RESEARCH ARTICLE

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Association between Dietary Inflammatory Index (DII) and Risk of Breast Cancer: a Case-Control Study

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Abstract

Background: Breast cancer (BrCa) is the most common cancer among women worldwide and is the second leading cause of cancer-related death in women, in developed countries. This cancer is among the top five most common cancers in Iran. Studies have shown that dietary components are implicated in the etiology of BrCa. The existence of molecular connections between inflammation and BrCa has been demonstrated via different bimolecular events. **Methods:** We examined the ability of the dietary inflammatory index (DIITM) to predict the risk of BrCa. This included 145 cases and 148 controls, who attended the specialized centers. DII scores were computed based on dietary intake assessed using a 168-item FFQ. Logistic regression models were used to estimate multivariable ORs. **Results:** Modeling DII as a continuous variable in relation to risk of BrCa showed a positive association after adjustment for age and energy (OR=1.76; 95% CI=1.43-2.18); and were nearly identical in the multivariable analyses (OR=1.80; 95% CI=1.42-2.28). DII as tertiles, and adjusting for age and energy, subjects in tertile 3 had an OR of 6.94 (95% CI= 3.26-14.79; P-trend ≤0.0001) in comparison to subjects in tertile 1. After multivariable adjustment, results were essentially identical as in the model adjusting for age and energy (OR tertile 3vs1=7.24; 95% CI=3.14-16.68; P-trend ≤0.001). Sub group analyses revealed similar positive associations with HER 2 receptor +ve, progesterone receptor +ve, estrogen receptor +ve and lymph node invasive cases. **Conclusion:** Subjects who consumed a more pro-inflammatory diet were at increased risk of BrCa compared to those who consumed a more anti-inflammatory diet.

Keywords: Breast Cancer- inflammation- dietary inflammatory index (DII)- nutritional assessment

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Introduction

Breast cancer (BrCa) is the most common cancer among women worldwide and is the second leading cause of cancer-related death in women, after lung cancer, in developed countries (Ferlay et al., 2015; Torre et al., 2015). According to the World Cancer Research Fund International, and Globocan, BrCa is the commonest cancer in women worldwide, accounting for a total of 1.7 million new cases diagnosed in 2012. This represents about 12% of all new cancer cases and 25% of all cancers in women (Ferlay et al., 2015; WCRF, 2015). This cancer is among the top five most common cancers in Iran and ranks first among cancers diagnosed in women (Almasi et al., 2016). More than 50,000 women in Iran suffer from this disease and each year more than 7,000 patients are added to this number (Almasi et al., 2016). BrCa has a diverse etiology and several risk factors contribute to its development (Hiatt et al., 2009; Almendro and Fuster, 2011). Among modifiable risk factors, diet stands out as a potentially important set of factors (Albuquerque et al., 2014). Because there is broad consensus that the vast majority of cancers are preventable (Anand et al., 2008; Vahid et al., 2015) it may be advisable to conduct studies on the relationship between diet and BrCa in developing countries.

Low-grade chronic systemic inflammation has emerged as an important factor the pathogenesis of chronic diseases such as diabetes, and of certain types of cancer (Coussens and Werb, 2002; Duncan et al., 2003). Inflammatory cytokines may be important factors in carcinogenesis.There is convincing evidence describing the influence of low-grade inflammation and cytokines in breast carcinogenesis (Nicolini et al., 2006; Porta et al., 2009). There also is considerable evidence that diet plays an important role in regulating chronic inflammation

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(Giugliano et al., 2006; Galland, 2010; Vahid et al., 2015).

Certain nutrients such as omega-3 fatty acids (Ferrucci et al., 2006), fiber (Bo et al., 2006), vitamin E (Upritchard et al., 2000), vitamin C (Upritchard et al., 2000), beta-carotenes (Kritchevsky et al., 2000) and magnesium (Bo et al., 2006) are associated with low levels of inflammation. A limitation of this single-food/nutrient-based approach is that these foods or nutrients are usually consumed with other food items and nutrients; thus, dietary interactions may modify the actual effects of the food or nutrient under study. The Dietary Inflammatory Index (DIITM) was designed to take into account all food items (either pro-inflammatory or anti-inflammatory) for which existing evidence indicates involvement in regulating inflammatory response.

The existence of molecular connections between inflammation pathways and BrCa has been demonstrated via a number of different bimolecular events (Madeddu et al., 2014). To investigate the role of diet-associated inflammation in BrCa risk we can use the DIITM (Cavicchia et al., 2009; Shivappa et al., 2014a), which has been shown to predict levels of inflammatory markers in blood (Cavicchia et al., 2009; Shivappa et al., 2014b). The DII can be used to evaluate the potential of diet-associated inflammatory effects in different populations using a variety of assessment instruments including recalls, records, and food frequency questionnaires (FFQ) (Shivappa et al., 2014a; Shivappa et al., 2014b; Wirth et al., 2014). In the current study, we examined the relationship between DII scores and the risk of BrCa. Our hypothesis is that a higher DII score (indicating a pro-inflammatory diet) increases the risk of BrCa incidence.

Materials and Methods

Participants

This hospital based case-control study was conducted at the Shahid Beheshti University of Medical Sciences (SBMU) Cancer Research Center (CRC) of Iran from March 2015 to February 2016. The study included 145 patients with BrCa and 148 controls. The cases were patients with BrCa who were diagnosed by a pathologist within the previous month. These patients were selected using a simple random sampling procedure. This involved preparing an exhaustive list (sampling frame) of all the eligible patients. From this list, the sample was drawn so that each patient had an equal chance of being drawn during each selection round. Controls were randomly selected from among other patients attending the same center. Controls were frequency matched on age (±10 year). Data on cases and controls were collected at the same time and interviewed in the same setting using standardized procedures. After providing written and verbal explanations about the methodology of the study, informed consent was received from all participants. The study protocol was approved by the local Ethics Review Committee at SBMU, Tehran, Iran.

Inclusion and exclusion criteria

Inclusion criteria for cases included the following: a) having a histopathologically confirmed BrCa diagnosis, b) willingness to cooperate in the study, c) not following a restrictive diet, including ones resulting in weight reduction or increase during the year prior to the interview, d) be between 20 and 80 years of age, e) be within three months from the time of diagnosis of BrCa, f) be free of conditions such as pregnancy, lactation, and neurological, gastrointestinal, hepatic, endocrine, immune, kidney and heart disorders and diseases, g) have no other malignancy apart from this cancer.

Exclusion criteria in the case group included the following: a) non-adherence to the study protocol, b) reporting caloric intake >5500 or < 800 kcal/day, c) Severe lethargy (The patient's inability to respond to the questions), d) Hormone therapy for menopause.

Inclusion criteria in control group included the following: a) willingness to cooperate in the study, b) the absence of any malignancy, c) not following a restrictive diet, including one resulting in weight reduction or increase during the year prior to the interview, d) to be between 20 and 80 years of age, f) be free of conditions such as pregnancy, lactation, and neurological, gastrointestinal, hepatic, endocrine, immune, kidney and heart disorders and diseases.

Exclusion criteria in the control group included the following: a) non-adherents to the study protocol, b) reporting total caloric intake >5500 or < 800 kcal/day, c) Hormone therapy for menopause.

Assessment of dietary intake

In this study, dietary intakes of the subjects over the past year were evaluated by a valid and reliable FFQ (Mirmiran et al., 2010). This FFQ queries about the average consumption frequency of 168 food items. To calculate the DII, it was necessary to have the intake information of some food items such as ginger and saffron which originally are not included in the FFQ. Therefore, some additional questions regarding such food items were asked during the interview. Participants were asked to report the frequency of consumption of each food item in the last year according to the standard size units (standard serving size) in the questionnaire. According to the questionnaire, depending on the type of food, subjects indicated their intake of the food items per day, week, month or year, or as never.

Information obtained from the FFQ was analyzed using Nutritionist IV (First Databank, Hearst Corp., San Bruno, CA, USA) in order to calculate the average daily intake of energy and nutrients. The DII was calculated according to the daily intake of food items affecting the profile of inflammation.

Assessment of physical activity

Physical activity was assessed by a validated questionnaire (Aadahl and Jorgensen, 2003). Participants were asked to rate their daily activities such as walking, exercise, sleep, hours devoted to watching television, housework, bathing, etc., along with the intensity of the activity reported. Total activity was reported for 24 hours and METs were calculated based on these self-reports.

Calculation of DII Scores

FFQ-derived dietary data were used to calculate DII scores for all participants. The DII is based on literature published through 2010 linking diet to inflammation. Individuals' intakes of food parameters on which the DII is based are then compared to a world standard database. A complete description of the DII is available elsewhere (Shivappa et al., 2014a). A description of validation work, including DII derived from both dietary recalls and a structured questionnaire similar to an FFQ and related to interval values of hs-CRP, also is available (Shivappa et al., 2014a). Briefly, to calculate DII for the participants of this study, the dietary data were first linked to the regionally representative world database we constructed that provided a robust estimate of a mean and standard deviation for each parameter (Shivappa et al., 2014a). These then become the multipliers to express an individual's exposure relative to the "standard global mean" as a z-score. This is achieved by subtracting the "standard global mean" from the amount reported and dividing this value by the standard deviation. To minimize the effect of "right skewing" (a common occurrence with dietary data), this value is then converted to a centered percentile score. The centered percentile score for each food parameter for each individual was then multiplied by the respective food parameter effect score, which is derived from the literature review, in order to obtain a food parameter-specific DII score for an individual. All of the food parameter-specific DII scores are then summed to create the overall DII score for every participant in the study (Shivappa et al., 2014a). DII= b1*n1+b2*n2.....b31*n31, where b refers to the literature-derived inflammatory effects score for each of the evaluable food parameters and n refers to the food parameter-specific centered percentiles, which were derived from this case-control's dietary data. Of the theoretically possible list of 45 food parameters, a total of 31 were available from this FFQ and therefore could be used to calculate DII (energy, carbohydrate, protein, total fat, fiber, cholesterol, saturated fat, mono-unsaturated fat, poly unsaturated fat, omega-3, omega-6, niacin, thiamin, riboflavin, vitamin B12, vitamin B6, iron, magnesium, selenium, zinc, vitamin A, vitamin C, vitamin D, vitamin E, folic acid, beta carotene, garlic, ginger, onion, turmeric, saffron, pepper).

Assessment of other variables

For all participants, the required information about age (integer year), smoking (yes/no/former smoker), education (illiterate/ low literate/diploma/ higher than diploma), family history of cancer (yes/no), employment (housekeeper/employee/retired), marital status (single/married/ divorced), menopause status (yes/no), number of children and other variables of interest were collected through general information questionnaire during the interviews.

The weight of each participant was measured with the least clothes using a SECA digital scale, which is accurate to 100 grams. Height was measured without shoes in standing position, leaning against the wall and shoulder blades under normal circumstances with an accuracy of 0.5 cm by the mean of a tape mounted on the wall. Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of height (square meters).

Statistical analysis

The DII was analyzed both as a continuous variable and as tertiles with cutpoints derived from controls. The DII, as tertiles, was examined across the following characteristics: age, energy, education, exercise (Mets hr/week), BMI, smoking, family history of cancer, age at menarche, parity, marital status, menopausal status, oral contraceptive use and hormone replacement therapy. Student t-tests or χ^2 tests were used for continuous and categorical variables, respectively. Odds ratios and 95% confidence intervals (OR; 95% CI) were estimated using logistic regression models, adjusting for age, and energy, and then fitting a model with additional adjustment for education, exercise (Mets hr/week), BMI, smoking, family history of cancer, age at menarche, parity, marital status, menopausal status, oral contraceptive use and hormone replacement therapy. P-value for trend was determined using the median value of the DII in each tertile. Separate analyses were conducted restricting to lymph node invasive, estrogen receptor positive, progesterone receptor positive and Human Epidermal Receptor (HER) 2 positive cases. Statistical tests were performed using SAS® 9.3 (SAS Institute Inc., Cary, NC); all p values were based on two-sided tests.

Results

DII scores in this study ranged from -4.22 (most anti-inflammatory score) to +3.93 (most pro-inflammatory score). Table 1 shows the socio-demographic and lifestyle characteristics of the 145 cases and 148 controls. Cases had significantly higher DII scores, were more physically active and more likely to have no formal education compared to controls. Control characteristics across categories of DII are provided in Table 2. There were some differences in sociodemographic factors, and lifestyle habits across DII categories. In particular, compared to women in tertile 1 (most anti-inflammatory diet), women in the third tertile (most pro-inflammatory diet) of DII were less likely to use oral contraceptives. There were no major differences across tertiles for other variables.

ORs and 95% CIs for the risk of BrCa are shown in Table 3. Results obtained from modeling DII as a continuous variable in relation to risk of BrCa showed a positive association after adjustment for age and energy (OR=1.76; 95% CI=1.43-2.18); and were nearly identical in the multivariable analyses (OR=1.80; 95% CI=1.42-2.28). When analyses were carried out with DII expressed as tertiles, and adjusting for age and energy, subjects in tertile 3 had an OR of 6.94 (95% CI= 3.26-14.79; P-trend $\leq$0.001) in comparison to subjects in tertile 1. Again, after multivariable adjustment, results were essentially identical as in the model adjusting only for age (OR tertile 3vs1=7.24; 95% CI=3.14-16.68; P-trend $\leq$0.001).

Analyses by cancer subtype are shown in Table 4.

Table 1. Characteristics of Patients in an Iranian Breast Cancer Case-control Study, 2015-16 (n=293).

	Mean±SD or N (%)		
	Controls (n=148)	Cases (n=145)	**P-value
Age, (years)	48.54±12.00	49.83±11.86	0.35
Age at menarche, (years)	13.00±1.26	13.23±1.44	0.16
Body Mass Index, (kg/m^2)	27.13±4.52	27.26±4.50	0.79
Dietary Inflammatory Index (DII)	0.29±1.40	0.83±1.61	0.002
Physical activity, (MET, h/d)	33.63±5.58	35.16±3.99	0.008
Family history of cancer	13 (8.78)	12 (8.28)	0.88
Education			0.002
No formal education	12 (8.11)	31 (21.38)	
Less than a high school diploma	22 (14.86)	13 (8.97)	
Diploma	63 (42.57)	44 (30.34)	
High school diploma and more	51 (34.46)	57 (39.31)	
Employment			0.16
Housekeeper	82 (55.41)	93 (64.14)	
Employee	53 (35.81)	37 (25.52)	
Retired	13 (8.78)	15 (10.34)	
Marital			0.11
Single	21 (14.19)	10 (6.90)	
Married	116 (78.38)	121 (83.45)	
Divorced	11 (7.43)	14 (9.66)	
Parity			0.97
None	25 (16.89)	23 (15.86)	
1-2 children	64 (43.24)	64 (44.14)	
>2 children	59 (39.86)	58 (40.00)	
Breast feeding	233 (85.66)	115 (84.56)	0.36
Menopausal status	68 (45.95)	71 (48.97)	0.60
Oral contraceptive use	43 (29.05)	78 (53.79)	<0.0001
Hormone replacement therapy	7 (4.73)	14 (9.66)	0.06
Smoking			0.54
Never smoker	142 (95.95)	135 (93.10)	
Past smoker	2 (1.35)	4 (2.76)	
Current smoker	4 (2.70)	6 (4.14)	

**P-values were estimated using chi-square ($\chi 2$) statistics, independent t-test for the difference between case and control groups.

Women in tertile 3 had higher odds of having HER2+, progesterone receptor +, estrogen receptor + and lymph node invasive BrCa compared to women in tertile 1.

Discussion

In this case-control study, which was designed to assess the relationship between inflammatory potential of diet, as assessed by the DII, and the risk of BrCa, we found that subjects with higher DII scores were at increased risk of BrCa. This result supported our hypothesis that consuming a more pro-inflammatory diet, is associated with an increased risk of BrCa. Results obtained from modeling DII as a continuous variable in relation to risk of BrCa also showed a positive association after adjustment for age and energy; indeed, results were nearly identical in the multivariable analyses. The same pattern was seen when analyses were carried out with DII expressed as tertiles.

This is the first study to examine the association between DII scores and BrCa in Iran. However, in other study, we valuated validity of DII in women with recurrent abortion (Vahid et al., 2017). Our studies results are consistent with the ability of the DII to predict BrCa that was observed in previous studies conducted in Italy, Sweden, and the US (Shivappa et al., 2015; Shivappa et al., 2016a; Shivappa et al., 2016b). On other hand, some studies have failed to observe a statistically significant increase in risk with elevated DII scores (Ge et al., 2015; Tabung et al., 2016). A recent meta-analyses of 24 prospective cohort studies suggested that dietary total fat and fatty acids might not be associated with increased risk of BrCa (Cao et al., 2016). In another meta-analyses of data from 21 prospective cohort studies, higher consumption of dietary marine n-3 polyunsaturated fatty acids, which contribute to lowering DII scores, was associated with a lower risk

Table 2. Participant Characteristics by Level of Dietary Inflammatory Index (DII) among Controls, Iranian Breast Cancer Case-control Study, 2015-2016 (n=148)

	Tertile 1	Tertile 2	Tertile 3	P-Value[a,b]
Age, (years)	47.96±9.74	49.08±13.01	48.59±13.17	0.79
Age at menarche, (years)	13.00±1.54	12.84±0.92	13.18±1.24	0.47
Body Mass Index (kg/m^2)	27.63±4.82	26.64±4.26	27.10±4.48	0.56
Physical activity, (MET, h/d)	34.49±5.53	31.79±4.98	34.59±5.85	0.93
Family history of cancer	2 (4.00)	6 (12.24)	5 (10.20)	0.32
Education				0.12
No formal education	3 (6.00)	3 (6.12)	6 (12.24)	
Less than a high school diploma	8 (16.00)	11 (22.45)	3 (6.12)	
Diploma	22 (44.00)	15 (30.61)	26 (53.06)	
High school diploma and more	17 (34.00)	20 (40.82)	14 (28.57)	
Employment				0.87
Housekeeper	27 (54.00)	28 (57.14)	27 (55.10)	
Employee	17 (34.00)	17 (34.69)	19 (38.78)	
Retired	6 (12.00)	4 (8.16)	3 (6.12)	
Marital				0.71
Single	6 (12.00)	6 (12.24)	9 (18.37)	
Married	41 (82.00)	40 (81.63)	35 (71.43)	
Divorced	3 (6.00)	3 (6.12)	5 (10.20)	0.93
Parity				0.45
None	7 (14.00)	7 (14.29)	11 (22.45)	
1-2 children	26 (52.00)	21 (42.86)	17 (34.69)	
>2 children	17 (34.00)	21 (42.86)	21 (42.86)	
Menopausal status	21 (42.00)	25 (51.02)	22 (44.90)	0.66
Oral contraceptive use	20 (40.00)	12 (24.49)	11 (22.45)	0.11
Hormone replacement therapy	1 (2.00)	5 (10.20)	1 (2.04)	0.09
Smoking				0.81
Never smoker	49 (98.00)	47 (95.92)	46 (93.88)	
Past smoker	0 (0.00)	1 (2.04)	1 (2.04)	
Current smoker	1 (2.00)	1 (2.04)	2 (4.08)	

[a]Student t-test was used for continuous variables; [b]Chi-square test was used for categorical variables

Table 3. Odds Ratios and 95% Confidence Intervals for the Association between DII and Breast Cancer in an Iranian Case-control Study, 2015-2016 (n=298)

	Dietary Inflammatory Index (Tertiles) OR (95% CI)			Ptrend-value[a]	DII (Continuous)[b] OR (95% CI)	P-Value
DII	Tertile 1 ≤ -0.46	Tertile 2-0.45 to +0.95	Tertile 3 >+0.95			
Cases/controls	29/5	44/49	72/49		145/148	
Age and energy adjusted	1 (ref.)	2.39 (1.20, 4.77)	6.94 (3.26, 14.79)	<0.0001	1.76 (1.43, 2.18)	<0.001
Multivariate-adjusted [c]	1 (ref.)	2.26 (1.03, 4.98)	7.24 (3.14, 16.68)	<0.0001	1.80 (1.42, 2.28)	<0.001

[a] P-value for trend derived using the median approach; [b]One unit increase corresponding to ≈34% of its range in the current study; [c]Adjusted for age, energy, education, exercise (Mets hr/week), BMI, smoking, family history of cancer, age at menarche, parity, marital status, menopausal status, oral contraceptive use and hormone replacement therapy.

Table 4. Odds Ratios and 95% Confidence Intervals for the Association between DII and Breast Cancer in an Iranian Case-control Study, 2015-2016 (n=298)

	Dietary Inflammatory Index (Tertiles) OR (95% CI)			Ptrend-value[a]	DII (Continuous)[b] OR (95% CI)	P-Value
DII	Tertile 1 ≤ -0.46	Tertile 2-0.45 to +0.95	Tertile 3>+0.95			
HER 2 receptor +ve cases (61/148)	1 (ref.)	3.27 (0.96, 11.07)	17.42 (4.84, 62.71)	<0.0001	2.52 (1.73, 3.67)	<0.0001
Progesterone receptor +ve cases (89/148)	1 (ref.)	2.54 (0.98, 6.60)	7.86 (2.87, 21.53)	<0.0001	1.87 (1.41, 2.48)	<0.0001
Estrogen receptor +ve cases (105/148)	1 (ref.)	2.67 (1.09, 6.52)	8.16 (3.14, 21.19)	<0.0001	1.86 (1.43, 2.43)	<0.0001
Lymph node invasive case (56/148)	1 (ref.)	6.61 (1.63, 26.77)	43.36 (9.42, 199.55)	<0.0001	3.89 (2.36, 6.42)	<0.0001

[a] P-value for trend derived using the median approach; [b]One unit increase corresponding to ≈34% of its range in the current study; [c]Adjusted for age, energy, education, exercise (Mets hr/week), BMI, smoking, family history of cancer, age at menarche, parity, marital status, menopausal status, oral contraceptive use and hormone replacement therapy.

of BrCa (Zheng et al., 2013). Some studies have shown that Mediterranean diet and diets composed largely of vegetables, fruit, fish, and soy are associated with a decreased risk of BrCa (Albuquerque et al., 2014). Also, diets containing high concentrations of fruits and vegetables are associated with low levels of CRP (Watzl et al., 2005). As mentioned, a limitation of this single-food/nutrient-based approach is that these foods or nutrients are usually consumed with other food items and nutrients; thus, dietary interactions may modify the actual effects of the food or nutrient under study. In formulating the DII, an entirely different approach was taken by focusing on the functional effects of foods and nutrients. As such, the DII relies on reviewing and scoring of the peer-reviewed literature on the subject of diet and inflammation. Also, it standardizes individuals' dietary intakes of pro- and anti-inflammatory food constituents to world reference values, resulting in values that are not dependent on units of consumption and can be used for comparison across studies (Shivappa et al., 2014a). The positive association observed between the DII and BrCa in this case-control study is very encouraging. One of the possible mechanisms for the positive association between the DII and the risk of BrCa and other chronic inflammatory states might be through the effect of a pro-inflammatory diet on insulin resistance, which is known to increase systemic inflammation (Festa et al., 2000; Vahid et al., 2016). Other possible mechanisms are related to the effect of a pro-inflammatory diet on increased cytokines (Slattery et al., 2014). Indeed, a review and meta-analysis supports the role of chronic inflammation in BrCa development (Chan et al., 2015). However, it should be acknowledged that there is disagreement on the subject. For example, in another study it was shown that the association between BrCa and inflammatory markers, and BrCa and obesity indicators appear independent of each other (Dias et al., 2016). Conflicting results across studies may be due to heterogeneity in the biology BrCa, the lack of information on inflammatory biomarker levels over a sufficiently long time, or both. Our study adds to evidence suggesting that diet-associated inflammation is involved in the etiology of BrCa. Further work will need to be done to assess attributable risk and delineate the exact mechanism of action.

An important strength of this study is that it is the first one in Iran to examine BrCa as an outcome related to DII. Another important strength is the use of a validated and reproducible FFQ (Mirmiran et al., 2010), which allowed for a comprehensive assessment of major nutrient sources in diet, although some measurement error inherent in the FFQ may be present. Also, controls were selected carefully by ensuring that none of them had any condition related to diet or other major risk factors associated with BrCa. However, in addition to its strengths, the study has certain weaknesses that need to be considered. As with other case-control studies, recall bias and selection bias were inevitable. Also, the relatively small sample size can be cited as other limitation of the study. However, administering validated FFQs by trained interviewers in a hospital setting might have further reduced the recall bias and improved comparability of information of cases and controls.

In conclusion, women who consumed a more pro-inflammatory diet, as indicated by higher DII scores, were at increased risk of BrCa compared to women who consumed a more anti-inflammatory diet. Thus, encouraging intake of more anti-inflammatory dietary factors, such as omega-3 fatty acids, plant-based foods rich in fiber, Beta-carotene and other carotenoids and phytochemicals, and reducing intake of pro-inflammatory factors, such as fried foods or processed foods rich in saturated fat or trans fatty acids, may be a strategy for reducing risk of some cases of BrCa. Future studies are needed to gain insight into the relationship between diet-associate inflammation and the risk of BrCa; this would deepen understanding about the role of diet in breast carcinogenesis. Future research also should test whether changing the inflammatory potential of diet can reduce chronic inflammation and the risk of BrCa. In so doing, utility of the DII can be extended to clinical settings to address inflammatory potency of one's diet, and possibly reduce future risk of chronic inflammatory-related diseases.

Disclosure

Dr. James R. Hébert owns controlling interest in Connecting Health Innovations LLC (CHI), a company planning to license the right to his invention of the dietary inflammatory index (DII) from the University of South Carolina in order to develop computer and smart phone applications for patient counseling and dietary intervention in clinical settings. Dr. Nitin Shivappa is an employee of CHI.

Conflict of Interested

The authors declare no conflict of interests.

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