

Research Article

Healthy Lifestyle on the Risk of Breast Cancer

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Abstract

Background: Many studies have analyzed the effect of behavioral risk factors such as common lifestyle patterns on the risk of disease. The aim of this study was to assess the effect of a healthy lifestyle index on the risk of breast cancer.

Methods: A population-based case-control study was conducted in Mexico from 2004 to 2007. One thousand incident cases and 1,074 controls, matched to cases by 5-year age category, region, and health institution, participated in the study. A healthy lifestyle index was developed by means of principal components by using dietary pattern, physical activity, alcohol consumption, and tobacco smoking. A conditional logistic regression model was used to assess this association.

Results: The healthy lifestyle index was defined as the combined effect of moderate and/or vigorous-intensity physical activity, low consumption of fat, processed foods, refined cereals, complex sugars, and the avoidance of tobacco smoking and alcohol consumption. Results showed a protective effect on both pre- (OR = 0.50, 95% CI: 0.29–0.84) and postmenopausal women (OR = 0.20, 95% CI: 0.11–0.37) when highest versus lowest index quintiles were compared.

Conclusions: Healthy lifestyle was associated with a reduction in the odds of having breast cancer. Primary prevention of this disease should be promoted in an integrated manner. Effective strategies need to be identified to engage women in healthy lifestyles.

Impact: This study is the first to assess a healthy lifestyle index in relation to the risk of breast cancer. *Cancer Epidemiol Biomarkers Prev*; 20(5); 912–22. ©2011 AACR.

Introduction

Recently, behavioral risk factors, such as common lifestyle patterns, have been related to the risk of disease. Traditionally, lifestyle indexes have been constructed by means of variables such as diet, physical activity, body mass index (BMI), alcohol consumption, and tobacco smoking; these characteristics have been associated with the risk of cardiovascular disease and diabetes (1–3). Behavioral risk factors are often correlated because people tend to follow common lifestyle patterns (2) influenced by intrapersonal, social, and cultural characteristics (4, 5).

Several studies have shown an independent effect of various lifestyle factors such as dietary patterns (6–8), micronutrients (9–11), physical activity (12–14), tobacco smoking (15), alcohol consumption (16,17), and anthropometric characteristics such as BMI, on the risk of breast cancer (18–20). Sedentary lifestyles have increased significantly in the past 20 years and, in combination with unhealthy dietary patterns, have been associated with an increased risk of weight gain and obesity (21, 22). Physical activity seems to reduce the risk of breast cancer by its effect on overweight and obesity, insulin resistance, and chronic inflammation (23, 24). In Mexico, only 16% of women exercise regularly; the national average of recreational physical activity for women is 5 minutes per day (25). Regarding diet, several studies have shown that the consumption of red meat, fat, and dairy products could increase the risk of breast cancer (26–31). In addition, moderate consumption of alcohol (i.e., 10 g/d) has also shown to increase the risk of this disease (16, 32). Women should be motivated to modify unhealthy lifestyles to decrease the risk of breast cancer (22). To our knowledge, there are no previous studies assessing the effect of these combined risk factors on the risk of breast cancer.

Controlled preventive strategies to reduce certain risk factors need to be analyzed jointly to evaluate their health impact and their implementation cost (33). Therefore,

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the aim of this study was to assess the effect of a healthy lifestyle index (including a healthy diet, moderate and vigorous-intensity physical activity, avoidance of smoking, and alcohol consumption) on the risk of breast cancer. This index included variables known to have an effect on the risk of this disease.

Methods

Population

A multicenter population-based case-control study was conducted in metropolitan areas of Mexico City, Monterrey, and Veracruz. One thousand cases and 1,074 controls were recruited; all participants were pre- or postmenopausal women, between 35 and 69 years of age, residing at one of the study sites during the past 5 years. A detailed description of the methodology employed on the selection of the study population, data collection on health, physical activity and diet, anthropometric measurements, and blood sampling has already been described (34).

Study subjects were enrolled between January 2004 and December 2007. Cases were identified by trained field staff at 12 hospitals from the major health care institutions in Mexico. Cases were selected by the following criteria, individuals who: (a) had a new histologic confirmed *in situ* or invasive diagnosis of breast cancer, regardless of the stage of disease (median = 3 days from the day of diagnosis); (b) were not previously treated with radiotherapy, chemotherapy, or antiestrogens such as tamoxifen during the previous 6 months; (c) were not taking antiestrogens at the time of the study, and (d) were not pregnant. Cases using antiestrogens ($n = 2$) were not included because of the effect of antiestrogens on breast density. Cases known to be HIV positive ($n = 1$) were excluded. The response rate for cases was 95.5% for Mexico City, 94.4% for Monterrey, and 97.4% for Veracruz.

Controls were selected on the basis of a probabilistic multistage design and were frequency-matched to cases according to 5-year age category, region, and health care system. An appointment was scheduled for each woman to attend the hospital to obtain anthropometric measurements, mammography, and a blood specimen. The response rate for controls was 87.4% for Mexico City, 90.1% for Monterrey, and 97.6% for Veracruz.

This collaborative study was approved by the Institutional Review Board at the National Institute of Public Health of Mexico and by equivalent committees at the participating hospitals.

Questionnaires

A structured questionnaire was administered in person to collect information on health, diet, and physical activity. The health questionnaire collected information on sociodemographic characteristics, lifetime alcohol consumption, reproductive factors (e.g., age at menarche and menopause, parity, and lactation history), use of oral

contraceptives, hormone therapy for menopause, family history of breast cancer, and smoking history, among others.

Physical activity

To assess physical activity within the previous 12 months, a semistructured interview (35, 36) based on a 7-day recall questionnaire was applied; it included time spent on physical activities and sleep. Physical activity was not limited to recreational activity but included other types of activities such as household work. Physical activity was divided into 3 categories: (a) light-intensity physical activities [1.1–2.9 metabolic equivalents of energy expenditure (METs)], (b) moderate-intensity physical activities (3.0–5.9 METs), and (c) vigorous-intensity physical activities (6 or more METs; ref. 37). The number of hours of physical activity per week, in each of the 3 categories, was calculated. For this study, we used only the moderate and vigorous-intensity physical activities in hours per week.

Diet

To measure diet during the previous year, we used a previously validated semiquantitative food frequency questionnaire for Mexicans, which included 104 items and 10 multiple choice consumption frequency categories, as described by Willett (38–40).

Food groups

Forty food groups were defined and certain foods were considered individually (e.g., eggs, mayonnaise, coffee, and beer) when they did not belong to a specific group or particular dietary pattern (e.g., oils, liquor, and animal origin fats; Appendix 1; ref. 41). A Western dietary pattern was constructed by principal factor analysis; its composition is presented in the Appendix 2. Given that Western dietary pattern has been associated with several diseases (e.g., type 2 diabetes, cardiovascular disease, stroke, and certain types of cancer) and with overweight and obesity (12, 42, 43), its lowest tertile was considered the one with the least risk.

Alcohol consumption

Information on alcohol consumption was obtained by asking women about their drinking habits the year prior to the onset of the symptoms. Alcohol was measured in grams and, for this study, was divided into 3 categories: (a) did not consume, (b) consumed less than 1 g/d, and (c) consumed 1 g/d or more. Women who did not consume alcohol were considered to have the lowest risk.

Tobacco smoking

Tobacco smoking was obtained as a dichotomous variable inquiring whether subjects had "consumed more than 100 cigarettes in their lifetime" (yes/no). For this study, the low-risk group was defined as those subjects who had never smoked or had smoked 100 or less cigarettes in their lifetime.

Statistical analysis

Western dietary pattern. The 104 food items were grouped into 40 food groups (Appendix 1) to construct the Western dietary pattern by means of principal factor analysis (44). The function ROTATE = VARIMAX was used to rotate the loading matrix by an orthogonal transformation (45). A factor loading of 0.58 or more was used to identify the primary factor on which the items are loaded. For each subject, factor scores for the Western dietary pattern were calculated (46). Final factor scores were derived by weighting each food group proportionally to its involvement in daily food intake of each woman. For the descriptive analysis, the Western dietary pattern index was categorized by using tertiles, being the lowest the one with the least risk (47).

Healthy lifestyle index. Diet, physical activity, alcohol consumption, and tobacco smoking were used to develop the healthy lifestyle index. It was considered healthy to practice moderate and vigorous-intensity physical activity, to belong to the lowest tertile of the Western dietary pattern, to have smoked less than 100 cigarettes, or to have never smoked and to have never consumed alcohol. This index was constructed by means of principal components. The Western dietary pattern was introduced inversely, being the third tertile the healthiest. Quintiles were generated on the basis of the distribution among controls. A polychoric correlation was undertaken given that variables were ordinal. Once the polychoric matrix was obtained, an analysis of principal factors was generated through a regression model, using only one factor. Diagnosis of the statistical model was made using the Kaisery–Meyer–Olkin test (47).

To compare cases and controls, χ^2 test for categorical variables and *t* test or Wilcoxon test for continuous variables was used. To estimate the association between the healthy lifestyle index, and the risk of breast cancer in pre- and postmenopausal women, conditional logistic regression models were used. A forward and backward stepwise model selection procedure was used to determine the final model. Models accounted for matching by age category, health care system, region, and factors adjusted for in previous literature such as: socioeconomic status (low, middle, and high; ref. 34), breast feeding (months), age at menarche (years), age at menopause (years), BMI = weight/height (kg/m²), family history of breast cancer in first-degree relatives [grandmother, mother, and sisters (yes/no)], personal history of diabetes (yes/no), waist-to-hip ratio (WHR), height (cm), daily intake of folate ($\mu\text{g}/\text{d}$), and total calories. All analyses were done by using STATA v10.

Results

Most breast cancer cases were invasive; there were only 10 pre- and 10 postmenopausal *in situ* cases. Table 1 shows the main characteristics of the study population by cases and controls. Regarding the Western dietary

pattern, there was a greater percent of cases than controls in the highest tertile (the one with the highest risk). With respect to the healthy lifestyle index, the cases were distributed mainly in the first 2 quintiles (the ones with the highest risk), whereas controls were distributed more evenly among them. Compared with controls, more cases had history of diabetes, family history of breast cancer, had smoked at least 100 cigarettes, consumed more alcohol, and reported lower parity, breast feeding, and physical activity.

Tables 2 and 3 show the frequency distribution of the characteristics by cases and controls in pre- and postmenopausal women by healthy lifestyle quintiles. With increasing quintiles, the frequency of tobacco smoking ($P < 0.001$), alcohol consumption ($P < 0.001$), Western dietary pattern intake ($P < 0.001$), daily total consumption of calories ($P < 0.001$; only in controls), and high socioeconomic status ($P < 0.001$; except in postmenopausal controls), decreased significantly. Table 4 shows the final multivariate models for pre- and postmenopausal women and the contribution of each lifestyle component; the odds of having breast cancer decreased with increasing healthy lifestyle quintiles in both pre- and postmenopausal women (P for trend < 0.001). There was a protective effect in both premenopausal (OR = 0.50, 95% CI: 0.29–0.84) and postmenopausal women (OR = 0.20, 95% CI: 0.11–0.37) when highest versus lowest quintiles were compared. Alcohol and physical activity were the variables that contributed the most to the overall risk reduction, particularly in postmenopausal women.

Discussion

The aim of this study was to assess the effect of 4 variables (i.e., physical activity, dietary pattern, tobacco smoking, and alcohol consumption) as components of an index defined as "Healthy Lifestyle" on the risk of breast cancer. Results showed a decrease in the odds of having breast cancer with increasing quintiles of the Healthy Lifestyle index. Higher values of the index are related to performing at least half hour per day of vigorous- or moderate-intensity physical activity, no consumption of alcohol, fat, processed foods, refined cereals, complex sugars, and no tobacco smoking. Comparable studies have been undertaken for diabetes type 2 (1), coronary heart disease (48), and risk of stroke in women (3). An advantage of this work is that having constructed an index based on dietary patterns, rather than on consumption of micronutrients such as folate, fiber, fat, omega-3, fatty acids, trans fat, and a glycemic index (1–3) makes recommendations easier to understand by the general population.

BMI was not included in the healthy lifestyle index, but multivariate models were adjusted for this characteristic. Previous studies have created an index incorporating BMI along with diet, smoking, alcohol consumption, and physical activity; however, BMI is a result of a lifestyle, not its component (13).

Table 1. Health, reproductive, and lifestyle characteristics in Mexican women (2004–2007)

	Cases (<i>n</i> = 1,000), (%)	Controls (<i>n</i> = 1,074), (%)	<i>P</i> ^a
Ever use of oral contraceptives			
No	55	55	
Yes	45	45	0.288
Personal history of diabetes ^b			
No	69	77	
Yes	18	14	0.035
Family history of breast cancer in first-degree relatives			
No	94	96	
Yes	6	4	0.015
Menopausal status			
Premenopause	41	44	
Postmenopause	59	56	0.186
≥100 cigarettes smoked in lifetime, %			
No	75	79	
Yes	25	21	0.040
Western dietary pattern			
Low consumption (tertile 1)	25	33	
Moderate consumption (tertile 2)	30	33	
High consumption (tertile 3)	45	34	<0.001
Healthy lifestyle			
Least (Q1)	37	20	
Middle-least (Q2)	27	19	
Middle (Q3)	16	20	
Middle-high (Q4)	10	20	
High (Q5)	9	20	<0.001
	Mean	Mean	
Age, y	52 ± 10	51 ± 9	0.902
Parity	3 ± 2	4 ± 2	<0.001
Breast feeding, mo	22 ± 30	30 ± 35	<0.001
BMI, kg/m ²	29 ± 6	31 ± 5	<0.001
Daily total consumption of calories, kcal	2,208 ± 774	1,937 ± 672	<0.001
Folate, µg/d	381 ± 176	345 ± 157	0.001
WHR	0.90 ± 0.10	0.91 ± 0.10	0.027
Moderate and vigorous-intensity physical activity, h/wk	12 ± 14	17 ± 17	<0.001
Height, cm	153 ± 7	152 ± 6	<0.001
Alcohol, g/d	1.50 ± 6	0.74 ± 4	<0.001

Abbreviations: Q1, Q2, Q3, Q4, and Q5, quintiles 1, 2, 3, 4, and 5.

^a"*P*" value: *t* test for continuous variables and χ^2 test for categorical variables.

^bPercentages do not reach 100% because of missing values.

The following arguments support the selection of variables included in the "Healthy Lifestyle" index:

There is a plenty of evidence that physical activity protects against postmenopausal breast cancer, with an average of 30% to 40% risk reduction with statistically significant linear trend (12, 49, 50, 14). However, in premenopausal women, the results are less consistent (12). Both moderate and vigorous-intensity physical activity confer nearly equal reduction on the risk of breast cancer (51).

The protective effect of physical activity seems to be partly related to a decreased exposure to sex hormones, to

insulin or insulin growth factor, and by preventing overweight and obesity (13).

Regarding the Western dietary pattern, an increased consumption of a Western diet has been related to an increased risk of breast cancer (OR = 1.31, 95% CI: 1.13–1.51, for the continuous score of the Western dietary pattern; ref. 42). Although the Western diet shows different nutritional profiles in Western communities, at large, this dietary pattern is high in meat, dairy products, fat, sugary foods (processed meats, pastries, baked goods, confectionery, and sweetened drinks),

Table 2. Population profile by quintiles of "Healthy lifestyle index" in premenopausal women, Mexico 2004–2007

Variables	Cases					Controls						
	Q1 ^a	Q2	Q3	Q4	Q5	P ^b	Q1 ^a	Q2	Q3	Q4	Q5	P ^b
Cigarettes smoked over lifetime, %												
<100	62.96	75.00	83.58	90.24	94.44	<0.001	60.00	65.88	80.00	80.20	87.37	<0.001
≥100	37.04	25.00	16.42	9.76	5.56		40.00	34.12	20.00	19.80	12.63	
Alcohol consumption per day ^c , %												
Never	5.19	30.36	43.28	31.71	53.70		7.62	32.29	36.67	59.41	75.79	
<1 g	41.48	52.68	49.25	65.85	46.30	ND	40.95	54.12	55.56	34.65	20.00	
≥1 g	53.33	16.96	7.46	2.44	0.00		51.43	10.59	7.78	5.94	4.21	<0.001
Moderate and vigorous-intensity physical activity ^c , h/wk	7.28	10.85	11.90	21.63	42.00	<0.001	7.13	11.32	13.43	19.38	39.7	<0.001
Western dietary pattern, %												
Tertile 1 (lowest)	2.96	10.71	43.28	56.10	70.37		3.81	4.71	38.89	56.44	67.37	
Tertile 2	20.74	50.00	31.34	29.27	22.22	<0.001	24.76	47.06	37.78	30.69	22.11	
Tertile 3 (highest)	76.30	39.29	25.37	14.63	7.41		71.43	48.24	23.33	12.87	10.53	<0.001
Socioeconomic status, %												
Low	30.37	25.89	34.33	43.90	24.07		19.05	31.76	25.56	30.69	43.16	
Middle	20.74	28.57	26.87	34.15	38.89		30.48	23.53	40.00	35.64	29.47	
High	48.89	45.54	38.81	21.95	37.04	0.042	50.48	44.71	34.44	33.66	27.37	0.003
Parity, %												
Nulliparous	13.33	4.46	10.45	9.76	15.09		10.48	7.06	7.78	8.00	8.42	
1 to 2	40.74	51.79	47.76	34.15	32.08		42.86	30.59	37.78	39.00	36.84	
≥3	45.93	43.75	41.79	56.10	52.83	0.126	46.67	62.35	54.44	53.00	54.74	0.768
Breast feeding, mo	16.65	16.04	16.11	18.26	22.05		17.94	22.16	21.82	19.95	21.49	0.715
History of diabetes, %												
No	94.53	87.62	92.06	89.47	96.00		93.94	89.16	88.24	94.95	92.63	
Yes	5.47	12.38	7.94	10.53	4.00	0.265	6.06	10.84	11.76	5.05	7.37	0.372
Family history of breast cancer, %												
No	96.30	98.21	100.00	97.56	100.00		99.05	97.65	97.78	98.02	100.00	
Yes	3.70	1.79	0.00	2.44	0.00	ND	0.95	2.35	2.22	1.98	0.00	ND
BMI, kg/m ²	27.63	28.45	28.22	29.13	28.75	0.401	29.64	30.27	29.97	30.43	29.65	0.753
WHR, %	88.90	89.03	87.55	88.53	88.17	0.832	91.42	90.29	88.98	91.34	89.46	0.439
Height, cm	154.04	154.63	153.27	155.30	154.75	0.438	154.33	153.19	153.79	153.58	152.18	0.106
Total daily calories consumption, kcal	2,356.02	2,273.96	2,229.48	2,265.36	2,160.11	0.602	2,336.54	1,965.14	2,048.94	1,815.63	1,859.67	<0.001
Western dietary pattern calories, kcal	1,319.76	1,372.98	1,287.62	1,516.45	1,365.16	0.313	1,430.24	1,167.49	1,286.53	1,083.90	1,114.59	<0.001

Abbreviations: ND, not determined; Q1, Q2, Q3, Q4, and Q5, quintiles 1, 2, 3, 4, and 5.

^aQ1 of the healthy index refers to the least healthy lifestyle.^bP value: χ^2 test for categorical variables and ANOVA test for continuous variables.^cThe year prior to the onset of the symptoms.

Table 3. Population profile by quintiles of "Healthy lifestyle index" in postmenopausal women, Mexico 2004–2007

Variables	Cases					Controls						
	Q1 ^a	Q2	Q3	Q4	Q5	P ^b	Q1 ^a	Q2	Q3	Q4	Q5	P ^b
Cigarettes smoked over lifetime, %												
<100	61.90	77.85	84.04	91.53	91.67		64.55	80.65	88.37	91.38	86.44	
≥100	38.10	22.15	15.96	8.47	8.33	<0.001	35.45	19.35	11.63	8.62	13.56	<0.001
Alcohol consumption per day ^c , %												
Never	6.06	40.51	43.62	72.88	58.33		6.36	33.87	50.39	55.17	75.42	
<1 g	40.69	52.53	56.38	27.12	38.89		54.55	53.23	47.29	42.24	22.88	
≥1 g	53.25	6.96	0.00	0.00	2.78	ND	39.09	12.90	2.33	2.59	1.69	<0.001
Moderate and vigorous-intensity physical activity ^c , h/wk	5.62	8.36	7.57	14.33	39.11	<0.001	6.05	9.05	11.43	18.95	38.26	<0.001
Western dietary pattern, %												
Tertile 1 (lower)	5.63	8.23	50.00	69.49	61.11		2.73	6.45	25.58	58.62	65.25	
Tertile 2	19.05	44.30	39.36	15.25	25.00		19.09	48.39	49.61	25.00	28.58	
Tertile 3 (upper)	75.32	47.47	10.64	15.25	13.89	<0.001	78.18	45.16	24.81	16.38	10.17	<0.001
Socioeconomic status, %												
Low	24.24	34.18	42.55	28.81	30.56		30.00	32.26	32.56	39.66	47.49	
Middle	22.08	26.58	19.15	35.59	30.56		30.91	37.90	35.66	35.34	31.36	
High	53.68	39.24	38.30	35.59	38.89	0.007	39.09	29.84	31.78	25.00	21.19	0.056
Parity, %												
Nulliparous	14.78	8.86	8.60	15.25	16.67		5.45	2.42	2.33	6.90	4.24	
1 to 2	27.83	27.22	30.11	30.51	19.44		19.09	19.35	24.81	17.24	24.58	
≥3	57.39	63.92	61.29	54.24	63.89	0.532	75.45	78.23	72.87	75.86	71.19	0.467
Breast feeding, mo	21.72	30.8	28.71	24.49	24.83		34.84	36.5	40.46	40.74	33.53	0.531
History of diabetes, %												
No	81.36	64.63	68.18	58.18	79.41		79.61	81.90	81.15	75.89	70.18	
Yes	18.64	35.37	31.82	41.82	20.59	<0.001	20.39	18.10	18.85	24.11	29.82	0.186
Family history of breast cancer, %												
No	95.67	97.47	91.49	98.31	97.22		96.36	100.00	100.00	98.28	96.61	
Yes	4.33	2.53	8.51	1.69	2.78	0.158	3.64	0.00	0.00	1.72	3.39	0.061
BMI, kg/m ²	29.74	29.49	30.44	29.76	29.21	0.649	30.01	31.21	31.93	30.68	29.90	0.013
WHR, %	93.32	90.81	88.71	89.64	90.18	0.002	93.13	91.99	92.01	92.23	89.69	0.080
Height, cm	151.35	151.64	152.05	153.21	153.79	0.239	150.44	150.78	151.06	150.34	150.67	0.918
Total daily calories consumption, kcal	2,273.37	2,140.31	1,956.82	2,014.35	2,188.60	0.013	2,074.79	1,965.15	1,917.53	1,687.41	1,694.98	<0.001
Western dietary pattern calories, kcal	1,213.73	1,237.60	1,131.49	1,106.49	1,309.69	0.342	1,149.20	1,123.09	1,137.94	979.25	919.07	<0.001

Abbreviations: ND, not determined; Q1, Q2, Q3, Q4, and Q5, quintiles 1, 2, 3, 4, and 5.

^aQ1 of the healthy index refers to the least healthy lifestyle.^bP value: χ^2 test for categorical variables and ANOVA test for continuous variables.^cThe year prior to the onset of the symptoms.

Table 4. Healthy lifestyle index and its components on the risk of breast cancer in pre- and postmenopausal women, Mexico, 2004 to 2007

	Premenopausal	Postmenopausal
Healthy lifestyle index ^a		
Q1 (least)	1.00	1.00
Q2	1.12 (0.72–1.73)	0.71 (0.48–1.05)
Q3	0.59 (0.37–0.96)	0.43 (0.27–0.67)
Q4	0.37 (0.21–0.64)	0.29 (0.18–0.48)
Q5 (upper)	0.50 (0.29–0.84)	0.20 (0.11–0.37)
Trend test	$P < 0.001$	$P < 0.001$
Healthy lifestyle index individual factors		
At least 100 cigarettes smoked over lifetime		
No	1.20 (0.83–1.73)	0.82 (0.57–1.18)
Yes	1.00	1.00
Western dietary pattern		
Tertile 1 (lower)	0.91 (0.57–1.45)	0.73 (0.46–1.15)
Tertile 2	0.82 (0.55–1.23)	0.74 (0.51–1.07)
Tertile 3 (upper)	1.00	1.00
Trend test	$P = 0.686$	$P = 0.089$
Alcohol consumption per day		
Never	0.79 (0.40–1.00)	0.56 (0.35–0.91)
<1 g	1.06 (0.69–1.64)	0.81 (0.51–1.28)
≥1 g	1.00	1.00
Trend test	$P = 0.023$	$P = 0.010$
Moderate and vigorous-intensity physical activity, h/wk	0.98 (0.97–0.99)	0.97 (0.95–0.98)

Abbreviations: Q1, Q2, Q3, Q4, and Q5, quintiles 1, 2, 3, 4, and 5.

NOTE: All values are given in OR (95% CI) unless stated.

OR values are adjusted by age category, health care system, and region, as well as for socioeconomic status, breastfeeding, BMI, family history of breast cancer, history of diabetes, folate consumption in diet, total daily calories consumption, height, and WHR.

^aQ1 of the healthy index refers to the least healthy lifestyle.

alcohol, and variable amounts of vegetables and fruits (12). Case-control studies developed in Uruguay (42) and China (7) found an association of the Western dietary pattern with an increased risk of breast cancer in postmenopausal women with estrogen receptor-positive tumors. A study in the United States (52) found an association between dietary patterns related to glycemic index and load with the risk of pre- and postmenopausal breast cancer.

The prudent dietary pattern has shown to protect against breast cancer in some women (8). Although we found a prudent dietary pattern (e.g., green/yellow vegetables, legumes, and fruits), it was only protective in postmenopausal women (OR = 0.67, 95% CI: 0.46–0.97; OR = 0.71, 95% CI: 0.42–1.20, when comparing middle and upper tertiles versus lower tertile, respectively); however, there was no statistically significant trend (P for trend = 0.13). Western dietary pattern was used to emphasize the types of food to avoid (Western dietary pattern), which are highly consumed by Mexican women.

Alcohol consumption has been associated to a modest risk of breast cancer (9, 53–57). Results from different

studies have shown that when compared with nondrinkers, those who consume 1 drink per day increase their risk by 10% to 12% (58, 59). A dose-response relationship has also been reported in cohort studies (54) linked to the physiologic process of estrogens, because alcohol consumption has been linked to estrogen receptor-positive tumors (57–61). Another postulated mechanism is that alcohol may induce cytochrome P-4502E1 (CYP2E1), in which metabolism of alcohol into acetaldehyde is involved in generating several procarcinogens. In addition, a low folate intake promotes an inadequate destruction of acetaldehydes, therefore increasing the risk (62).

Carcinogens found in tobacco smoke, once they are in the blood stream, might be transported to the breast through plasma lipoproteins (63–65). The effect of cigarette smoking as a possible breast cancer risk factor (66–69) has been controversial (70); the effect varies according to starting age, intensity, duration, induction period (71–73), and some have suggested an interaction with certain genes (15).

Given the recall bias, an inherent limitation of case-control studies, cohort studies should be conducted. To

Appendix 1. Food groups used in the analysis of dietary patterns

Group	Foods and food groups	Foods
1	Whole milk	Whole milk
2	Nonfat dairy products	Fresh or cottage, and Oaxaca cheese
3	Fatty dairy products	Manchego and cream cheese, yogurt, milk ice cream, and cream
4	Fruits	Banana, orange, melon, apple, watermelon, pineapple, papaya, pear, mango, mandarin, strawberry, apricot or nectarine, grapes, plums, mamey, and zapote
5	Juices	Orange or grapefruit
6	Egg	Egg
7	Chicken	Chicken
8	Processed foods	Ham, "chicharrón" (deep fried pork skin), sausages, bacon, longaniza, or chorizo (spicy pork sausage)
9	Red meats	Beef, pork, "Carnitas" (deep fried pork meat) and barbacoa (beef or goat meat wrapped in maguey leaves cooked in a pit)
10	Fish	Tuna, fresh fish, sardines, and sea food
11	Viscera	Liver steak or chicken gizzard
12	Tomato	Tomatoes in cooked sauce, and fresh tomatoes in salads
13	Potatoes	Potatoes
14	Orange vegetables	Carrots and squash flowers
15	Vegetables of leafy greens	Lettuce and spinach
16	Green vegetables	Nopales (cactus variety) and green beans
17	Other vegetables	Zucchini, chayote, or cauliflower
18	Vegetable cream	Vegetable cream
19	Avocado	Avocado
20	Chili	Teaspoon of hot sauce, canned chili, dishes with dried chilies
21	Beans	Beans
22	Legumes	Green peas, lentils, dried and green broad beans, or chickpeas
23	Corn	Corn tortilla and corn on the cob
24	Refined cereals	Flour tortillas, white bread, rice, and pastas
25	Whole-wheat cereals	Whole-wheat sliced bread, oats, and cereal with fiber
26	Sweet cereals	Sweet bread and boxed cereal
27	Dessert	Cake, spoon of powder chocolate, honey or quince jelly, or a brick of chocolate
28	Fried foods	Fried foods
29	Sweetened beverages	Cola drinks, other soda flavored drinks, sweetened flavored drinks, "atole" (corn dough drink) with and without milk
30	Unsweetened beverages	Diet drinks
31	Coffee	Coffee
32	Beer	Beer
33	Table wine	Table wine
34	Liquor	Rum, brandy, or tequila
35	Oils	Corn, soy, sunflower, and safflower (carthamus)
36	Olive oil	Olive oil
37	Vegetable origin fat	Margarine and vegetable oil
38	Animal origin fats	Butter and animal lard
39	Mayonnaise	Mayonnaise
40	Typical Mexican dishes	"Tacos," "sopes," "quesadilla," "pozole," and "tamales"

reduce this bias, incident cases were included in this study.

In conclusion, a healthy lifestyle was associated with a reduction in the odds of having breast cancer. Primary prevention should be promoted in an integrated man-

ner. As concluded by this study, the recommended healthy lifestyle consists of a dietary pattern low in fat, processed foods, refined cereals, and complex sugars; the daily practice of at least half an hour of moderate- and/or vigorous-intensity physical activity,

Appendix 2. Rotated factor loadings for food groups for Western dietary pattern

Variable	Western factor
Mayonnaise	0.58
Oils	0.57
Vegetable origin fats	0.49
Animal origin fats	0.47
Typical Mexican dishes	0.44
Processed foods	0.44
Refined cereals	0.43
Chili	0.43
Fatty dairy products	0.39
Sweetened beverages	0.39
Corn	0.37
Red meats	0.35
Eggs	0.31
Dessert	0.28
Fried foods	0.28
Sweet cereals	0.26
Beans	0.26
Beer	0.13
Diet soft drinks	0.12
Viscera	0.12

and avoidance of smoking and alcohol consumption. Effective strategies need to be identified to engage women in healthy lifestyles.

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There are no potential conflicts of interest.

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