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Is carbohydrate consumption a risk factor for breast cancer?

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ABSTRACT

Objective: The aim of this study is to determine the association between excessive carbohydrate and simple sugar consumption and the increased risk of breast cancer.

Methods: Patients in the control group who were followed up with a diagnosis of breast cancer in our clinic between June 2021 and June 2022 and did not have breast cancer were included in the study. Demographic data of the patients (age, gender), presence of comorbid diseases, menopause status, body mass index (BMI), fat rate (body and abdominal), and average carbohydrate and simple sugar consumption rate in the daily diet were recorded.

Results: The mean age of the patients was 45.98 ± 11.53 years. 78 (24.3%) of the patients were in group 1, and 243 (75.7%) were in group 2. There was no statistically significant difference between the groups regarding age, menopausal period, presence of comorbid diseases, BMI, daily fiber consumption, and body and abdominal fat ratio ($p>0.05$). The average carbohydrate and simple sugar consumption rate in the daily diet in group 1 was statistically significantly higher than in group 2 ($p<0.002$, $p=0.005$, respectively). Consuming high amounts of carbohydrates and simple sugar in the daily diet statistically increases breast cancer ($p<0.05$).

Conclusion: In our study, a strong relationship was found between carbohydrate and simple sugar consumption in the daily diet and breast cancer risk. Considering the increasing prevalence of simple sugar and carbohydrate consumption, we expect that this specific factor will strongly contribute to reducing the incidence of breast cancer in the future.

Keywords: breast cancer, carbohydrate, neoplasms, nutrition, risk factors

Introduction

Cancer, one of the most common diseases in the world, is one of the social health problems with a high mortality rate.[1] Today, it ranks second among the causes of death after cardiovascular diseases. It is estimated to rise to first place in the next twenty years, with approximately 29.5 million new cancer cases.[2,3] Breast cancer is the most frequently diagnosed cancer in women. The accounting for 29% of all cancers.[1]

Cancer can occur due to environmental and genetic reasons. While genetic factors have a minimal effect, it is known that cancer develops mainly due to environmental factors.[4] The most important environmental factors are cigarettes, foods, obesity, hormones, viruses, and physical and chemical agents. The relationship between cancer and nutrition varies between 10-70%, averaging 35%.[5] Alcohol consumption has been proven to be associated with cancer. The relationship between nutritional factors other than these and breast cancer is not clear.

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Epidemiological studies assessing the intake of other foods, such as meat, dairy, and soy products, have yielded inconsistent results. Dietary fat intake has also been investigated as a possible risk factor because it may increase endogenous estrogen levels, but the results obtained from the studies have been found contradictory.[6] Although the relationship between breast cancer and carbohydrates in the diet is not clear, it is stated that the effect of glucose on insulin levels may be related to the risk of cancer.[7]

High carbohydrate and simple sugar consumption is associated with cancer development through various molecular pathways. High glycemic load/carbohydrate intake may lead to postprandial hyperinsulinemia and increased bioavailability of circulating IGF-1, thereby stimulating the PI3K/AKT and MAPK pathways via IGF-1R.[8] This, in turn, may support tumorigenic processes associated with proliferation and inhibition of apoptosis. The role of the IGF-1/IGF-1R axis in breast cancer is supported by strong biological rationale, with reports indicating differential sensitivities depending on molecular subtype.[9] Large‐scale meta-analyses and reviews suggest that the hyperinsulinemia–IGF-1 axis may be linked to risk, although the magnitude of this association appears to vary according to context (e.g. metabolic status, subtype).[8]

Carbohydrates are organic compounds that are among the essential nutrients, provide energy to the body, and are the most abundant in nature. Among various factors affecting the risk of breast cancer, nutrition attracts excellent attention as it is a modifiable risk factor.[10] The aim of this study is to determine the association between excessive carbohydrate and simple sugar consumption and the increased risk of breast cancer.

Main Points

- It has been found that high consumption of carbohydrates and simple sugars in the daily diet significantly increases the risk of breast cancer.
- Reducing consumption of simple sugars and refined carbohydrates in particular is important in terms of public health policies aimed at reducing the incidence of breast cancer.
- This study highlights the need to focus on carbohydrate and sugar intake in the development of nutrition-based prevention strategies.

Material and Method

The study was designed as a cross-sectional analysis. Factors influencing or associated with the development of breast cancer were examined.

Patient selection

It was examined as a prospective observational study with patients in the control group who were followed up with a diagnosis of breast cancer in the oncology clinic of our hospital between June 2021 and June 2022 and were known not to have breast cancer. Patients who were diagnosed with breast cancer, underwent surgery, underwent oncology follow-up, and agreed to participate in the study were included. The control group of the study consists of patients without a history of breast cancer who come to the general surgery outpatient clinic for routine breast check-ups. Patients whose data were incomplete and who did not agree to participate in the study were excluded. Patients who were followed up with a diagnosis of breast cancer were grouped as group 1, and control patients were grouped as group 2. High carbohydrate and simple sugar consumption was analyzed as a risk factor for breast cancer development.

Data collecting

Demographic data (age, gender), anthropometric measurements (BMI, body fat percentage, abdominal fat percentage), presence of comorbid diseases, menopausal period, and carbohydrate and simple sugar consumption data from seventy-two-hour food consumption records were recorded for the patients, including in the study.

Food consumption analysis

In the study, seventy-two-hour food consumption records of the patients were recorded. For food consumption records to be reliable, tea cups, water glasses, bowls, dessert spoons, tablespoons, serving spoons, ladles, a slice of bread, a meatball, chicken, fish, and a slice of cheese, and their quantities were shared visually. The patients were given detailed information about the amount of food consumption by looking at the samples. The patients were asked to write down the foods they consumed daily when coming to the follow-up examination. The researcher evaluated food consumption records using the BEBIS® 8.1 (Ebispro for Windows, Stuttgart, Germany; Turkish Version BEBIS®, Nutrition Information System, Version 8.1) program. The

average carbohydrate, simple sugar consumption rate, and fiber amount were noted.

Cut-off value for carbohydrates and simple sugars

According to current international guidelines, carbohydrate intake is recommended to constitute 45–60% of total energy. Intakes above this range are considered "high carbohydrate consumption." Therefore, in our study, individuals who obtained more than 60% of their total energy from carbohydrates were classified as having high carbohydrate intake.[11]

According to the recommendations of the World Health Organization (WHO) and the United States Dietary Guidelines (USDA), free or added sugars should not exceed 10% of total energy intake. This threshold has been established to reduce the risk of chronic diseases such as obesity, type 2 diabetes, and cancer. Accordingly, in our study, individuals who obtained more than 10% of their daily energy intake from simple sugars were classified as having high simple sugar consumption.[12]

Anthropometric measurements

The patients' height, body weight, waist, and hip circumference were recorded. While waist and hip circumference measurements were taken, individuals were taken standing upright and without any clothing. Measurements were taken with a tape measure. During the measurements, care was taken to ensure that the tape measure was in contact with the skin without applying too much pressure. After the measurement was taken, it was recorded in millimeters on the study form. Body mass index was calculated by dividing body weight (kg) by the square of height (m2). Body weight, total body, and abdominal area fat percentage were measured with a TANİTA TBF-300 brand scale while fasting, wearing light clothing, and without shoes.

BMI (>25 kg/m2), body fat ratio (>27%), waist/hip ratio (>0.85) and daily fiber consumption amount (>20 g/day) consumption rate cut-off values have been determined.[13-15]

Statistical analysis

While making statistics of continuous data in the scales, mean and standard deviation, minimum and maximum values of the features were used. Frequency and percentage values were used when defining categorical variables. Independent t-test was used to compare the means of two independent groups. The Chi-square test was used to evaluate the relationship between categorical variables. To evaluate the incidence of breast cancer with clinical data, logistic regression analysis was performed with backward and entered methods with statistically significant variables. The statistical significance level of the data was taken as $p<0.05$. Statistical analyses were performed using the MedCalc program and www.e-picos.com.

Ethics committee approval

Ethics committee approval for this study was obtained from a Osmaniye Korkut Ata University Science Scientific Research and Publication Ethics Board (Date: 20.10.2023, Approval Number: 2023/07/15) and the study was conducted in accordance with the principles of the Declaration of Helsinki.

Results

During the study, 78 patients who were followed up with a diagnosis of breast cancer in our hospital's oncology clinic were included in the study. Five breast cancer patients with missing data and two who did not agree to participate in the study were excluded from the study. The study was conducted with a total of 321 patients, 78 of whom were diagnosed with breast cancer (group 1) and 243 of whom were in the control group (group 2) who met the inclusion criteria. The demographic and clinical characteristics of the patients in both groups are summarized in Table 1.

All patients were women. The mean age was 45.98±11.53 years. 122 (38%) of the patients were in the premenopausal period, and 199 (62%) were in the postmenopausal period. 67 (20.9%) of the patients had a history of comorbid diseases. Of these, 59 (18.4%) had diabetes mellitus and 42 (13.1%) had hypertension.

The mean BMI was 27.89±7.12 kg/m2. The average body fat ratio was 37.12±7.29. The mean abdominal fat percentage was 36.33±9.87. The average amount of fiber consumed in the daily diet was 19.23±5.43 grams.

BMI value was <25 kg/m2 in 44 (13.7%) of the patients and ≥25 kg/m2 in 277 (86.3%). Body fat ratio was ≤27 in 52 (16.2%) of the patients and >27 in 269 (83.8%). The waist/hip ratio was ≤0.85 in 105 (32.7%) of the patients

Table 1. Demographic and clinical data of patients

		Breast Cancer	Control Group	
	All patient (n=321)	**Group 1 (n=78)**	**Group 2 (n=243)**	**p value**
	x±SD	**x±SD**	**x±SD**	
Age (years)	45.98±11.53	47.07±10.09	45.36±11.27	0.24*
BMI (kg/m^2)	27.89±7.12	28.81±6.99	27.65±6.23	0.17*
Body fat percentage (%)	37.12±7.29	38.17±7.12	36.79±6.67	0.12*
Abdominal fat percentage (%)	36.33±9.87	37.29±9.43	35.99±8.71	0.26*
Waist/hip ratio	0.94±0.34	0.96±0.24	0.93±0.36	0.49*
Carbohydrate consumption	64.11±13.45	69.52±12.37	62.18±9.82	0.002*
Simple sugar consumption rate (%)	14.02±6.78	15.11±6.02	13.24±4.81	0.005*
Pulp (gr)	19.23±5.43	18.73±5.39	19.57±4.04	0.14**
	n (%)	**n (%)**	**n (%)**	
menopausal				
premenopausal	122 (38)	27 (34.7)	95 (39.1)	0.48**
postmenopausal	199 (62)	51 (65.3)	148 (60.9)	
BMI				
<25	44 (13.7)	9 (11.5)	35 (14.4)	0.52**
≥25	277 (86.3)	69 (88.5)	208(85.6)	
Fat				
High	269 (83.8)	68 (87.2)	201 (82.7)	0.35**
Normal	52 (16.2)	10 (12.8)	42 (17.3)	
Waist/hip ratio				
High	216 (67.3)	55 (70.5)	161 (66.3)	0.49**
Normal	105 (32.7)	23 (29.5)	82 (33.7)	
Comorbid disease	67 (20.9)	17 (21.8)	50 ()	0.82**
Diabetes mellitus	59 (18.4)	14 (17.9)	45 (18.5)	0.91**
Hypertension	42 (13.1)	11 (14.1)	31 (12.8)	0.76**
Carbohydrate consumption				
High	176 (54.8)	55 (70.5)	121 (49.8)	0.001**
Normal	145 (45.2)	23 (29.5)	122 (50.2)	
Simple sugar consumption				
High (>10)	196 (61.1)	63 (80.8)	133 (54.7)	<0.001**
Normal (≤10)	125 (38.9)	15 (19.2)	110 (44.3)	
Pulp				
Low (<20)	262 (83.6)	61 (78.2)	201 (82.7)	0.37
Normal (≥20)	59 (18.4)	17 (21.8)	42 (17.3)	

*Student t test. **Chi square

and >0.85 in 216 (67.3%). The carbohydrate ratio in daily energy intake was ≤60% in 176 (54.8%) of the patients and >60% in 145 (45.2%). The simple sugar consumption rate was ≤10 in 125 (38.9%) of the patients and >10 in 196 (61.1%). The daily fiber consumption amount was ≥20 g/day in 262 (83.6%) of the patients and <20 g/day in 59 (18.4%).

There was no statistically significant difference between the groups regarding age, menopausal period, presence of comorbid diseases, BMI, daily fiber consumption, and body and abdominal fat ratio (p>0.05).

The average daily carbohydrate consumption rate was 69.52±12.37 in group 1 and 62.18±9.82 in group 2. The average daily simple sugar consumption rate was 15.11±6.02 in group 1 and 13.24±4.81 in group 2. The average carbohydrate and simple sugar consumption rate in the daily diet in group 1 was statistically significantly higher than in group 2 (p<0.002, p=0.005, respectively).

The risk of developing breast cancer in those who obtain more than 60% of their daily energy intake from carbohydrates is 241% of the risk of those who obtain <60% (OR: 2.41, 95% CI 1.39 - 4.17). The risk of developing breast cancer in those whose simple sugar intake is more than 10% of the carbohydrate amount in their daily diet is 347% of the risk of those whose carbohydrate intake is ≤10% (OR: 3.47, 95% CI 1.87 - 6.44). Consuming high amounts of carbohydrates and simple sugar in the daily diet statistically increases breast cancer (p<0.05) (Table 2).

Discussion

The current study showed that high consumption of carbohydrates and simple sugars in the daily diet increased the risk of breast cancer (p<0.05). Cancer is the second leading cause of death in the world.[2] Our study is essential for public health when considering nutrition-related risk factors in breast cancer.

In recent years, the carbohydrate content in the diet has changed. The consumption of refined sugar has increased the diet's glycemic index (GI) and glycemic load (GL). High GI foods, such as simple sugars, refined carbohydrates, and starches, cause a rapid increase in blood sugar. As a result, insulin release increases. High insulin levels cause the production of Insulin-like growth factor-1 (IGF-1) and testosterone, which are considered risk factors for breast cancer. In addition, chronic hyperinsulinemia associated with insulin resistance has a vital role in the etiology of breast cancer because it induces IGF-1 production, which can cause mutagenic changes.[16] In our study, the high consumption of carbohydrates and simple sugars may be related to the mentioned mechanism. In future studies, the hypothesis related to the etiology of the disease may be supported by measuring blood insulin levels and IGF-1.

In a prospective study, the relationship between developing breast cancer and consumption of carbohydrate-containing foods was examined. After an eighteen-year follow-up period, female cases of breast cancer were observed. However, there is no relationship between breast cancer and total fiber consumption, carbohydrate intake, and GL.[17] In studies examining dietary carbohydrate intake and breast cancer risk, GL and GI of food were examined.[18]

A study of 688 pre- and postmenopausal breast cancer survivors prospectively examined various nutritional factors associated with cancer prognosis. No significant relationship was found between carbohydrate intake, GL or Gİ and breast cancer-specific mortality.[19] While only one of the studies included in a recent meta-analysis showed a modest increase in breast cancer risk in women with a high-GI or GL-related diet, two other studies also observed controversial results. The current study observed a significant difference in carbohydrate intake between Group 1 and Group 2. However, the fact that GI and GL were not evaluated is a limitation.[20]

A prospective study from Japan analyzed age-adjusted mortality from breast cancer from National Nutrition Survey data and Japan Vital Statistics. As a result, an inverse correlation was found between carbohydrate intake and death from breast cancer.[21] This may be due to the increase in fiber associated with carbohydrate

Table 2. The relationship between carbohydrate and simple sugar consumption in breast cancer formation with multivariate analysis

	Odds ratio	95% Confidence Interval	p value
Carbohydrate	2.41	1.39 – 4.17	<0.05
Simple sugar	3.47	1.87 – 6.44	<0.05

intake. Contrary to the stated opinion, our study found no relationship between fiber content and breast cancer.

There is a direct proportional relationship between carbohydrate intake and breast cancer risk. It is predicted that the relationship between breast cancer and carbohydrates is primarily caused by simple sugar intake. In the review conducted by Li et al., dietary carbohydrate intake was suggested to be associated with lower breast cancer incidence, mortality, and recurrence risk.[22]

Many prospective cohort studies have been conducted recently on dietary fiber intake and breast cancer. Most results show that the relationship between the two is not significant. Precise estimates of dietary fiber intake are conflicting due to difficulties in obtaining and limited heterogeneity of fiber intake in geographically limited populations.[23] In a random-effects meta-analysis of prospective observational studies, Farvid et al. demonstrated that higher total fiber intake was associated with a reduced risk of breast cancer. This finding was consistent for both soluble fiber and among women with premenopausal and postmenopausal breast cancer.[24]

Early exposure to environmental carcinogens, endocrine disruptors, and unhealthy foods (such as refined sugars, processed fats, and food additives) is hypothesized to promote molecular damage that increases breast cancer risk. In their review, Natarajan et al. aimed to gather information on potential exposures during adolescence and emphasized that preventing environmental exposure at this stage is challenging. The authors highlighted that young women are repeatedly exposed to media messages promoting unhealthy foods, representing a significant risk factor. Moreover, adolescents living in disadvantaged neighborhoods face additional challenges such as limited access to healthy foods and increased exposure to polluted air, water, and soil.[25]

In a study conducted in Denmark, the relationship between breast cancer and dietary carbohydrate intake in postmenopausal women was examined. No significant relationship was found between breast cancer and carbohydrate intake and fructose, which is the carbohydrate subgroup.[26]

In another prospective cohort study examining the relationship between dietary fructose intake and cancer risk, breast cancer was detected in 3.36% of women participating in the study between 1980 and 1998. As a result of statistical analysis, no relationship was found between fructose consumption and breast cancer in postmenopausal and premenopausal women.[17] A recent meta-analysis found not association between total sugar and fructose intake and breast cancer risk.[27] Contrary to the literature, our study suggests that as simple sugar consumption increases, the risk of breast cancer increases by 347% and can be considered a risk factor.

Today, most people consume foods and beverages sweetened with high-fructose corn syrup. Excessive dietary sugar intake, particularly fructose, is associated with an altered metabolic state both systemically and within specific tissues. This altered metabolism has multiple profound effects and is linked to the development of various diseases, including diabetes, cardiovascular disorders, and even cancer. In their review, Strober and Brady highlighted the association between increased dietary fructose intake, the development of metabolic dysfunctions, and the rising incidence of breast cancer.[28]

This topic also has implications across different domains. Since estrogen, progesterone, and insulin-like growth factor levels vary with menopausal status in breast cancer, the hyperinsulinemic stimuli triggered by carbohydrate consumption may elicit different biological responses in premenopausal and postmenopausal women. In their meta-analysis, Schlesinger et al. reported findings suggesting that the association between carbohydrate intake, glycemic load, and breast cancer risk was more pronounced among postmenopausal women.[27]

It is thought that the lack of a consistent relationship between dietary factors and breast cancer in epidemiological studies may be due to measurement and data errors resulting from the evaluation method of diet and insufficient dietary diversity in individual studies.

It is essential to take preventive measures against the association between high carbohydrate and simple sugar consumption and breast cancer. Concrete public health strategies should be considered. Our specific recommendations include the development of nutrition policies, clear and informative food labeling, implementation of additional taxation on such foods, and widespread community-based nutrition education programs.

The study's strengths were that the patients' daily food consumption and frequency were examined. This distribution feature has shown that carbohydrate and simple sugar consumption increases the likelihood of being a risk factor for breast cancer. In addition, the food

consumption record training given to the participants face-to-face at the beginning of the study increased the reliability of the forms taken during the control examination.

Our study has some limitations. Due to its cross-sectional descriptive design, causality between carbohydrate intake and breast cancer could not be established; the relationship was identified as an association rather than a causal effect. The study does not adequately control for possible confounding variables such as physical activity, smoking and alcohol intake, which are necessary to isolate the effect of carbohydrate intake on breast cancer risk. The patients' carbohydrate and simple sugar intake data were obtained through a 72-hour dietary recall. This method is subject to recall bias and may include inaccuracies or omissions in the recorded information.

Since the relationship between breast cancer and carbohydrate intake is largely associated with hyperinsulinemia, assessing patients' insulin and IGF-1 levels through blood tests could have provided objective evidence for future studies. Evaluating Gİ and GL in addition to carbohydrate amount in the study would have been more accurate in evaluating cumulative effects. Finally, evaluating glucose, fructose, or galactose as a simple sugar source could provide data on which type of monosaccharide has a stronger relationship.

Conclusion

High daily intake of carbohydrates and simple sugars is associated with an increased risk of breast cancer. Considering the growing prevalence of excessive sugar and carbohydrate consumption, this factor is expected to play a significant role in reducing future breast cancer incidence. Policies aimed at reducing simple sugar intake to below 10% of total energy and limiting refined carbohydrate consumption are strongly recommended.

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Ethical approval

This study has been approved by the Osmaniye Korkut Ata University Science Scientific Research and Publication Ethics Board (approval date 20.10.2023, number 2023/07/15). Written informed consent was obtained from the participants.

Author contribution

The authors declare contribution to the paper as follows: Study conception and design: AT; data collection: AT, EGD; analysis and interpretation of results: AT; draft manuscript preparation: AT, EGD. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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