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Unveiling the spice of life: Exploring the impact of spicy food consumption on breast cancer risk through a comparative study

Leni Merdawati [1]*, Wei-Shan Chin [2], Reni Prima Gusty [1], Hui-Chuan Huang [3]

[1] Department of Medical-Surgical Nursing, Faculty of Nursing, Universitas Andalas, Padang, Sumatera Barat, INDONESIA
[2] School of Nursing, College of Medicine, National Taiwan University, Taipei, TAIWAN
[3] School of Nursing, College of Nursing, Taipei Medical University, Taipei, TAIWAN
***Corresponding Author:** lenimerdawati@nrs.unand.ac.id

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ABSTRACT

Purpose: To examine the association between spicy food consumption and the risk of breast cancer in females.

Methods: A cross-sectional comparative study was conducted, involving 84 females diagnosed with breast cancer and 84 age-matched females without the disease. Data collection included measurements of demographic characteristics, reproductive factors, lifestyle, and dietary habits. To assess the association between spicy food consumption and the risk of breast cancer, a logistic regression model was employed.

Results: Spicy food consumption of more than six days/week resulted in a high risk for the occurrence of breast cancer (odds ratio = 2.72; 95% confidence interval, 1.06~6.98). The partial correlation test confirmed a significant positive correlation between frequent spicy food consumption and breast cancer risk.

Conclusions: Spicy food consumption more than six days a week poses a higher risk of breast cancer risk. Education and health management strategies may help reduce the risk of breast cancer.

Keywords: breast cancer, capsaicin, females, spicy, risk

INTRODUCTION

Breast cancer is the most common cause of cancer deaths for females worldwide [1]. In 2020, there were 7.8 million women with breast cancer [2], and the worldwide incidence of females with breast cancer is projected to reach approximately 3.2 million new cases per year by 2050 [3]. Women with breast cancer who receive a diagnosis and treatment may have various distressing symptoms such as fatigue, pain, anxiety, and depression that worsen their quality of life [4]. Thus, promoting women's health to prevent breast cancer is an important public health issue.

Previous studies found that many influential factors can contribute to the occurrence of breast cancer, including a family history of breast cancer [5], age of menarche, higher age at the first pregnancy [6], obesity [7], smoking [8], and low physical activity [9]. Additionally, dietary habits, such as a high intake of red meat and fats, and sparse fruit and vegetable consumption, are also important risk factors related to the occurrence of breast cancer [10]. Recent studies proposed that high spicy food consumption was associated with risks of gastric and colon cancers [11]. However, the association of spicy food consumption with breast cancer remains unclear.

Spicy foods mainly contain capsaicin, the main irritant and pungent agent in chilies and red peppers [12]. Capsaicin was shown to alter several genes involved in cancer cell survival, growth arrest, angiogenesis, and metastasis [13]. In addition, a study conducted in Korea found that capsaicin alters the metabolism of chemical carcinogens and might promote carcinogenesis at high doses [14]. To the present, only two studies examine the association between spicy food and breast cancer; however, the results were controversial. One study that applied a specific kind of spicy food found that pepper was correlated with breast cancer [15]. The other one did not show an association, and various confounders were not adjusted for with regard to the occurrence of breast cancer [16]. Differences in exposure selection and inadequate statistical analysis may be possible reasons for the discrepancies. Thus, further studies examining the association between exposure to spicy food and breast cancer incidence and while adjusts for confounding factors.

Chilies and red peppers are widely used as spices in various foods and are essential ingredients in numerous cuisines around the world, especially in Asian countries [17]. Investigations of the effects of spicy food on breast cancer may contribute to dietary education for achieving healthy and safe diet. Thus, this study aimed to examine the association between spicy food consumption intake and breast cancer incidence in a female population. By identifying the effect of spicy food on breast cancer, suitable dietary education can be provided for women who consume spicy foods to reduce and/or prevent the risks of breast cancer.

METHODS

Study Design and Participants

A cross-sectional study with a case-reference design and convenience sampling method was conducted to recruit study participants between July and August 2018. A case group with breast cancer and a reference group without breast cancer were recruited to investigate the correlation of spicy food consumption with breast cancer. Women with a diagnosis of breast cancer were recruited from a public hospital in West Sumatera, Indonesia, when they visited the hospital for a regular examination. The inclusion criteria of cases were

(1) being more than 18 years,

(2) having been diagnosed with breast cancer and having received a mastectomy, chemotherapy, or radiation therapy, and

(3) being able to communicate and complete the study questionnaires.

An age-matched reference group was selected from the same hospital. Women who received a medical check-up or accompanied their families to a general medical or surgical outpatient department were recruited as a reference group. The inclusion criteria for the reference group were

(1) age more than 18 years and

(2) a female gender.

Both case and control groups excluded participants who had a history of other cancers or cognitive impairment to avoid misestimating the correlation between spicy food consumption and breast cancer. This study was reported according to the strengthening the reporting of observational studies in epidemiology [18].

The sample size calculation for this study was based on a two-tailed α of 0.05, a power of 0.80, and an effect size of 0.30, referenced from a small to moderate effect size (effect size of 0.30) of examining spicy food and breast cancer risk from previous studies [15, 16]. Ultimately, it was determined that 84 participants in each group were needed for this study.

Measurements

Demographic characteristics

Demographic characteristics comprised age (i.e., ≥ 55 or < 55 years), level of education (i.e., elementary school, junior high school, senior high school, and college), family history of breast cancer (yes or no), marital status, and body mass index (BMI) (≥ 24 or < 24 kg/m^2).

Reproductive factors

Reproductive factors comprised the age of menarche (< 12 or ≥ 12 years), age at first pregnancy (≥ 30 or < 30 years), duration of breastfeeding (< 12 or ≥ 12 months), the status of menopause (yes or no), and the use of regular oral hormonal contraceptives (yes or no).

Lifestyle and dietary habits

Lifestyle factors comprise smoking (yes/no) and regular exercise (yes/no). In terms of dietary habits, participants were asked to specify the frequency of consuming spicy foods, animal fat, fruits, and vegetables each week. Spicy food consumption was defined as the intake of fresh chilies, peppers, chili sauce, or other strongly flavored food with a meal [19]. Spicy food consumption was assessed with the question, “Do you eat spicy food with your meals?” and “How many days (0 to 7 days) in a week do you consume spicy food?” The definition of animal fat was food derived from chicken, beef, and other sources of animal fat [20]. The frequency of animal fat consumption was determined by the question, “How many days (0 to 7 days) in a week do you consume animal fat?” Natural fruits and vegetables rather than dried fruits and vegetables were assessed. Respondents rated consumption from 0 to 7 days to demonstrate the actual numbers of days they consumed fruits and vegetables. The results of dietary habits were categorized into high (≥ 6 days) or low (< 6 days).

Data Collection and Ethics

Participation in this study was entirely voluntary, with all participants informed of their right to withdraw at any time without repercussions. Before data collection, informed consent was obtained, ensuring participants understood the study’s purpose, procedures, and rights, including confidentiality and anonymity. Data collection was conducted by ten trained assistants following written consent, with each participant undergoing a face-to-face interview to complete the questionnaires. The study received approval from the committee of the medical research ethics of the Dr. M. Djamil Hospital (IRB No.PE.219.2018).

Statistical Analyses

All statistical analyses were performed using SPSS 22.0 software (SPSS, Chicago, IL, USA). A Chi-squared test was used to compare differences in demographic characteristics, reproductive factors, dietary habits, and lifestyle factors between the case and reference groups. A binary logistic regression analysis was used to examine the association of spicy foods with breast cancer. In model 1, variables with a $p \leq 0.20$ in the Chi-squared test were entered into the univariate logistic regression analysis to examine influential factors of breast cancer [21]. In model 2, a multivariate logistic regression analysis was performed to test the correlation between spicy food consumption and breast cancer risk after adjusting for significant factors identified in model 1. A partial correlation coefficient was conducted to confirm the correlation between the frequency of weekly spicy food consumption and breast cancer risk. Statistical significance was defined as any $p < 0.05$.

RESULTS

Demographic Characteristics, Reproductive Factors, Lifestyle, and Dietary Habits

In total, 84 patients with breast cancer and 84 reference participants without breast cancer were recruited for this study. **Table 1** summarizes the study participants’ demographics, reproductive factors, lifestyle, and dietary habits. Results showed that the ages, educational levels, and marital status of participants with breast cancer were similar to those of the reference group ($p > 0.05$), indicating that a comparable reference group was included in the study.

In contrast to the reference group without breast cancer, the breast cancer group showed significant differences in the family history of breast cancer, BMI, age of menarche, age of first pregnancy, duration of breastfeeding, the use of oral hormonal drugs, and smoking behaviors (all $p < 0.05$). The breast cancer group had higher percentages with a family

Table 1. Group comparison of demographic characteristics, reproductive factors, lifestyle, and dietary habits

	WBC (N = 84)		WOBC (N = 84)		X^2	*p*
	N	%	N	%		
Age					1.82	.177
≥ 55 years old	29	34.5	21	25.0		
< 55 years old	55	65.5	63	75.0		
Level of education					0.99	.318
Low	77	91.7	73	86.9		
High	7	8.3	11	13.1		
Marital status					0.64	.42
Married	67	79.9	71	84.5		
Divorce/others	17	20.2	13	15.5		
Family history with breast cancer					4.98	.026
Yes	11	13.1	3	3.6		
No	73	86.9	81	96.4		
BMI, kg/m^2					31.11	< .001
≥ 24	49	58.3	14	16.7		
< 24	35	41.7	70	18.3		
Age of menarche					31.54	< .001
< 12 years old	44	52.4	10	11.9		
≥ 12 years old	40	47.6	74	88.1		
Age at first pregnancy					9.52	.002
≥ 30 years old	19	22.6	5	6.0		
< 30 years old	65	77.4	79	94.0		
Duration of breast feeding					24.88	< .001
< 12 m	52	61.9	20	23.8		
≥ 12 m	32	38.1	64	76.2		
Status of menopause					1.14	.285
Yes	66	78.6	60	71.5		
No	15	17.9	34	40.5		
The use of oral hormonal drugs					10.40	.001
Yes	69	84.1	49	59.0		
No	13	15.9	34	41.0		
Smoking					4.76	.029
Yes	9	10.7	2	2.4		
No	75	89.3	82	97.6		
Regular exercise					3.37	.066
No	74	88.1	65	77.4		
Yes	10	11.9	19	22.6		
Spicy food consumption					8.96	.003
≥ 6	43	51.2	24	28.6		
< 6	41	48.8	60	71.4		
Animal fat consumption					5.31	.021
≥ 6	23	27.4	11	13.1		
< 6	61	72.6	73	86.9		
Fruit/vegetables					0.20	.647
< 6	74	88.1	72	85.7		
≥ 6	10	11.9	12	14.3		

Note. WBC: With breast cancer & WOBC: Without breast cancer

history of breast cancer (13.1% vs. 3.6%), with a high BMI (58.3% vs. 16.7%), with a younger age of menarche (< 12 years) (52.4% vs.11.9%), with older age at first pregnancy (> 30 years) (22.6% vs. 6.0%), with a shorter duration of breastfeeding (< 12 months) (61.9% vs. 23.8%), with those taking oral hormonal drugs (84.1% vs. 59.0%), and with smoking behavior (10.7% vs. 2.4%) than the reference group without breast cancer.

Moreover, the breast cancer group had significantly higher percentages of weekly spicy food (51.2% vs. 28.6%) and animal fat consumption (27.4% vs. 13.1%) compared to the reference group without breast cancer ($p < 0.05$).

Risk Factors of Breast Cancer in Women With Breast Cancer

After considering risk factors with a $p < 0.20$, the univariate logistic regression showed that age (odds ratio [OR] = 1.58; 95% confidence interval [CI], 0.81~13.09), family history (OR = 4.07; CI, 1.09~15.16), BMI (OR = 7.00.; CI, 3.41~14.37), age of menarche (OR = 8.14.; CI, 3.71~17.88), age at first pregnancy (OR = 4.62.; CI, 1.64~13.05), duration of breastfeeding of < 12 months (OR = 5.20; CI, 2.67~10.14), the use of oral hormonal contraceptives (OR = 3.13; CI, 1.54~6.53), and regular exercise (OR = 2.16; CI, 0.92~4.99) were correlated with the breast cancer risk.

Table 2. Determinants of breast cancer by binary logistic regression

	Univariate LR			Multivariate LR		
	OR	(95% CI)	*p*	OR	(95% CI)	*p*
Age						
≥ 55/< 55 years old	1.58	(0.81-3.09)	.178	-	-	-
Family history						
Yes/no	4.07	(1.09-15.16)	.037	5.54	(0.78-39.15)	.086
BMI, kg/m^2						
≥ 24/< 24	7.00	(3.41-14.37)	< .001	3.52	(1.40-8.88)	.008
Age of menarche, y						
< 12/≥ 12 years old	8.14	(3.71-17.88)	< .001	6.75	(2.45-18.63)	< .001
Age at first pregnancy, y						
≥ 30/< 30 years old	4.62	(1.64-13.05)	.004	6.59	(1.73-25.07)	.006
Duration of breast feeding (months)						
< 12/≥ 12 months	5.20	(2.67-10.14)	< .001	7.35	(2.86-18.78)	< .001
The use of oral hormonal drugs						
Yes/no	3.13	(1.54-6.35)	.002	4.68	(1.62-13.54)	.004
Smoking						
Yes/no	0.05	(0.04-.097)	.046	3.06	(0.36-25.87	.304
Regular exercise						
No/yes	2.16	(0.92-4.99)	.070	-	-	-
Spicy food consumption						
≥ 6/< 6	2.62	(1.39-4.96)	.003	2.72	(1.06-6.98)	.037
Animal fat consumption						
≥ 6/< 6	2.50	(1.13-5.54	.024	2.49	(0.80-7.69)	.114

Note. LR: Logistic regression

In addition, those participants with spicy food consumption of more than 6 days per week (OR = 2.62; CI, 1.39~4.96) and greater animal fat consumption (OR = 2.50; CI, 1.13~5.54) had higher risks of breast cancer (**Table 2**).

The multivariate logistic regression further confirmed that those who consumed spicy foods more than 6 days a week had a higher risk of breast cancer compared to those who consumed spicy foods fewer than 6 days a week (OR = 2.72; CI, 1.06~6.98) after adjusting for age, family history, BMI, age of menarche, age at first pregnancy, duration of breastfeeding, the use of oral hormonal medications, regular exercise, and animal fat consumption (**Table 2**).

The Association of Spicy Food Consumption With the Risk of Breast Cancer

Partial correlation analysis further demonstrated a positive correlation between weekly spicy food consumption and breast cancer risk after controlling for family history, BMI, age of menarche, age at first pregnancy, duration of breastfeeding, the use of oral hormonal medications, a smoking habit, and animal fat consumption ($r = 0.379$, $p < 0.001$). The findings showed that high-frequency consumption of spicy foods might increase the risk of developing breast cancer (**Figure 1**).

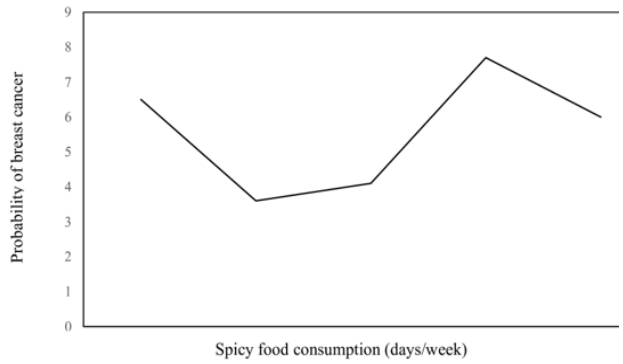

Figure 1. The relationship between spicy food consumption frequency weekly and breast cancer (partial correlation coefficient after adjusting family history, BMI, age of menarche, age at first pregnancy, duration of breastfeeding, use of oral hormonal mecation, and animal fat consumption: r = 0.379 & $p < 0.001$) (Source: Authors' own elaboration, from partial correlation analysis)

DISCUSSION

Regarding dietary habits, highly processed foods and foods with high contents of sugar and animal fat are known to be correlated with breast cancer risk [22]. Our findings further proposed that females who consumed spicy foods more than 6 days weekly had a higher risk of breast cancer than those with weekly spicy food consumption of fewer than 6 days. Previous studies found that spicy food was a significant risk factor for breast cancer [15, 16]. However, those studies did not provide a clear frequency of spicy food consumption. They did not adjust for possible confounding factors and thus may have misestimates the association between exposure to spicy foods and breast cancer incidence. Our study surveyed the frequency of spicy food consumption, considered all possible risk factors in the risk estimation, and recruited an age-matched reference group to examine the correlation between consuming spicy food and breast cancer risks. Thus, the results of consuming spicy food more than 6 days a week, possibly increasing the breast cancer risk, could be reliable.

The results attained in this study support the hypothesis that spicy foods are correlated with breast cancer and that a high-frequency spicy food intake can increase the risk of developing breast cancer. A possible explanation is that spicy foods mainly contain capsaicin, the main irritant and pungent agent that can cause cancer development [17]. Whether capsaicin acts as a carcinogen or as a cancer-preventive agent remains controversial [23]. However, high-dose capsaicin intake was found to cause changes in chemical metabolism and increase carcinogenesis [24]. Moreover, a previous study found that medium-high capsaicin intake can increase gastric cancer and oral cancer compared to low intake [25]. Thus, high-dose capsaicin consumption may be correlated with cancer risks. Because our study could not identify an accurate dose of capsaicin components in spicy foods, consuming a high frequency of spicy foods might take in more capsaicin and increase breast cancer risk. Suitable dietary education regarding decreasing spicy foods or capsaicin intake to reduce the occurrence of breast cancer should be provided for the general population, particularly women. More well-designed studies should be considered.

Another possible reason explaining the association between exposure to spicy food and breast cancer is that high consumption of animal fats from red meat and full-fat dairy is associated with a 33% increased of breast cancer in premenopausal women [26]. Previous studies found that salty foods, processed foods, and animal fats were correlated with cancer risks [22, 27]. A high salt intake level is known to increase DNA synthesis and the proliferation of damaged cells and induce angiogenesis and immune dysfunction, all of which play direct roles in cancer proliferation [28, 29]. Moreover, high processed food consumption was also associated with increased breast cancer risks due to nitrite contents and food preservatives [30, 31]. Because consuming spicy foods is not equivalent to using pure capsaicin, the possible harmful effects of subordinate materials in spicy food like processed meats, salty foods, and animal fats with breast cancer risk should be a consideration.

The main dietary staple among the Minangkabau (West Sumatra Province) in Indonesia includes foods rich in fat, often cooked with coconut milk and fried using coconut oil as a daily staple. However, using coconut and its derivatives has been flagged as a health concern [32]. Additionally, previous research has highlighted that frequent consumption of fried foods has been linked to an elevate likelihood of developing breast cancer [33]. Our study revealed that a significant majority of breast cancer patients (88.1%) consumed fruits and vegetables less than six times per week. Therefore, inadequate vegetable intake might contribute to a risk factor for breast cancer [33]. It is crucial to note that consuming spicy foods alone is not a direct cause of breast cancer, as various dietary and lifestyle factors contribute to this complex disease. Furthermore, focusing exclusively on the patients with breast cancer in West Sumatra may limit the broader applicability of our results to other populations with different patterns and genetics backgrounds. Thus, longitudinal studies would be necessary to explore causal relationships more robustly.

Breast cancer genes like breast cancer gene 1 (BRCA1) and breast cancer gene 2 (BRCA2) mutation are at risk of breast cancer. Previous research indicates that the BRCA1 and BRCA2 genes are associated with an increased risk of breast cancer. Studies have found that 60% of women with mutations in these genes have a higher risk of developing breast cancer. Moreover, approximately 30% to 40% of breast cancer patients with BRCA1 or BRCA2 mutations may develop contralateral breast cancer within 20 years of their initial diagnosis, compared to the general population [34, 35]. Consequently, it is crucial for future studies to include considerations of BRCA1 and BRCA2 gene factors.

In this study, the breast cancer group had significantly higher frequencies of a family history of breast cancer, high BMI, younger age of menarche, older age of first pregnancy, shorter duration of breastfeeding, use of oral hormonal drugs, and smoking behaviors compared to the reference group without breast cancer. Previous studies confirmed that these risk factors were correlated with breast cancer risks [36, 37]. Moreover, women who had two or more relatives with breast cancer have the strongest risk factor of breast cancer risk and combination of family history and relatives age at diagnosis [5].

Thus, the recruited breast cancer group may be representative. Also, the reference group was of a similar age and had a similar educational level and marital status to the breast cancer group, indicating that a comparable reference group was recruited for this study. Thus, the results examining the association of spicy foods with breast cancer should be reliable by using comparable case and control groups.

Limitations and Further Direction

Our study adopted a case-reference group design, an adequate sample size, and adjustment for possible covariates; thus, the internal validity of this study confirming the association of spicy food with breast cancer could be proven. However, several limitations need to be considered when interpreting the results. First, given the cross-sectional nature of the current study, causal relations between spicy food and breast cancer cannot be drawn. Second, the study population was recruited from females in one community in Indonesia, so the generalizability of the findings to other countries and males is limited. Because spicy food comprises all foods that contain chilies or pepper, similar to other countries, further studies identifying the association between spicy food and breast cancer in other countries or populations should be conducted. Third, our study adopted a self-reporting method to collect data on dietary habits that may have caused a recall bias. Because a clear definition of spicy food, concrete responses, and well-trained research assistants were used to complete data collection, these may have reduced the risk of recall bias [38]. Finally, various risk factors for breast cancer were included in the study; however, genes related to breast cancer, such as BRCA1 and BRCA2, were not examined. Further studies incorporating gene assessments, dietary habits, and other risk factors on breast cancer risk should be considered.

CONCLUSIONS

Our study utilized a case-reference study design and confirmed that spicy food consumption for more than 6 days a week poses a higher breast cancer risk than consumption for fewer than 6 days. Furthermore, a high frequency of spicy food might increase the risk of developing breast cancer. Spicy foods are some of the most often consumed foods included in the daily diet in some 2countries, such as Mexico, Indonesia, China, and Thailand [39]. Given that a high frequency of spicy food was positively associated with a significant increase in the risk of breast cancer. Providing health education and management regarding the proper intake of spicy foods in the daily diet to reduce the risk of developing breast cancer in female populations maybe needed. Although capsaicin in spicy food may be beneficial for cancer risks [40], more well-designed studies should be conducted to clarify the optimal number of spicy foods or capsaicin for cancer prevention should be conducted.

Author contributions: LM: conducted the cross-sectional study, data collection, analysis, drafting, and revised the manuscript; **W-SC:** conducted data analysis and provided intellectual suggestions on manuscript revision; **RPG:** involved in data collection/management; & **H-CH:** provided methodological support, data analysis, and revised the manuscript. All authors have agreed with the results and conclusions.

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Ethical statement: This study was approved by the Padang Dr. M. Djamil Hospital on 6 September 2018 with approval number PE.219.2018. Written informed consents were obtained from the participants.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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