Evaluation Of The Association Between Obesity, Dietary Phytochemical Index, and Breast Cancer Risk and Knowledge Level

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Abstract. Breast cancer is one of the most common cancers globally and has been reported as the leading cause of cancer-related death in women. Obesity is defined as one of the most important risk factors for breast cancer. Besides, oncological studies have reported that regular daily consumption of phytochemicals can reduce the risk of breast cancer. Therefore, this study aimed to clarify the association between obesity, dietary phytochemical index (DPI), breast cancer risk (BCR) and knowledge level (BCKL). *Methods:* This study was conducted with women aged 18 years and older. Participants filled out sociodemographic and lifestyle characteristics, anthropometric data, 24-hour retrospective food consumption records, BCR, and BCKL scales via Google forms. Body weight, height, and waist circumference (WC) were declared by the participants. BMI, waist to height ratio (WtHr), DPI, BCR and BCKL calculations were made by the researchers. *Results:* In terms of BCR, 94.2% of the participants were in the low, 3.3% in the medium, 0.3% in the high, and 2.2% in the highest risk group. Besides, there were significant differences between body weight, height, BMI, WC, and WtHr values of BCR groups. Yet, no significant difference was observed between the DPI of BCR groups. Moreover, DPI was not associated with BMI, WC, BCR, and BCKL. However, BMI was significantly correlated (moderate-to-strong) with WC and BCR (r=0.719 and r=0.605, respectively). Also, WC was significantly correlated (moderate) with BCR (r=0.475). The association between WC and BCKL (r=0.088) was statistically significant but not clinically. *Conclusion:* In conclusion, although BCR was not associated with DPI, it was associated with BMI and WC values, which are the indicators of obesity. In the light of this information, the associations between obesity, DPI, BCR, and BCKL will be understood more clearly in future studies with a large sample in which BCR groups have an equal distribution.

Key words: Dietary phytochemical index, breast cancer, obesity

Introduction

Breast cancer is one of the most frequently diagnosed cancers worldwide and has been reported as the leading cause of cancer-related death in women (1). In Turkey, it was stated that 24.1% of all cancers were breast cancer (2). A good understanding of the incidence/survival rate for breast cancer and the underlying risk factors helps identify patients at high risk of progression and intervene early (1, 3). Major risk factors for breast cancer have been reported as female gender, family history, advanced age, atypical hyperplasia, BRCA-1, and BRCA-2 gene mutations (4). Minor risk factors include the prolonged time between menarche and menopause, age at first childbearing, diet, and alcohol consumption (4, 5).

In addition, obesity was also defined as one of the most important risk factors for breast cancer (6).

An increase in body weight was associated with breast cancer risk (BCR) in postmenopausal women in several large studies, including the Nurses' Health Study, which included more than 87,000 women, and the European Future Research on Cancer (EPIC) study of approximately 250,000 postmenopausal women (7). In addition, in the Women's Health Initiative Clinical Trial study with 67,142 postmenopausal women with a 13-year follow-up period, the risk of developing breast cancer was reported to be 52% and 86% higher in class 1 and class 2-3 obese women, respectively, compared to women with normal body mass index (BMI) (8).

Cancer formation is a multistage process accompanied by damage caused by oxidation due to tumor formation by different mechanisms (9). Resistance to current therapeutic approaches to breast cancer treatment (10, 11) and severe side effects have greatly reduced the effectiveness of interventions (12). As a result, researchers have turned to alternative and safer chemotherapeutic strategies such as phytochemicals. Phytochemicals are defined as bioactive compounds that have antioxidant and anti-inflammatory activities, play a key role in cell signaling pathways, prevent the onset and progression of cancer, are non-nutrient, and are among the secondary metabolites of plants (13). In current studies, as a result of the free radical scavenging properties of phytochemicals, it is stated that they can prevent the development and progression of cancer at various stages thanks to their properties such as exhibiting antioxidant activity, regulating cell proliferation, cell differentiation, and gene expression in oncogenes and tumor suppressor genes, inducing apoptosis, modulating detoxification and oxidation enzyme activities, stimulating the immune system, regulating hormone-dependent carcinogenesis, and having anti-bacterial and anti-viral effects (14-18). In oncological studies, it has been reported that regular daily consumption of phytochemicals can reduce BCR (19-21). Phytochemicals such as curcumin, resveratrol, epigallocatechin gallate (EGCG), silibinin, benzyl isothiocyanate, genistein, and quercetin have been shown to suppress breast carcinoma by modulation of various signal transduction pathways, genes, and gene products (22-24). These phytochemicals in foods have synergistic effects against carcinogenesis. Especially vegetables and fruits are the foods with the most phytochemicals. It has been determined that the BCR is reduced by 50% in individuals who consume about 5 servings of vegetables and fruits a day compared to those who consume less than 2 servings of vegetables and fruits (25).

It is important to reveal the risk factors and raise awareness for breast cancer, whose prognosis can change and the survival rate increases in early screening and diagnosis. In addition, understanding the association between phytochemical consumption and breast cancer, as well as the potential mechanisms of action, is of great importance for the onset and development of this disease. Therefore, this study aimed to clarify the association between obesity, dietary phytochemical index (DPI), BCR, and breast cancer knowledge level (BCKL).

Methods

Study Sample

This research was planned as a cross-sectional study based on observation, and 639 volunteer women aged 18-78 years participated in this study. Participants were reached through an online survey form created through Google forms. Data collection tools consisted of a questionnaire including socio-demographic and lifestyle characteristics, anthropometric data, BCR and breast cancer knowledge level (BCKL) scales, and a 24-hour retrospective food consumption record form. The study was evaluated by Gazi University Ethics Commission on 12/01/2021 with the research code 2021-298 and was found ethically appropriate.

Individuals who were younger than 18 years of age and who left without completing the questionnaire, although they were voluntary, were not included in the study. In addition, individuals with very high (>5000 kcal) or very low (<500 kcal) dietary calories were excluded according to the results of the 24-hour retrospective food consumption record. As a result of the study, a total of 639 individuals were reached, and the effect size calculated according to the posthoc power analysis with the help of G-power 3.1.9.6 was 0.16, and the power value obtained from 0.05 type 1 errors and 639 individuals was 0.951.

Data Collection Tools

An online questionnaire containing 23 questions related to socio-demographic and lifestyle characteristics such as age, marital status, educational status, illness history, smoking and alcohol use, diet practices, number and frequency of meals, meal skipping status, vitamin and mineral supplementation, and sleep pattern was applied to the participants.

Evaluation of Anthropometric Measurements of Individuals

Body weight, height, and waist circumference (WC) measurements of the participants were evaluated based on their online self-reports. The participants were instructed to measure the WC with a non-stretchable tape measure over the abdomen at the level of the umbilicus (belly button) without pressing. BMI was calculated by the researchers by dividing body weight (kg) by the square of height (m^2) and was evaluated according to the BMI classification determined by the World Health Organization (WHO) (26).

Evaluation of Food Consumption

To determine the amount of energy and nutrients obtained in the diet, the "24-hour retrospective food consumption record" was filled online by the participants. A sample form and an informative video on how to fill in the form have been uploaded to the system online for the participants. The daily average consumption amounts of the foods in the food groups and the amounts of daily energy and nutrients obtained in the diet were calculated using the Nutrition Information System (BeBIS) Food Consumption Analysis Computer Program version 8.1 through the data obtained.

Calculation of Dietary Phytochemical Index

In the study, the "Phytochemical Index (PI)" method developed by McCarty was used to determine the total dietary phytochemical intake of individuals (27). Dietary phytochemical ındex (DPI) value was calculated as the percentage of energy from phytochemical-rich foods in total daily energy intake [DPI = (daily energy from phytochemical-rich foods (kcal)/total energy (kcal)) x 100]. The category of foods rich in phytochemicals included fruits and vegetables, legumes, whole-grain foods, oilseeds, soy products, olives, and olive oil. Foods with rich phytochemical content such as 100% natural fruit and vegetable juices and tomato sauce are also included in the fruit and vegetable groups. Potato, on the other hand, was not considered a vegetable due to its high starch content.

Breast Cancer Risk Assessment Form

This form was developed by the American Cancer Society to determine the BCR levels of individuals. In this study, the BCR Assessment Form consisting of 6 sections and 20 sub-items, which was accepted by the Turkish Ministry of Health and recommended to be used in the National Family Planning Service Guide, was used (28). Individuals were classified according to their BCR levels determined by their total score in the BCR Assessment Form (29).

Classification	Point Intervals
Low Risk	<200 points
Medium Risk	201-300 points
High Risk	301-400 points
Highest Risk	>400 points

Comprehensive Breast Cancer Knowledge Test

In the Comprehensive Breast Cancer Knowledge Test (CBCKT), which was developed by Stager (30) in 1993 and whose Turkish validity and reliability study was conducted by Başak and Tosun (31) in 2015, there are 20 questions in total including 8 correct and 12 incorrect questions. All questions are answered as True or False. There are two sub-dimensions in CBCKT: general knowledge and treatability.

Statistical Analysis

The necessary statistical analyzes and evaluations of the data obtained from the study were made using the IBM SPSS (Statistical Packet for Social Sciences) for Windows Version 26.0 package program.

Categorical data were presented as frequency (n) and percent (%), while numerical data were expressed as lower-upper/min-max, mean ($\bar{X}$), standard deviation (±SD), or median values. Chi-square test (Pearson Chi-Square and Fisher-Freeman-Halton test) was used for the association between BCR categories and categorical variables, and the Kruskal-Wallis H test was used because the data were not homogeneously distributed in the change of continuous variables according to risk categories. The association between the DPI, BMI, WC, BCKL, and BCR variables was calculated with the Spearman rank correlation coefficient. The results were considered significant when p<0.05 at the 95% confidence interval in these tests.

Results

The data of individuals on BCR factors are shown in Table 1. 97.5% of the individuals participating in the study reported that they had no history of breast cancer. The majority of individuals diagnosed with breast cancer were diagnosed before menopause. Besides, 85.4% of the individuals reported that they do not have a family history of breast cancer. In comparison, 10.8% have an aunt/grandmother with a breast cancer history, 3.6% have a mother or sister with a breast cancer history, and 0.2% have both mother and sister with a breast cancer history. Further, 79.3% of individuals reported that their first menstrual bleeding occurred between the ages of 12-14. In addition, 77.2% of the individuals reported that they had no children, and 18.5% reported that the age of the first childbearing was 30 and earlier. When individuals were classified according to their BMI, it was seen that 10.5% were underweight, 65.7% were normal, 17.7% were slightly overweight, and 6.1% were obese. Also, when individuals were classified according to BCR, it was found that almost all (94.2%) were in the low-risk group, while only a few were in the medium (3.3%), high (0.3%), and the highest (2.2%) risk groups.

The association between some demographic characteristics of individuals according to BCR groups is given in Table 2. When this association was examined, age ($\chi2$=119.510; p<0.001), marital status ($\chi2$=51.607; p<0.001), health status ($\chi2$=49.343; p<0.001), dieting ($\chi2$=19.365; p <0.001), and skipping the main meal ($\chi2$=6,998; p=0.029) were found to be associated with BCR.

In Table 3, when the anthropometric measurements of individuals are examined by considering their BCR status, there were significant differences between body weight (H=10.618; p=0.005), height (H=6.634; p=0.036), BMI (H=16.882; p<0.001), WC (H=12.654; p=0.002), and waist to height ratio (WtHR) (H=13.834; p=0.001) values of groups.

In Table 4, when the effect of dietary intake of individuals according to BCR groups was examined, it was seen that there was a significant difference only in the dried legumes group (H=10.170; p=0.006). According to BCR groups, a significant difference was obtained between the medium, low and high-highest risk groups in terms of dried legume consumption. Higher dried legume consumption was observed in the medium-risk group compared to other risk groups.

On the other hand, in Table 5, it was seen that the total scores of CBCKT general knowledge and treatability did not change significantly according to the BCR groups.

Table 6 shows the association between individuals' BCR, BCKL, BMI, WC, and DPI values. According to this table, there was no statistically significant association between DPI and other variables. A moderate-to-strong significant association was found between BMI and WC and BCR (r=0.719 and r=0.605, respectively). A moderate significant association was found between WC and BCR (r=0.475). The association between WC and BCKL (r=0.088) is statistically significant but not clinically significant.

Discussion

Breast cancer is known as the most common type of cancer among women worldwide (32). It is stated that cancer-related deaths can be reduced by 30% with a healthy lifestyle and healthy dietary changes, which are its integral components (33). This study aimed to evaluate the association between breast cancer risk (BCR), breast cancer knowledge level (BCKL),

Table 1. Characteristics of individuals regarding BCR factors

			Risk Score	
		n(%)	X̄±SS	min-max (median)
Age (years)	<30 years	487 (76.2)	73.97±36.56	40-535 (60)
	30-40 years	80 (12.5)	130.88±63.33	70-430 (107.5)
	41-50 years	41 (6.4)	217.44±120.23	125-575 (175)
	51-60 years	26 (4.1)	251.35±120.12	150-575 (200)
	>60 years*	5 (0.8)	320±153.50	200-500 (225)
Family history of breast cancer	None	546 (85.4)	86.54±63.10	40-500 (60)
	Aunt/grandmother	69 (10.8)	151.45±87.73	90-575 (135)
	Mother or Sister	23 (3.6)	236.43±146.07	110-575 (177.5)
	Mother and Sister	1 (0.2)	535±535	535-535 (535)
Breast cancer history	None	623 (97.5)	89.61±46.57	40-300 (60)
	Yes	16 (2.5)	482.19±60.74	360-575 (475)
Breast cancer diagnosis	Before menopause	14 (2.2)	483.93±63.97	360-575 (475)
	After menopause	2 (0.3)	470±42.42	440-500 (470)
First menstruation	≥15 years	93 (14.6)	89.03±79.94	40-515 (50)
	12-14 years	507 (79.3)	99.78±78.39	50-575 (60)
	≤11 years	39 (6.1)	119.87±47.14	75-255 (110)
Age at menopause			46.28±6.11 years	
First childbearing age	No, I don't have children	493 (77.2)	75.48±41.24	40-535 (60)
	<30 years	118 (18.5)	167.08±94.61	75-515 (150)
	≥30 years	28 (4.4)	236.43±146.07	110-575 (177.5)
BMI categories	Lean (<18.5)	67 (10.5)	63.43±54.78	40-440 (50)
	Normal (18.5-24.9)	420 (65.7)	85.55±59.05	50-515 (60)
	Overweight (25-29.9)	113 (17.7)	149.20±105.64	75-575 (110)
	Obese (>30)	39 (6.1)	166.79±85.03	75-535 (160)
Total BCR score	Low risk (≤200)	602 (94.2)	84.77±39.08	40-200 (60)
	Medium risk (201-300)	21 (3.3)	228.57±24.19	200-300 (225)
	High risk (301-400)	2 (0.3)	377.50±24.74	360-395 (377.5)
	Highest risk (≥400)	14 (2.2)	497.14±47.78	430-575 (487.5)

*Since the risk score is constant for the age of 60, it has been neglected. BCR: Breast Cancer Risk; BMI, Body Mass Index.

obesity, which negatively affects healthy life, and the phytochemical index used in the evaluation of diet.

The mean age of the individuals participating in the study was found to be 28.43±9.33 (unshown data), and 76.2% of them were found to be under the age of 30. In the development of breast cancer, BCR increases with increasing age, and therefore age is known as the most important independent risk factor (34, 35). Similarly, in this study, it was determined that age is a factor that increases BCR. 97.5% of the individuals reported that they had no history of breast cancer, and it was seen that the majority of individuals diagnosed with breast cancer were diagnosed before menopause (Tab. 1). When the individuals participating in the study were classified using the BCR Assessment Form (29), it was found that 94.2% were in

Table 2. Some demographic characteristics of individuals regarding BCR groups

		(n=602) Low risk (<200)	**(n=21) Medium risk (201–300)**	**(n=16) High and Highest risk (>301)**	χ^2	**p**
Age (years)	<30 years	485 (99.6)[a]	0 (0)[a]	2 (0.4)[a]	119.510**	**<0.001**
	30-40 years	70 (87.5)[b]	8 (10)[b]	2 (2.5)[a,b]		
	41-50 years	29 (70.7)[b,c]	6 (14.6)[b]	6 (14.6)[b,c]		
	51-60 years	17 (65.4)[b,c]	5 (19.2)[b]	4 (15.4)[b,c]		
	>60 years	1 (20.0)[c]	2 (40.0)[b]	2 (40.0)[c]		
Marital status	Single	450 (98.7)[a]	3 (0.7)[a]	3 (0.7)[a]	51.607**	**<0.001**
	Married	152 (83.1)[b]	18 (9.8)[b]	13 (7.1)[b]		
Educational status	High school and below	64 (88.9)	5 (6.9)	3 (4.2)	4.678**	0.082
	University and above	538 (94.9)	16 (2.8)	13 (2.3)		
Health problem	None	462 (97.9)[a]	10 (2.1)[a]	0 (0.0)[a]	49.343**	**<0.001**
	Yes, I have	140 (83.9)[b]	11 (6.5)[b]	16 (9.5)[b]		
Disease type	Bone-Joint Diseases	23 (88.5)[a]	1 (3.8)	2 (7.7)[a]	112.853***	**<0.001**
	Thyroid Diseases	26 (70.3)[a]	5 (13.5)	6 (16.2)[a]		
	Cardiovascular Diseases	19 (76.0)[a]	3 (12.0)	3 (12.0)[a]		
	Respiratory System Diseases	18 (78.3)[a]	1 (4.3)	4 (17.4)[a]		
	Neurological/Psychiatric Diseases	16 (69.6)[a]	2 (8.7)	5 (21.7)[a]		
	Diabetes	10 (62.5)[a]	2 (12.5)	4 (25.0)[a]		
	Digestive System Diseases	20 (74.1)[a]	3 (11.1)	4 (14.8)[a]		
	Cancer	1 (7.1)[b]	1 (7.1)	12 (85.7)[b]		
	Other	25 (83.3)[a]	2 (6.7)	3 (10.0)[a]		
Diet application	No, I have no diet plan	507 (94.9)[a]	14 (2.6)	13 (2.4)	19.365**	**0.045**
	Weight loss diet	71 (91.0)	6 (7.7)	1 (1.3)		
	Body weight gain diet	10 (100.0)	0 (0.0)	0 (0.0)		
	Low fat, low cholesterol diet	8 (88.9)	0 (0.0)	1 (11.1)		
	Low-fat, low-cholesterol, salt-free diet	4 (66.7)[b]	1 (16.7)	1 (16.7)		
	Salt-free, sodium-restricted diet	1 (100.0)	0 (0.0)	0 (0.0)		
Dietary advice	Doctor	13 (86.7)	2 (13.3)	0 (0.0)	8.601**	0.461
	Sports trainer	5 (100.0)	0 (0.0)	0 (0.0)		
	Family/relatives	3 (75.0)	1 (25.0)	0 (0.0)		
	Media/internet	11 (84.6)	1 (7.7)	1 (7.7)		
	Dietitian	47 (92.2)	3 (5.9)	1 (2.0)		
	Myself	13 (92.9)	0 (0.0)	1 (7.1)		
Do you skip the main meal?	No	197 (92.9)	12 (5.7)[a]	3 (1.4)	6.998*	**0.029**
	Yes or sometimes	405 (94.8)	9 (2.1)[b]	13 (3.0)		

		(n=602) Low risk (<200)	(n=21) Medium risk (201–300)	(n=16) High and Highest risk (>301)	χ^2	p
Which main meal do you skip?	Breakfast	130 (97.7)	1 (0.8)	2 (1.5)	3.661**	0.388
	Lunch	249 (93.3)	8 (3.0)	10 (3.7)		
	Dinner	26 (96.3)	0 (0.0)	1 (3.7)		
Number of main meals	1-2 main meals	346 (95.1)	10 (2.7)	8 (2.2)	1.129*	0.587
	3 main meals	256 (93.1)	11 (4.0)	8 (2.9)		
Number of snacks	None	86 (94.5)	3 (3.3)	2 (2.2)	3.295**	0.499
	1-2 snacks	403 (94.6)	11 (2.6)	12 (2.8)		
	3 + snacks	113 (92.6)	7 (5.7)	2 (1.6)		
Do you use vitamin-mineral supplements?	No, I don't	452 (94.6)	16 (3.3)	10 (2.1)	1.331*	0.574
	Yes	150 (93.2)	5 (3.1)	6 (3.7)		
Do you smoke?	No	465 (94.7)	14 (2.9)	12 (2.4)	1.541**	0.449
	Yes/I left	137 (92.6)	7 (4.7)	4 (2.7)		
Do you use alcohol?	No	488 (94.0)	18 (3.5)	13 (2.5)	0.284**	0.836
	Yes/I left	114 (95.8)	3 (2.5)	2 (1.7)		

* Pearson Chi-square
** Fisher-Freeman-Halton Test
*** Multiple response cases are considered. Bonferonni correction has been made.
[a,b,c] There is a significant difference between groups with different letters.

the low-risk group, 3.3% in the medium and 2.5% in the high-highest risk group. When evaluated according to BCR, it was observed that individuals with low and medium risk were concentrated in the age group of 30 years and under, while individuals aged 40 and over were in the majority in the high and highest risk group. Similar to this study, in a study by Eroğu et al. (36) conducted with 5000 cases, it was found that 94.4% of women were in the low-risk group, 4.9% in the medium-risk group, 0.4% in the high-risk group and 0.3% in the highest risk group. In addition, according to age groups, it has been observed that there is an increase in BCR in the age group of 40-50 years (36). For this reason, it has been stated that annual screening should be done in women aged 40 and over (36). Besides, it was determined that the majority (71.4%) of the participants in this study were single and did not have any health problems (73.7%). After the dieting status of participants was examined, it was observed that there was a significant difference between those who did not diet in the group with low BCR and those who followed a low-fat, low-cholesterol and salt-free diet. Thus, it can be concluded that individuals who do not follow any diet have a lower risk. However, it should be taken into account that this situation may be caused by comorbid diseases of individuals who follow a low-fat, low-cholesterol, and salt-free diet (Tab. 2).

After the anthropometric measurements of individuals were examined according to BCR groups, significant differences were found in terms of body weight, height, BMI, WC, and WtHR. According to BCR groups, there are differences in body weight, WC, and WtHR in low and medium-risk groups. It has been observed that these values are higher in the medium-risk group. There was a significant difference between the low and high-highest-risk groups in terms of height. It was observed that the height was higher in the low-risk group. Also, there were significant differences in BMIs in the low-risk group and the medium and high-highest-risk groups. It has been observed that individuals in the low-risk group have a lower BMI. An increase in BMI is associated with higher risk and mortality for breast cancer in both premenopausal and postmenopausal periods (37). Similar to this study, a meta-analysis of 34 studies involving

Table 3. Some anthropometric measurements of individuals regarding BCR groups and classifications of these measurements

		(n=602) Low risk (<200)	(n=21) Medium risk (201–300)	(n=16) High and Highest risk (>301)	H / χ^2	p
Measurement parameters		X̄±SS (min-max)	X̄±SS (min-max)	X̄±SS (min-max)		
Body weight (kg)		60.88±11.55 (35-124)[a]	68.95±12.17 (48-92)[b]	65.00±13.63 (49-102)	10.618	0.005
Height (cm)		163.81±5.78 (147-183)[a]	161.81±3.94 (155-169)	160.87±5.77 (152-172)[b]	6.634	0.036
BMI (kg/m²)		22.69±4.20 (15.15-47.25)[a]	26,45±5,07 (17.01-34.21)[b]	25.06±4.52 (17.71-34,48)[b]	16.882	<0.001
BMI Classification	Lean (n/%)	65 (97.0)[a]	1 (1.5)[a]	1 (1.5)	23.447**	<0.001
	Normal body weight (n/%)	404 (96.2)[a]	9 (2.1)[a]	7 (1.7)		
	Overweight (n/%)	102 (90.3)[a,b]	4 (3.5)[a]	7 (6.2)		
	Class I Obese (n/%)	31 (79.5)[b]	7 (17.9)[b]	1 (2.6)		
WC (cm)		76.38±14.34 (47-160)[a]	88.05±16.56 (67-120)[b]	79.87±13.40 (60-103)	12.654	0.002
WC Classification	Normal (n/%)	386 (96.0)[a]	8 (2.0)[a]	8 (2.0)	7.062*	0.031
	Risk (n/%)	216 (91.1)[b]	13 (5.5)[b]	8 (3.4)		
WtHR (cm/cm)		0.47±0.09 (0.28-1.01)[a]	0.54±0,105 (0.40-0.73)[b]	0.49±0.08 (0.38-0.62)	13.834	0.001
WtHR Classifica-tion	Low risk (n/%)	136 (97.1)[a]	1 (0.7)[a]	3 (2.1)	13.616**	0.021
	Normal (n/%)	304 (95.6)[a,b]	8 (2.5)[a]	6 (1.9)		
	Risky (n/%)	107 (90.7)[a,b]	6 (5.1)[a,b]	5 (4.2)		
	May require treatment (n/%)	55 (87.3)[b]	6 (9.5)[b]	2 (3.2)		

BMI: Body Mass İndex; WC: Waist Circumference; WtHR: Waist to Height Ratio.
* Pearson Chi-square
** Fisher-Freeman-Halton Test
a,b There is a significant difference between groups with different letters.

>2.5 million women, including 23,909 with postmenopausal breast cancer, showed that the risk of postmenopausal breast cancer was positively associated with each 5 kg/m² increase in BMI (38). In the Cancer Prevention Study conducted by the American Cancer Society, 495,477 women were examined between 1982 and 1998 (37). As a result, it was stated that the risk of mortality in women with BMI >40 kg/m² was 2 times higher than those with a BMI of 18-24.9 kg/m², and it was concluded that there was a strong correlation between BMI and breast cancer mortality (37). In addition, Neuhouser et al. (8) reported increased BCR in women with a baseline BMI <25.0 kg/m² and gaining >5% of body weight during the follow-up period. WC is one of the factors that can increase BCR like BMI. In the Cancer Prevention cohort study of Gaudet et al. (39), with an 11-year follow-up, higher WC was associated with higher BCR. Similar to these studies, our research found a moderate-to-strong association between BMI, WC, and BCR (Tab. 3).

Considering all these, obesity characterized by high BMI and WC is one of the most important factors that increase BCR. Kabat et al. (40) reported that obesity was associated with an increased BCR, independent of metabolic health. With the development of obesity, the number and size of fat cells increase, which triggers estrogen production, and the BCR increases with the increase in estrogen (40). Obesity has been shown to increase BCR by two times, especially in the postmenopausal period, while the incidence of breast

Table 4. Evaluation of individuals' dietary intake according to BCR groups

Dietary intake	(n =602) Low risk (<200) X̄±SS	(n =21) Medium risk (201–300) X̄±SS	(n =16) High and Highest risk (>301) X̄±SS	H	p
DPI	23.77±15.75	28.57±13.43	22.21±11.81	3.145	0.208
Energy (kcal/day)	1296.12±482.57	1417.14±630.98	1356.92±498.92	0.574	0.751
Carbohydrate (E%)	43.93±10.69	42.29±8.28	41.75±8	1.532	0.465
Protein (E%)	16.13±4.50	16±3,63	16.5±2.5	0.911	0.634
Animal protein (g/day)	29.92±17.95	30.35±18.28	32.51±13.93	0.967	0.617
Animal protein (P%)	56.66±19.24	55.59±13.48	59.41±13.11	0.542	0.763
Vegetable protein (g/day)	20.38±10.49	22.43±7.19	21.08±6.84	3.666	0.160
Vegetable protein (P%)	43.34±19.24	44.84±14.13	40.59±13.11	0.641	0.726
Fat (E%)	39.86±9.49	41.62±8.69	41.62±7.94	1.073	0.585
SFA (E%)	22.03±11.71	23.44±8.77	21.31±9.88	0.844	0.656
MUFA (E%)	21.12±10.35	21.38±8.73	22.02±9.42	0.461	0.794
PUFA (E%)	10.38±6.55	12.17±8.16	11.66±5.93	3.058	0.217
ω-6 (g)	8.45±5.73	9.54±7.26	9.18±5.75	0.999	0.607
ω-3 (g)	2.19±12.79	1.42±0.73	1.22±1.01	2.379	0.304
ω-6/ω-3 ratio	7.28±5.88	6.53±3.09	10.31±8.11	2.457	0.293
Vitamin C (mg/day)	97.01±80.17	96.48±66.77	115.69±92.59	0.515	0.773
Vitamin A (RAE/day)	1101.84±2580.21	804.24±461.85	991.60±674.91	0.595	0.742
Vitamin E (mg/day)	9.53±6.30	10.43±6.6	10.59±5.13	1.875	0.392
Vit. B_1 (mg/day)	4.26±59.83	0.8±0.30	0.77±0.35	4.549	0.103
Vit. B_2 (mg/day)	1.06±0.63	1.15±0.42	1.11±0.33	3.308	0.191
Vit. B_3 (mg/day)	10±7.18	8.91±352	9.29±3.63	0.349	0.840
Vit. B_5 (mg/day)	3.73±1.76	3.74±1.24	3.95±1.43	0.716	0.699
Vit. B_6 (mg/day)	35.69±808.96	1.02±0.46	1.03±0.47	0.620	0.733
Vit. B_9 (µg/day)	239.38±263.39	253.12±113.25	242.65±124.9	1.796	0.407
Vit. B_{12} (µg/day)	22.02±226.41	3.33±2.6	2.83±1.86	0.522	0.770
Sodium (mg/day)	2447.90±1908.95	5351.23±10902.16	2468.41±1316.21	1.984	0.371
Potassium (mg/day)	1887.05±773.32	2208.35±1060.32	2057.24±916.96	2.216	0.330
Calcium (mg/day)	571.64±273.23	731.4±540.33	630.32±354.98	2.106	0.349
Phosphor (mg/day)	824.85±339.94	976.93±385.57	870.54±281.97	4.030	0.133
Magnesium (mg/day)	206.26±97.18	242.72±95.12	221.97±91.51	5.374	0.068
Iron (mg/day)	11.63±51.30	8.83±4.13	7.82±2.79	1.824	0.402
Zinc (mg/day)	7.50±3.75	7.97±3.07	7.91±2.87	2.058	0.357
ORAC	4029.35±3694.31	5089.5±4869.25	2464.02±2232.97	3.393	0.183
Antioxidant (mmol/day)	6.83±30.90	9.64±31.15	1.79±1.03	3.568	0.168
Total fiber (g/day)	15.59±7.36	20.23±10.2	17.59±10.44	4.658	0.097
Vegetable and fruit (g/day)	309.10±210.63	332.95±236.96	355.12±223.52	0.803	0.669
Dried legumes (g/day)	8.16±24.62[a]	18.95±43.57[b]	7.87±27.75[a]	10.170	**0.006**
Whole grains (g/day)	16.24±33.25	25.19±42.36	7.5±21.76	2.984	0.225

Dietary intake	(n =602) Low risk (<200) X̄±SS	(n =21) Medium risk (201–300) X̄±SS	(n =16) High and Highest risk (>301) X̄±SS	H	p
Olive (g/day)	8.86±12.40	13±16.13	13±12.74	4.276	0.118
Olive oil (g/day)	4.73±6.52	4.29±4.16	5.87±4.3	2.847	0.241
Oily seeds (g/day)	12.02±22.59	14.09±20.44	13.5±21.32	1.003	0.606

DPI: Dietary Phytochemical Index; E: Energy; MUFA: Monounsaturated Fatty Acids; ORAC: Oxygen Radical Absorbance Capacity; P: Protein; PUFA: Polyunsaturated Fatty Acids; RAE: Retinoic Acid Equivalent; SFA: Saturated Fatty Acids; ω: Omega.
[a,b] There is a significant difference between groups with different letters.

Table 5. Evaluation of BCKL of individuals according to BCR groups

	(n = 602) Low risk (<200) X̄±SS	(n = 21) Medium risk (201–300) X̄±SS	(n = 16) High and Highest risk (>301) X̄±SS	H	p
Total CBCKT score	14.38±2.38	14±2.21	15.69±2.06	5.49	0.064
Total general knowledge score	7.67±1.74	7.48±1.72	8.5±1.59	3.34	0.188
Total treatability score	6.71±1.36	6.52±1.78	7.19±0,91	1.78	0.410

CBCKT: the Comprehensive Breast Cancer Knowledge Test.

Table 6. The association between BCR, BCKL, BMI, WC, and DPI

	BCR	BCKL	BMI	WC	DPI
BCR	1.000	0.029	0.605**	0.475**	0.043
BCKL	0.029	1.000	0.071	0.088*	0.031
BMI	0.605**	0.071	1.000	0.719**	0.072
WC	0.475**	0.088*	0.719**	1.000	0.053
DPI	0.043	0.031	0.072	0.053	1.000

BCKL: Breast Cancer Knowledge Level; BCR: Breast Cancer Risk; BMI: Body Mass Index; DPI: Dietary Phytochemical Index; WC: Waist Circumference.
* The correlation is significant at the <0.01 level.
** The correlation is significant at the <0.05 level.

cancer in the premenopausal period is lower in obese people and higher in lean people (2, 34, 41). In the Multiethnic Cohort Study, it was reported that obesity was associated with higher mortality in all-cause mortality, including breast cancer, in women aged 50 years and older, regardless of race (42). On the other hand, in the Contraceptive and Reproductive Experiences case-control study, it was stated that while obesity was associated with an increase in breast cancer-specific mortality in white women, this association was not observed in African American women (43). In addition to these, some studies do not support the effect of obesity on breast cancer (44). Although the specific effect of obesity was not revealed in this study, because we studied with the young age group, it can be said that obesity will become even more critical in the future, considering the increase in both risk and body weight with increasing age.

Diet is another factor that can affect both obesity and BCR. For example, in a study by Castello et al. (45), a Mediterranean-style diet with high consumption of fruits and vegetables, dried legumes, oily fish, and vegetable oil was associated with a lower risk of breast cancer. It is thought that this positive effect of the Mediterranean-style diet may be due to its rich phytochemical content. Similarly, in another study by Bahadoran et al. (46), it was shown that a diet rich in phytochemicals might reduce BCR. Furthermore, in the meta-analysis study of Warren et al. (47), it was stated that a diet rich in vegetables reduced BCR by 25%, and a diet rich in fruits by 6%. On the other hand, in this study, after the dietary intakes of the BCR groups were evaluated, the medium-risk group had higher dried legume consumption compared to other risk groups (Tab. 4). However, no statistically significant difference was found between consumption of other food groups and nutrients according to the BCR groups. It is thought that this is because the BCR group distributions of the individuals participating in this study were mainly in low and medium-risk groups.

Breast cancer is a common public health problem all over the world. To fight this disease, it is necessary to know the factors that prevent early screening. The most important of these factors is not having enough information about breast cancer. In this study, although it was not statistically significant, it was seen that the Comprehensive Breast Cancer Knowledge Test (CBCKT) total score and the general knowledge and treatability scores, which are the sub-scores of the scale, were higher in the high and highest risk group than in the low and medium risk groups.

In conclusion, although BCR was not associated with DPI, it was associated with BMI and WC values, which are the indicators of obesity. However, our study has some limitations. The most significant limitation of this study is that the distribution of individuals between BCR groups was not similar in the sample studied. Individuals in the high and highest risk group were considerably less compared to the medium and low-risk groups. Besides, even if a sample form and an informative video on how to fill in the form have been uploaded to the system online for the participants, there may still be the risk of bias of food consumption records due to they collected online. Similarly, although the participants were instructed how to measure the WC, it was obtained based on their declaration. The body weight and height values of the participants were based on their online self-reports as well. On the other hand, the relatively high number of total samples and the examination of BCR, BCKL, obesity, and DPI together constitute the strengths of our study. The results of this study show the BCKL of women in the community and once again emphasize the importance of the association between obesity and BCR. In the light of this information, the association between obesity, dietary phytochemical index, BCR, and BCKL will be understood more clearly in future studies, provided that the BCR groups have an equal distribution, the data are obtained based on observation, and the measurements are made by the researchers themselves rather than self-reported by participants.

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Ethical Standards: This study was evaluated by Gazi University Ethics Commission on 12/01/2021 with the research code 2021-298 and was found ethically appropriate. All participants provided written informed consent.

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