity, energy intake, alcohol use, smoking and education] associated with dietary intakes.

Results—Mean daily intakes were: 2.57 vegetable servings [± standard deviation (SD) 1.22], 1.56 fruit servings (± 0.9), 11.21 g fiber (± 5.32) and 33.85 % energy from fat (± 9.05), 241.98 μg folate (± 120.80) and 1.33 mg vitamin B6 (± 0.62). Regression analyses showed that younger age, smoking, lower education and higher BMI had a significant association with decreasing vegetable, fruit and/or fiber intakes. BMI had a significant positive association with % energy from fat. Similar results were observed when assessing independent variables with micronutrient intakes studied.

Conclusions—These data suggest that women with FHBOC should be encouraged to meet dietary guidelines for cancer prevention. Specifically, public health dietary interventions should target women with FHBOC who are smokers, less educated, have a higher BMI and are younger. Such interventions may potentially reduce breast and/or ovarian cancer risk in this population.

Keywords

Family history of cancer; Breast and/or ovarian cancer; Diet; Cancer prevention behaviors; Micronutrients; Folate; Education; Body Mass Index; Vegetable and fruit; Fiber

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Conflict of interest statement
The authors of this manuscript have no financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work.

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Introduction

Previous research has demonstrated that women with a family history of breast and/or ovarian cancer are at higher risk for being diagnosed with breast and/or ovarian cancer (1-7). Five to ten percent of breast cancers and 10% of ovarian cancers or 18,000 new cases of breast cancer and 1,900 new cases of ovarian cancer per year in the United States are hereditary cancers (5-7). Several dietary factors, including dietary fat, fiber and micronutrients such as folate and carotenoids have been associated with breast cancer risk (8-12). A recent report published by the World Cancer Research Fund (WCRF) expert panel indicated that the relationship between diet, including vegetable, fruit and fiber with breast and/or ovarian cancer risk is still inconclusive, and that there is some (but limited) evidence suggesting a role for dietary fat in breast cancer etiology, particularly in post-menopausal women, and a role for non-starchy vegetables in reducing ovarian cancer (13). Further, the National Cancer Institute (NCI) and/or the American Cancer Society (ACS) guidelines for a cancer protective diet include consuming at least five servings of fruit and vegetable, 20 - 30 grams of fiber and < 30% energy from fat daily (14,15).

Most studies investigating dietary factors associated with breast cancer risk have been conducted in sporadic breast cancer, but few have examined lifestyle factors, specifically diet in women with a family history of breast and/or ovarian cancer (FHBOC) (16-19). Studies assessing the relationship between diet and breast cancer risk in women with FHBOC have shown a significant association between diet and breast cancer risk, specifically with caloric intake, vegetable and fruit consumption, and overall diet quality (17,18,20).

Health conscious behaviors such as cancer screening, complementary alternative medicine (CAM) use and diet have been previously studied among women with FHBOC or other cancer consistent with BRCA1/2 heredity (19,21-28). Mueller and colleagues found that in 164 BRCA+ mutation carriers (a sample derived from women with FHBOC), diet was one of the two most common CAM use modalities (28). Another study indicated that women at high risk for breast and/or ovarian cancer were more likely to have better health behaviors, such as eating 5 daily servings of fruits and vegetables, protecting themselves from the sun, and not smoking, compared with the general population (19).

The studies assessing dietary intakes in women with a family history of breast and/or ovarian cancer have shown a relationship between dietary intakes and breast cancer risk, and therefore studying dietary factors in these women could provide information on potential dietary intervention strategies for reducing breast and/or ovarian cancer risk in women with FHBOC. The purpose of the present study was to examine dietary intakes, including macro and micronutrients in women with FHBOC. In addition, we investigated factors [i.e. body mass index (BMI), education, smoking status, and other variables] that could be associated with dietary intakes, including vegetable, fruit, fiber and % energy from fat, as well as cancer protective micronutrients in this population.

2. Material and Methods

2.1 Study Population

The population under study was recruited as part of a larger population-based study conducted in Southern California which examined the effects of family history, genetics and lifestyle on breast and/or ovarian cancer risk. Detailed telephone interviews elicited family cancer history information on all first- and second-degree relatives and first cousins of women with breast and/or ovarian cancer (the affected female) enrolled in a population-

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based cancer registry (29,30). Breast and/or ovarian cancer were grouped together because a high percentage of familial cases are attributed to mutations in the BRCA 1 and BRCA 2 genes which confer increased risk for breast and/or ovarian cancer (31-34). In the present study, with consent from the affected female with breast and/or ovarian cancer, sisters/ cousins without cancer were identified and consented to participate.

Eligibility for the present study included absence of personal history of breast and/or ovarian cancer, ability to complete questionnaires, and to have to be at least as old as the affected sister/cousin at the time of the sister/cousin's date of diagnosis. We obtained complete dietary, anthropometric, lifestyle and socio-demographic data, including smoking, education, height and weight on 211 women with FHBOC. The study protocol was approved by the Internal Review Board (IRB) of the University of California, Irvine (HSR#: 91-137) and by the California State University, Fullerton (HSR#: 07-0278).

2.2 Dietary Assessment and other measures

Usual dietary intakes of participants enrolled in the present study were assessed by the 100-item NCI-Block food frequency questionnaire (FFQ) (35). The FFQ was self-administered and completed via mail after enrollment into the study. Participants were provided specific instructions to answer all questions accurately and carefully and to complete the FFQ based on their “usual” dietary pattern. Details regarding development and validity of the FFQ have been previously published (35). Food group, total energy intakes and nutrient analyses were calculated by the DietSys 4.0 program (35). Also, self-reported height, weight and alcohol use data were collected via the FFQ. A risk factor questionnaire (RFQ), completed via mail, was used to obtain self-reported data on age, ethnicity, smoking, education and number of children.

2.3 Statistical Analysis

Descriptive statistics were performed for demographic data including age, ethnicity and education. Height and weight data were used to calculate body mass index (kg/m^2). Mean intakes of food groups (vegetable and fruit intakes), and of % energy from fat, energy (kcal) and fiber were calculated. Mean intakes of nutrients, including dietary folate, vitamin B1, vitamin B6, vitamin C, and the carotenoids, alpha-carotene, beta-carotene, lutein, lycopene and beta-crytoxanthin were calculated. Also, we conducted a *t*-test and examined differences between nutrient intake derived from food and dietary supplements compared with nutrient intake derived from food only for several variables (total folate, total vitamin B1, total vitamin B6, total vitamin C).

Separate multiple linear regression analyses were conducted to examine predictors of each dietary and macro- and micro-nutrient outcome variable (shown in previous studies to be associated with breast and/or ovarian cancer risk). Dietary variables were log transformed for normal distribution. Independent variables (possibly associated with each dietary variable) included age, parity, energy (kcal) intake, BMI (kg/m^2), current alcohol use, current smoking and education. Age, parity and energy (kcal) intake were included as continuous variables in the model, and alcohol use (current use/no current use), smoking (ordinal: never use, previous use and current use with current use having highest risk) and education (college education/no college education) were categorical. In order to increase power to detect associations, we included continuous variables where possible in the models. All analyses were conducted using SAS Version 9.1.

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3. Results

Table 1 presents descriptive data on socio-demographic and lifestyle variables of the sample. Mean daily dietary intakes for food groups, and mean daily and quartile intakes for nutrients are shown in Table 2. For all dietary intakes, including vegetable, fruit, fiber and % energy from fat, a majority of the present study sample did not meet the NCI/ACS dietary guidelines for cancer prevention (14,15). Also, nutrient intakes from food only and food plus supplements are shown in table 2. Total nutrient intakes (from diet plus supplements) for folate, vitamin B1, vitamin B6 and vitamin C were significantly higher compared with nutrients from diet only.

Table 3 presents multiple linear regression models for the food groups vegetable and fruit intakes, and for the macronutrients fiber and % energy from fat. Age, BMI and college education were independently and significantly associated with vegetable intake. Smoking showed a tendency towards a negative association with vegetable intake. Age, BMI and smoking were independently and significantly associated with fruit intake. Education showed a tendency towards a positive association with fiber intake. BMI and education were independently and significantly associated with % energy from fat intake.

Multivariate linear regression analyses of independent variables associated with micronutrients are shown in Table 4. Education had an independent, significant positive association with total folate intake, but not with dietary folate intake. However, BMI had a significant negative association with dietary folate intake. Education and smoking were independently and significantly associated with dietary B1 intake, however only education was significantly related to total vitamin B1 intake. Similarly education was significantly associated with dietary vitamin B6 and total vitamin B6 intakes. Several variables including BMI, alcohol use, smoking and education were significantly associated with dietary vitamin C intake; while only BMI and alcohol use were significantly associated with total vitamin C intake. For the carotenoids, several significant associations were observed with the independent variables, including education, age and BMI.

4. Discussion

Our results suggest that women with FHBOC had some college education and most of them were normal to overweight. Also, the findings show that women with FHBOC were not meeting the NCI and/or ACS guidelines for cancer prevention, including vegetable, fruit, fiber and % energy from fat intakes. The women in the present sample were not meeting the recommended allowances from diet alone for folate and vitamin B6, however with the addition of dietary supplements, the allowances were met and/or exceeded dietary guidelines. Also, participants were meeting dietary allowances for vitamin B1 and vitamin C. In general, higher education, not smoking, increasing age and lower BMI were associated with an increase in vegetable, fruit and/or fiber intakes. Conversely a higher BMI and less education were associated with increased dietary fat (% energy) intake. We observed a similar trend with micronutrient intakes, showing that a higher education, a lower BMI and not smoking were associated with increased dietary nutrient intakes.

Women with FHBOC in our study had some similar, yet distinct characteristics compared with women enrolled in previous studies (16,18,19). Nkondjock and colleagues assessed characteristics of unaffected BRCA and non-BRCA carriers in French-Canadian women and reported that half (46% and 59%, respectively) never smoked, the unaffected BRCA carriers had some college education (12.4 yrs of education), and the maximum BMI was 25.0 and 26.8 kg/m2, respectively. Similarly, half of the women with FHBOC in the present study never smoked and had a mean BMI in the overweight category, but nearly 75% had some

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college education. Also similar to our results, in another study of women presenting for genetic testing, < 10% currently smoked, and consumed nine alcoholic drinks within the last month (19). These results suggest that women in our sample had similar characteristics (i.e BMI, smoking and education level) compared with unaffected BRCA carriers and non-carriers, and with women who have a family history of breast and/or ovarian cancer.

A few studies have assessed dietary intakes, including vegetable and fruit intakes and micronutrients in women at high risk and/or with FHBOC (16-19). Emmons and colleagues reported that 61% of women presenting for genetic testing for breast and/or ovarian cancer consumed five or more servings of fruit and vegetables per day (19). However, a substantial portion (approx. 33%) did not meet recommended guidelines for nutrition and physical activity, which could affect future cancer risk (19). In another report, the median intake in the 2nd tertile of dietary fiber intake for women with a family history of breast and/or ovarian cancer was 18.5 grams/day (16). Similar to our study, a Canadian cohort of women at high risk for breast and/or ovarian cancer reported consuming 32.2 (± 7.2) percent calories from fat (17). Data from the 1988 - 1994 National Health and Nutrition Examination Survey (NHANES) III showed that the general non-Hispanic white population in the United States (U.S.) consumed 1.55 (± 2.86) fruit servings/day which is comparable to our results of 1.56 servings/day, however women in the present study consumed less vegetable servings/day (2.57 servings) compared with the general U.S. population (3.35 ± 3.69) (36). Previous studies assessing micronutrient intakes in women at high risk for breast and/or ovarian cancer showed that women in the 2nd tertile of folate (650 μg/day, 357.6 – 436.9 μg/day, respectively) and vitamin C (166.9 – 310.1 mg/d) intakes exceeded dietary allowance recommendations, however it is unclear whether these studies included dietary supplemental intakes (16,17).

Prior to developing a targeted nutrition intervention and/or education program for women with FHBOC, predictors associated with dietary intakes in this population should be investigated. We showed that women with less education, smokers, younger age and higher BMI had lower vegetable, fruit and micronutrient intakes. To the knowledge of the authors, this is the first study to examine education and lifestyle variables associated with dietary intakes in women with FHBOC. A recent study in pregnant women from New Zealand showed that smoking, education and age were significant predictors of nutrient intakes (37). Similar to the previous study and our results, another study of overweight and/or obese postmenopausal women revealed that smoking history and lower education were associated with poorer diet quality (38). Results from our study suggest, as shown in other populations, that public health interventions geared towards women with FHBOC should target less educated, younger, smoking and overweight women who may potentially benefit from a nutrition education program/intervention.

The present study contributes to the literature by increasing information on factors associated with vegetable, fruit and micronutrient intakes in women with FHBOC. Limitations of the present study should be acknowledged. Women in the present study resided in Southern California and therefore results are only generalizable to women with FHBOC in Southern California. Another limitation is that physical activity, a factor that could influence the associations found in the present study was not measured. In addition, even though we conducted a population-based study, further studies in different ethnic groups could increase information on diet and predictors of dietary intakes in women with FHBOC in other ethnicities. Also, because we conducted a cross-sectional study, temporal sequence of the dependent and independent variables can not be established.

Based on the present results, women positive for FHBOC should be encouraged to consume a diet based on food from of plant origin, rich in fiber, folate, carotenoids and other cancer

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protective nutrients. The findings on predictors of dietary intakes could provide guidance on developing dietary interventions geared towards a sub-group of women with specific characteristics potentially reducing breast and/or ovarian cancer risk in this population.

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Table 1

Socio-demographic and lifestyle characteristics of women with FHBOC (n = 211)

Variable	
Age, yrs (mean ± SD)	58.9 ± 12.7
≤ 40 years	17 (8.06%)
41-50 years	45 (21.32%)
51-60 years	52 (24.65%)
61-70 years	52 (24.65%)
71-80 years	39 (18.49%)
≥ 81 years	6 (2.84%)
Parity (mean ± SD)	2.4 ± 1.6
Nulliparous	29 (13.74%)
1 birth	24 (11.37%)
2 births	60 (28.44%)
3 births	52 (24.64%)
≥ 4 births	46 (21.80%)
BMI, kg/m^2 (mean ± SD)	26.1 ± 5.1
Underweight (≤ 19 kg/m^2)	4 (1.90%)
Normal (19-24.9 kg/m^2)	102 (48.3%)
Overweight (25 – 29.9 kg/m^2)	62 (29.4%)
Obese (≥ 30 kg/m^2)	43 (20.4%)
Current alcohol use, n (%)	
Yes	116 (55.0)
No	95 (45.0)
Smoking status, n (%)	
Never smoker	112 (53.0)
Previous Smoker	76 (36.0)
Current Smoker	23 (11.0)
College education, n (%)	
Yes	158 (74.9)
No	53 (25.1)

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Table 2

Daily food and nutrient intakes (from food plus supplements) of women with FHBOC (n = 211)

Dietary Intakes		**NCI/ACS guidelines**[1]	**Met Guidelines n (%)**	
Food groups and macronutrients (mean ± SD)				
Vegetables (servings)	2.57 ± 1.22	5 servings	13 (6.16)	
Fruit (servings)	1.56 ± 0.96	5 servings	0 (0.00)	
Fiber (grams)	11.21 ± 5.32	25 – 30 grams	2 (0.95)	
% Energy from fat	33.85 ± 9.05	< 30 % energy	75 (35.55)	
Micronutrients (mean ± SD)				
	Dietary	Total[2]		*p*
Folate (mg)	241.98 ± 120.80	447.92 ± 313.82		< .0001
25th percentile	169.56	213.54		
50th percentile	219.40	390.07		
75th percentile	299.85	624.43		
Vitamin B1 (g)	1.02 ± 0.46	2.65 ± 4.18		< .0001
25th percentile	0.70	0.90		
50th percentile	0.95	1.80		
75th percentile	1.27	2.79		
Vitamin B6 (mg)	1.33 ± 0.62	2.71 ± 2.49		< .0001
25th percentile	0.90	1.17		
50th percentile	1.21	2.36		
75th percentile	1.71	3.58		
Vitamin C (mg)	119.97 ± 81.48	465.76 ± 719.76		< .0001
25th percentile	61.87	100.52		
50th percentile	105.40	210.61		
75th percentile	146.84	562.00		
Alpha Carotene (μg)	341.12 ± 344.79			
25th percentile	130.48			
50th percentile	220.14			
75th percentile	425.64			

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Dietary Intakes	NCI/ACS guidelines[1]	Met Guidelines n (%)
Beta Carotene (μg)	2322.59 ± 1760.95	
25th percentile	1112.58	
50th percentile	1743.08	
75th percentile	3080.43	
Lutein (μg)	1675.86 ± 2126.20	
25th percentile	654.96	
50th percentile	1124.63	
75th percentile	2012.35	
Beta- cryptoxanthin (μg)	87.25 ± 65.79	
25th percentile	43.15	
50th percentile	74.95	
75th percentile	112.63	
Lycopene (μg)	1603.47 ± 1363.38	
25th percentile 50th percentile	738.02 1286.03	
75th percentile	2141.55	

[1]: Dietary guidelines are based on 1995 dietary guideline recommendations.

[2]: Total includes nutrients from food plus supplements.

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Table 3

Multivariate linear regression models[1] of factors associated with dependent variables of vegetable, fruit, fiber and % energy from fat intakes in women with FHBOC (n = 211)

	Age β (p)	Parity β (p)	BMI β (p)	Alcohol[2] β (p)	Smoking[2] β (p)	College Education[2] β (p)
Dietary Intake						
Vegetables (servings)	0.130 (0.05)	0.071 (0.27)	-0.194 (< .001)	0.075 (0.25)	-0.118 (0.07)	0.159 (0.01)
Fruit (servings)	0.181 (0.01)	0.000 (1.00)	0.315 (< .001)	0.070 (0.30)	-0.156 (0.02)	0.646 (0.34)
Fiber (grams)	0.061 (0.31)	0.059 (0.32)	-0.087 (0.15)	0.004 (0.94)	-0.044 (0.45)	0.112 (0.06)
% Energy from fat	-0.048 (0.48)	-0.129 (0.053)	0.22 (0.002)	0.212 (0.17)	-0.001 (0.99)	-0.139 (0.04)

[1]: All standardized regression coefficients (Beta) are adjusted for all other independent variables in the model and daily energy intake (kilocalories).

[2]: Alcohol is included in the model as current use vs no current use, smoking as ordinal (never smoker, previous smoker and current smoker) and college education as college education vs no college education.

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Table 4

Multivariate linear regression models[1] of factors associated with micronutrient intakes (dependent variables) in women with FHBOC (n = 211)

	Age β (p)	Parity β (p)	BMI β (p)	Alcohol[2] β (p)	Smoking[2] β (p)	College education[2] β (p)
Nutrient Intake						
Dietary Folate (mg)	0.065 (0.27)	0.004 (0.95)	-0.115 (0.053)	0.077 (0.18)	-0.067 (0.24)	0.094 (0.10)
Total folate (mg)	0.065 (0.34)	-0.070 (0.30)	-0.078 (0.26)	0.094 (0.17)	-0.078 (0.24)	0.157 (0.02)
Vitamin B1 (g)	0.062 (0.21)	-0.025 (0.62)	-0.035 (0.50)	-0.036 (0.46)	-0.095 (0.051)	0.109 (0.03)
Total Vitamin B1 (g)	0.032 (0.64)	-0.070 (0.31)	-0.047 (0.51)	0.069 (0.31)	-0.066 (0.33)	0.171 (0.013)
Vitamin B6 (mg)	0.000 (0.56)	0.004 (0.58)	-0.003 (0.17)	-0.008 (0.70)	-0.013 (0.38)	.0480 (0.04)
Total Vitamin B6	0.031 (0.46)	0.029 (0.48)	-0.074 (0.46)	-0.019 (0.37)	-0.046 (0.37)	0.107 (0.01)
Vitamin C (mg)	0.069 (0.27)	-0.012 (0.85)	-0.179 (0.01)	0.126 (0.05)	-0.147 (0.02)	0.137 (0.03)
Total Vitamin C	0.087 (0.22)	-0.009 (0.89)	-0.184 (0.011)	0.152 (0.03)	0.000 (1.00)	0.089 (0.20)
α-Carotene	0.099 (0.16)	0.134 (0.052)	-0.108 (0.13)	-0.037 (0.59)	-0.039 (0.56)	0.144 (0.04)
β-Carotene	0.075 (0.26)	0.096 (0.15)	-0.125 (0.06)	0.034 (0.61)	-0.088 (0.17)	0.176 (0.01)
Lutein	0.025 (0.71)	0.040 (0.53)	-0.175 (0.01)	0.157 (0.02)	-0.121 (0.06)	0.145 (0.02)
β-cryptoxanthin	0.072 (0.28)	0.039 (0.54)	-0.074 (0.27)	0.099 (0.13)	-0.072 (0.27)	0.032 (0.62)
Lycopene	-0.194 (0.004)	0.062 (0.34)	-0.055 (0.42)	0.047 (0.48)	-0.058 (0.93)	0.069 (0.29)

[1]: All standardized regression coefficients (Beta) are adjusted for all other independent variables in the model and daily energy intake (kilocalories).

[2]: Alcohol is included in the model as current use vs no current use, smoking as ordinal (never smoker, previous smoker and current smoker) and college education as college education vs no college education.