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Physical Activity and Breast Cancer Risk Among Women in the Southwestern United States

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Abstract

Physical activity may influence breast cancer risk through multiple mechanisms and at different periods in life. In this study we evaluate breast cancer risk associated with total and vigorous physical activity at ages 15, 30, and 50 years and the referent year prior to diagnosis/selection. Participants were non-Hispanic white (NHW) (1527 cases and 1601 control subjects) and Hispanic/American Indian (HAI) (798 cases and 924 controls) women. Both total and vigorous activity reduced risk of breast cancer in a dose-response manner. Among premenopausal women, only high total metabolic equivalent of the task (MET) hours of activity during the referent year was associated with reduced breast cancer risk in NHW women (odds ratio [OR] 0.62; 95% confidence interval [CI] 0.43, 0.91). Among postmenopausal women, physical activity had the greatest influence among women not recently exposed to hormones. Among these women, high total lifetime activity reduced risk of breast cancer for both NHW (OR 0.60; 95% CI 0.36, 1.02; *p* trend 0.01) and HAI women (OR 0.52; 95% CI 0.23, 1.16; *p* trend 0.07). Additionally, high total MET hours of activity at age 30 years (OR 0.56; 95% CI 0.37, 0.85) and at age 15 years (OR 0.57; 95% CI 0.38, 0.88) reduced breast cancer risk among postmenopausal NHW women not recently exposed to hormones. Among HAI women, more recent activity performed during the referent year and at age 50 appeared to have the greatest influence on breast cancer risk. Among postmenopausal NHW women. there was a significant interaction between physical activity and hormone replacement therapy (*p* value, 0.01), while among postmenopausal HAI women, physical activity interacted with body mass index (*p* value, 0.04). These data suggest that physical activity is important in reducing risk of breast cancer in both NHW and HAI women.

Keywords

BMI; Breast Cancer; Physical Activity; Hispanic; Hormones

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Introduction

Physical activity has been shown to reduce risk of breast cancer (1–6). Studies have suggested that total activity, lifetime recreational activity, nonrecreational activity, and vigorous activity may be important components of activity that influence breast cancer risk (2,3,6,7). Some studies suggest stronger associations for physical activity among premenopausal women than among postmenopausal women, while other studies do not show differences in association by menopausal status (1). It also has been suggested that activity patterns in early life may influence breast cancer risk as an adult (8). Hypothesized mechanisms for the association between physical activity and breast cancer include maintaining energy balance (7), reducing steroid hormone levels (9,10) influencing insulin and insulin-related growth factors (11), and altering inflammatory response (12). It is possible that physical activity operates within a complex set of conditions that may differ at various periods throughout life.

Most studies of physical activity and breast cancer risk have been conducted among non-Hispanic white (NHW) women. In this study, we evaluated associations between physical activity and breast cancer risk among both Hispanic and American Indian (HAI) women and NHW women living in the southwestern United States. There are marked differences in the underlying risk of breast cancer between American Indian, Hispanic, and NHW women living in the southwestern United States (13). Breast cancer rates among American Indian and Hispanic women are substantially lower than among NHW women living in the same area. Lifestyle factors that contribute to these differences in breast cancer risk are of interest because of implications for understanding the disease process as well as methods of disease prevention. We aimed to evaluate associations by ethnicity, by menopausal status, and by the type, intensity, and timing of activity. To develop a better understanding of potential mechanisms linking physical activity to the relative risk of breast cancer, we assessed the interplay between physical activity and other risk factors for breast cancer, including body size and weight gain, hormone replacement therapy (HRT), and ever having used aspirin or nonsteroidal anti-inflammatory drugs (NSAIDs).

Methods

Eligible participants were women living in Arizona, Colorado, New Mexico, or Utah at the time of breast cancer diagnosis or selection. Since the focus of the study was to evaluate breast cancer risk factors in HAI populations living in the southwestern United States, all HAI women identified were eligible and NHW cases were randomly selected on the basis of the distribution of Hispanic cases. The GUESS (Generally Useful Ethnic Survey System) program was used to initially identify women who were Hispanic based on surname; ethnicity information from cancer registries or lists generated for control selection also were used to define initial ethnicity (14). We screened all women identified to verify ethnicity and eligibility prior to study enrollment.

Cases were histologically confirmed and diagnosed between October 1999 and May 2004 with breast cancer, International Classification of Diseases-Oncology (ICD-O) sites C50.0–C50.6 and C50.8–C50.9, in situ or invasive. State tumor registries were used to initially identify and subsequently confirm case eligibility. NHW cases were randomly selected in proportion to the Hispanic cases identified. Of cases identified, 68% of women cooperated (69% of Arizona cases, 67% of Colorado cases, 66% of New Mexico cases, and 73% of Utah cases). Control subjects were selected from the target populations to match case distribution by 5-year age groups, ethnicity, and center. In Arizona and Colorado, participants under 65 years of age were randomly selected from a commercial mailing list; in New Mexico and Utah, they were randomly selected from driver's license lists. In all states, women 65 years and older were randomly selected from Centers for Medicare and Medical Services (CMS) (social security lists). Study-wide cooperation rates for controls were 42% (35% in Arizona, 34% in Colorado, 44% in New Mexico, and 65% in Utah). All participants provided informed consent; the study was approved by the Institutional Review Board for Human Subjects at each institution (Arizona, Colorado, New Mexico, and Utah).

Participants were asked to self-report race and ethnic background by selecting one or more of the following groups: Hispanic/Latina, white not of Hispanic origin, American Indian or Alaska Native, or other. Women who reported being only African American, Asian, or Pacific Islander were excluded from the study. Of first-primary breast cancer cases identified, 798 self-identified as Hispanic/American Indian (N = 720 Hispanic; N = 15 Hispanic and American Indian; N = 15 American Indian; 24 non-Hispanic white and Hispanic, 7 non-Hispanic white, Hispanic and American Indian; and 17 non-Hispanic white and American Indian); and 1527 NHW women were interviewed with valid study data. Of controls identified, 924 Hispanic/American Indian (N = 824 Hispanic; N = 13 Hispanic and American Indian; N = 13 American Indian; N = 27 NHW and Hispanic; N = 9 non-Hispanic white, Hispanic, and American Indian; and N = 38 NHW and American Indian), and 1601 women who self-identified as being only NHW participated. The small number of respondents who reported being American Indian precluded separate analysis for this group. These American Indian women (2.5% of the population) are included with Hispanics for these analyses; additional analyses by genetic admixture supports grouping of these participants (15).

Diet and lifestyle data were collected in person by trained and certified interviewers using a computerized questionnaire. The study referent year was the year prior to diagnosis or selection. The median time from diagnosis to interview for cases was 671 days for Arizona, 540 days for Colorado, 599 days for New Mexico, and 267 days for Utah. In an effort to make recall similar for controls as for cases, referent year was set to correspond with diagnosis date of cases. Methods for quality control have been described in detail (16). Briefly, all interviews were audiotaped and a random sample of these tapes was reviewed for consistency and quality across interviewers and centers. Respondents were given the option of having the interview administered in either English or Spanish. The percentage of Hispanic women completing the questionnaire in Spanish was 32% in Arizona, 10% in Colorado, 10% in New Mexico, and 46% in Utah.

A detailed physical activity questionnaire adapted from the Cross-Cultural Activity Participation Study (CAPS) (17) was developed to capture activity performed at various levels of intensity, including activities performed at leisure, work, and around the home. The following activities were ascertained: activities performed at home (light-effort household chores, heavy-effort household chores, and lawn, yard and farm chores of light and intense nature); care activities (activities requiring light and intense effort during care of children, adults, or animals); walking (both leisurely pace and at a moderate-to-brisk pace as for walking for exercise or to get places); sports and conditioning activities (dancing, golfing, Softball, volleyball, basketball, tennis, or other racquet sports, backpacking, skiing, biking, stretching and yoga, lifting weights, jogging, running, swimming, rowing or canoeing, exercise machines, and any other sports or conditioning); work activities (time spent sitting, standing, and walking); and volunteer activities (time spent sitting, standing and walking). Women were asked to report the amount, intensity, and duration of activities they performed during the referent year, that is, the calendar year prior to diagnosis or selection, and at ages 15, 30, and 50 years. A lifetime activity score was calculated on the basis of quartile ranking of activity at these 3 time periods plus the referent year. Total metabolic equivalent of the task (MET) values were assigned to each activity based on the Compendium of Physical Activities (18).

Other questionnaire data included dietary intake, reproductive history, family history of cancer and diabetes, use of HRT, history of regular (i.e., ≥3 times a week for at least 1 month) aspirin and NSAID use, and cigarette smoking history. Dietary intake data were collected using an extensive diet history questionnaire that was modified to incorporate foods commonly eaten in the southwestern United States (19). Weight was measured at the time of interview to the nearest 0.5 lb. Height was measured to the nearest 0.5 inch. Weight also was recalled for ages 15, 30, 50 years and the referent year. Weight during the referent period was used to calculate body mass index (BMI) using the formula of weight in kilograms (kg)/height in square meters (m^2). Weight gain was calculated from age 15 years to referent year.

Analyses were stratified by self-reported race/ethnicity and by menopausal status. Menopausal status on the referent date (i.e., date of diagnosis or selection) was reported as (1) still having periods and not going through menopause or the change of life; (2) still having periods but possibly going through menopause or the change of life; (3) going through menopause or the change of life; (4) periods had stopped by themselves; (5) an operation which stopped periods; (6) still having periods and on HRT; (7) taking medication that had stopped periods; (8) pregnant or pregnancy ended within 2 months or was nursing. Women were classified as being premenopausal or perimenopausal if they responded “yes” to answers 1, 2, 3, or 8 and postmenopausal if they responded “yes” to answer 4 or 5 or 7. Women who responded “yes” to 6 were classified as premenopausal if their age at reference date was 57 years or younger and postmenopausal if older than 57. Additionally, women who were identified as being postmenopausal at their referent date were further categorized by their recent exposure to hormones either through use of HRT or recently going through menopause. We considered women having recent hormone exposure if they had used HRT within the past 2 years or were premenopausal or perimenopausal during the 2 years prior to the referent date; other postmenopausal women were considered not recently exposed to hormones.

Multivariable logistic regression models were used to estimate the adjusted associations between physical activity and breast cancer risk. Adjustments were made for matching variables of age and center as well as other potential confounding variables including parity, BMI reported during the referent year, and total energy intake (kcal/d). Adjustment for family history of breast cancer did not alter results and is not included as an adjustment variable. We evaluated associations among postmenopausal women based on their recent estrogen exposure. We classified women who became postmenopausal within the 2 years prior to the referent year and those who were taking HRT as being recently exposed to hormones, and the remainder of postmenopausal women were classified as not being recently exposed to hormones. We assessed total activity which included both moderate and vigorous levels of intensity as well as vigorous activities separately for ages 15, 30, and 50 years, and referent year. Linear trend was tested with the exposures treated as ordinal categories and using the ordinal categories as continuous variables in the regression models. In the analyses we included both invasive (Surveillance Epidemiology and End Results [SEER] behavior code 3) and in situ (SEER behavior code 2) breast cancers since no meaningful differences were observed by behavior code for physical activity and breast cancer risk. Hormone receptor status of tumors, as reported to local tumor registries, was based on estrogen and progesterone receptor positivity as reported by the local cancer registries. To evaluate interactions between physical activity (ordinal categories) and BMI, weight gain, HRT use, and ever-regular use of aspirin/NSAIDs, we used the relative excess risk from interaction (RERI) model (20). In interaction models we categorized physical activity into 3 levels rather than 4 to more robustly evaluate these interactions. All statistical analysis was performed using SAS software, version 9.0 (SAS Institute, Cary, NC).

Results

The majority of women were postmenopausal at the time of diagnosis or selection (Table 1). Of these postmenopausal women, synthetic estrogen exposure (i.e., HRT) within the past 2 years was reported in 55.8% of NHW controls and 45.8% of HAI controls. Whereas 51.1% of HAI control subjects reported a high school education or less, only 24.2% of NHW women reported that level of education. HAI women were more likely to have 5 or more children than NHW women. NHW women reported more MET hours of activity per week and lower average BMIs for the referent year than HAI women.

Among premenopausal women, high levels of total MET hours per week of physical activity during the referent year were significantly inversely associated with breast cancer risk among NHW women (Table 2). There were no clear trends in the association between physical activity and breast cancer risk among premenopausal HAI women. Although risk estimates at the highest level of activity were generally below 1.0 for most associations for all physical activity variables for both NHW and HAI women, they did not reach statistical significance except as mentioned above.

Because of differences in associations between physical activity and breast cancer risk among postmenopausal women based on their recent exposure to hormones, we present data for women recently exposed to hormones (Table 3) and not recently exposed to hormones (Table 4). We did not observe any significant association between physical activity and breast cancer risk among women recently exposed to hormones (Table 3). High levels of total (lifetime total activity score: odds ratio [OR] 0.60, 95% confidence interval [CI] 0.36–1.02 for NHW; OR 0.52, 95% CI 0.23–1.16 for HAI) and high levels of vigorous activity (lifetime vigorous activity: HAI women, OR 0.48, 95% CI 0.23–1.00, p linear trend 0.03) reduced risk of breast cancer risk among postmenopausal women not recently exposed to hormones (Table 4). A significant dose response was observed for NHW women as level of lifetime total activity score increased ($p = 0.01$), total MET hours of activity at age 30 increased ($p < 0.01$), and both increasing levels of total and vigorous MET hours at age 15 years ($p = 0.03$ and 0.05, respectively). Among HAI women, a significant linear trend toward reduced risk with increasing levels of activity were observed for total MET hours of activity during the referent year ($p \leq 0.01$), increasing levels of vigorous activity during the referent year ($p = 0.02$), increasing levels of lifetime vigorous hours per week ($p = 0.03$), and increasing levels of vigorous activity at age 50 ($p = 0.04$).

We evaluated associations by estrogen and progesterone tumor receptor status with physical activity. We did not observe any unique associations with either estrogen receptor or progesterone receptor positive or negative tumors (data not shown in Tables).

To obtain better insight into biological mechanisms that might link physical activity to breast cancer risk, we evaluated the interactions between lifetime activity levels and body size, recent hormone exposure, and ever-use of NSAIDs or aspirin (Table 5). As most of the associations with physical activity were observed among postmenopausal women, we present data for postmenopausal women in Table 5. There was a significant interaction between recent hormone exposure and physical activity among NHW women. Breast cancer risk associated with high total lifetime physical activity levels was apparent only among postmenopausal women who had not been recently exposed to hormones. Interactions between physical activity and aspirin/NSAID use, BMI, and weight gain are shown only for postmenopausal women who were not exposed to hormones (Table 5); similar associations were not observed for postmenopausal women recently exposed to hormones. A borderline significant interaction ($p = 0.07$) between physical activity and ever having used aspirin/NSAIDs was observed for NHW women. High activity was most protective among women who reported ever using aspirin/NSAIDs. Neither BMI nor weight gain significantly interacted with physical activity among NHW. However, both BMI and weight gain interacted significantly with physical activity to alter breast cancer risk among HAI women. The pattern of risk associated with these interactions was such that breast cancer risk decreased with increasing levels of physical activity at all weight gain and BMI levels. Among those with a BMI of 25 or less, the relative risk went from 1.0 (referent) for women who were sedentary to 0.26 for the most active women; among women who were obese, the relative risk went from 1.00 for sedentary women to 0.61 for those most active. For NHW there was approximately a 50% reduction in risk for women with normal weight and women who were obese. Similar associations were observed for weight gain.

Discussion

Physical activity was associated with a reduced risk of breast cancer among HAI women as well as NHW women living in the southwestern United States. This is one of the first studies to evaluate breast cancer risk associated with physical activity among HAI women. The most consistent reduction in risk was observed among both Hispanic and NHW women who were postmenopausal and not recently exposed to hormones. Among these women, high levels of both total activity and activity performed at a more vigorous level of intensity were associated with reduced breast cancer risk in a dose-response manner. Physical activity throughout life appeared to be important for postmenopausal women who were not exposed to hormones. Physical activity early in life was associated with reduced breast cancer risk among postmenopausal NHW women, whereas higher levels of physical activity at age 50 and during the referent year was associated with breast cancer risk among HAI women. Although the numbers were smaller to evaluate interactions than to assess main effects, it appears that different factors modified the association between physical activity and breast cancer risk among NHW and HAI women.

While early studies primarily evaluated the associations between physical activity and breast cancer using measurements of recent activity (8), studies also have attempted to obtain a more comprehensive picture of the relationship between physical activity and breast cancer risk. Of particular interest is timing of activity in association with risk. It is important to understand whether activity in the more recent past is independently associated with breast cancer risk, thus serving as a means to prevention. Associations between breast cancer risk associated with birth weight and height lend support for the hypothesis that early events also may influence subsequent risk (21). It has been proposed that exposure to strenuous physical activity in adolescence may cause amenorrhea and result in reduced risk of breast cancer (22). As in this study, others have sought to estimate associations with physical activity at various times in a woman's life as well as with a lifetime composite activity index.

A study by McTiernan and colleagues (3) examined breast cancer risk associated with activity at ages 18, 35, and 50 years in postmenopausal women. In that study they observed that high levels of strenuous physical activity at age 35 was associated with reduced risk of breast cancer among postmenopausal women (OR 0.86, 95% CI 0.78–0.95). The evaluation by McTiernan et al of total current activity and current strenuous activity showed similar results to what we report (OR 0.78, 95% CI 0.62–1.00). However, they did not observe differences in associations by use of HRT. A study in Norway did not observe significant associations between breast cancer risk and physical activity at ages 14 and 30 years and enrollment in a group of mostly premenopausal women (mean age at diagnosis, 48 years) (23). Lifetime activity has been shown to be importantly associated with breast cancer risk both in this study and in others. A large multicenter case-control study evaluated lifetime recreational exercise with breast cancer risk in black and white women and observed a 20% reduction in breast cancer risk associated with lifetime activity among both black and white women. As in our study, a study in Canada suggests that lifetime physical activity may be most protective for postmenopausal breast cancer (24).

The intensity of activity necessary to reduce risk of breast cancer is also an important public health issue. Our assessment of total activity included both moderate and vigorous levels of activity. For lifetime breast cancer risk associated with physical activity, total activity appeared to be more important than individual activity components such as vigorous activity. While at some ages slightly stronger associations were observed for vigorous activity for HAI women, it is possible that this reflects issues surrounding collection of physical activity data and possible activities performed at various times in life (25). In our previous work, we observed different activity patterns for NHW and HAI women; these patterns were different within HAI women based on level of acculturation (25). HAI women were more likely to engage in occupational and household sources of activity, whereas NHW women more often reported recreational activity. Other studies have shown that vigorous activity is more reliably collected than moderate or light activities (26,27). It is not clear whether types of activities were recalled equally or whether activities being asked about were equally relevant for HAI and NHW women. However, support for our observation that total activity is important is supported by the work of others (3).

In our study, menopausal status along with recent estrogen exposure appeared to be an important modifier of breast cancer risk associated with high levels of physical activity. We observed a strong interaction between physical activity and HRT and risk of breast cancer among NHW postmenopausal women. This suggests that the effects of physical activity on postmenopausal breast cancer risk may be mediated by hormonal pathways. It has been shown that physical activity modifies the adverse effects of increased adiposity on estrogen metabolism (9). Others have observed that physical activity is most protective among postmenopausal women not using HRT (28). We can only speculate the reasons for these associations. It is possible that this group of women is most susceptible to obesity and energy imbalance. The pattern of association between physical activity and breast cancer is similar to that observed for obesity and breast cancer in this population, lending some support for the hypothesis (13). However, contradictory to an energy balance mechanism is the observation that physical activity had its greatest impact among HAI women with normal weight or those who gained the least amount of weight. Thus other mechanisms also may be involved in the relationship between breast cancer risk and physical activity level.

Insulin has been shown to be reduced by high physical activity (29) and has been hypothesized as being associated with breast cancer risk (11). Thus high levels of physical activity could reduce risk of breast cancer through an insulin-signaling pathway. Activity could influence breast cancer risk at young ages as well as at a more recent past through this mechanism. Assessment of interaction between physical activity and aspirin/NSAIDs, BMI, and weight change provided some clues to possible mechanisms. The association with aspirin/NSAIDs suggests that an inflammation-related pathway may be involved. It has been shown that high physical activity is associated with lower levels of markers of inflammation (30). Estrogens have been shown to be proinflammatory (31); others have shown that certain estrogen, such as 17β-estradiol inhibits inflammatory gene expression that is regulated by nuclear factor κB (32). However, of interest is the observed pattern of associations; activity is most protective among those with normal body size and not exposed to estrogen. This would imply that physical activity reduces risk even among women not considered to be the highest-risk individuals. While this seems contradictory to any proposed mechanism, others also have shown significant interaction between physical activity and BMI and breast cancer risk with the same pattern of association, physical activity having its greatest influence among those with the lowest level of BMI (3). However, risk of breast cancer also was lower among women who were obese if they exercised than if they were sedentary, suggesting that activity may offset these harmful factors associated with obesity; physical activity also has a protective effect among women of normal body size.

There are several considerations in relation to the results based on collection of physical activity data, in that accuracy of physical activity measurement may vary by age and length of time being asked to recall. We are only aware of one study that examined recall of activities at various times throughout life (33). In that study, where activity was recalled during the referent year as well as before age 17, and at ages 18–34, 35–50, and over 50, occupational activity was the component of lifetime and referent period activity most accurately recalled. Exercise and sports were the least accurately recalled component of physical activity at ages less than 17 years and 18 to 34; however, more intense activities were most consistently recalled at all ages. Measurement differences may account for some inconsistencies in associations at younger ages or between HAI and NHW women.

The study has limitations. Response rates were low, although not considerably different between HAI and NHW cases. This could result in selection bias if controls selected are different from the target population of control subjects. It is possible that healthier control subjects who were more physically active participated. However, our risk estimates are similar to those reported elsewhere and inverse associations are observed for recall of more distant activity, indicating that associations for some exposures are not affected by selection bias to any greater extent than in other studies. Few women reported high levels of activity, resulting in many findings that were of borderline significance. However, we detected significant linear trends for many physical activity variables suggesting their importance despite our lack of power. We were limited in power to detect significant interactions for many factors, especially with vigorous activity that was infrequently performed in certain subsets of the population. Despite these limitations, the study contributes to our understanding of breast cancer in this population and provides some of the first data on associations between physical activity and breast cancer in Hispanic women living in the southwestern United States.

In summary, these data indicate that several aspects of physical activity reduce risk of breast cancer in a dose-dependent manner. Physical activity appears to be most important for women who are postmenopausal who have not been recently exposed to hormones. While lifetime activity is important, activity close to the time of diagnosis also appears to be important, suggesting that even if women have not previously been active, they might well benefit from increasing physical activity levels not only for cardiovascular fitness, but also to reduce risk of breast cancer. These associations appear to be important for both HAI and NHW women living in the southwestern United States and for women regardless of their body weight.

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Selected Abbreviations and Acronyms

NHW	Non-Hispanic white
HAI	Hispanic/American Indian
MET	metabolic equivalent of the task
OR	odds ratio
CI	confidence interval
HRT	hormone replacement therapy
BMI	body mass index
NSAIDS	non-steroidal anti-inflammatory drugs
CAPS	Cross-cultural Activity Participation Study
SEER	Surveillance Epidemiology and End Results
RERI	relative excess risk from interaction
HS	high school
GED	general equivalency diploma

TABLE 1

Description of population*

	Non-Hispanic white					Hispanic/American Indian					
	Cases		Controls			Cases		Controls			
	No.	%	No.	%	*p* Value†	No.	%	No.	%	*p* Value‡	*p* Value§
Total	1527	48.8	1601	51.2		798	46.3	924	53.7		
Center											
AZ	232	15.2	305	19.1		169	21.2	208	22.5		
CO	318	20.8	301	18.8		165	20.7	201	21.8		
NM	645	42.2	618	38.6		362	45.4	324	35.1		
UT	332	21.7	377	23.5		102	12.8	191	20.7		
Age, years											
25–39	99	6.5	116	7.2		93	11.7	97	10.5		
40–49	433	28.4	420	26.2		266	33.3	252	27.3		
50–59	453	29.7	411	25.7		228	28.6	242	26.2		
60–69	356	23.3	371	23.2		148	18.5	214	23.2		
70–79	186	12.2	283	17.7		63	7.9	119	12.9		
Menopause status											
Pre/peri	538	35.3	492	30.8		333	41.8	333	36.2		
Post	986	64.7	1108	69.3		463	58.2	587	63.8		
Behavior											
In situ	264	17.5				131	16.6				0.58
Invasive	1246	82.5				660	83.4				
Recent hormone exposure (postmenopause)											
Synthetic (HRT)	609	62.5	614	55.8	<.01	185	40.4	264	45.8	<0.12	<0.01
Natural (recent menopause)	89	9.1	96	8.7		88	19.2	67	11.6		
None	277	28.4	390	35.5		185	40.4	246	42.6		
Education level											
<HS Grad/GED	26	1.7	32	2.1	0.52	192	25.9	187	22.3	0.22	<0.01
High school	308	20.7	344	22.1		218	29.4	242	28.8		

	Non-Hispanic white					Hispanic/American Indian					
	Cases		Controls			Cases		Controls			
	No.	**%**	**No.**	**%**	***p* Value**†	**No.**	**%**	**No.**	**%**	***p* Value**‡	***p* Value**§
Some college/trade	561	37.7	599	38.4		218	29.4	256	30.5		
BA/BS degree or higher	593	39.9	584	37.5		114	15.4	154	18.4		
Parity											
0	260	17.0	226	14.2	<.01	77	9.7	89	9.7	<0.01	<0.01
1–2	696	45.6	657	41.1		327	41.1	312	33.9		
3–4	476	31.2	545	34.1		281	35.3	346	37.6		
5+	93	6.1	169	10.6		111	13.9	173	18.8		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		
Referent year BMI	26.8	0.16	27.0	0.15	0.35	28.1	0.21	29.1	0.20	<0.01	<0.01
Hours total activity/wk	5.2	0.1	5.3	0.1	0.72	4.9	0.2	4.6	0.2	0.49	<0.01
Total MET hr/wk	26.3	0.8	26.8	0.8	0.64	24.1	1.2	22.6	1.1	0.36	<0.01

BMI = body mass index; GED = general equivalency diploma; HRT = hormone replacement therapy; HS = high school; MET = metabolic equivalent of the task (value); SD = standard deviation.

* Numbers differ slightly because of missing values for some variables.

† Compares non-Hispanic white cases and controls.

‡ Compares Hispanic cases and controls.

§ Compares non-Hispanic white and Hispanic women.

TABLE 2

Association between breast cancer and physical activity in premenopausal and perimenopausal women

	Non-Hispanic white			Hispanic/American Indian		
	Controls	Cases		Controls	Cases	
	No.	No.	OR (95% CI)*	No.	No.	OR (95% CI)
Total MET hr/wk referent year						
<5 hr/wk	77	108	1.00	107	103	1.00
5–14.9 hr/wk	128	135	0.74 (0.50, 1.10)	87	81	0.95 (0.63, 1.45)
15–29.9 hr/wk	119	130	0.76 (0.51, 1.12)	68	62	0.93 (0.59, 1.46)
≥30 hr/wk	167	162	0.62 (0.43, 0.91)	68	81	1.15 (0.73, 1.80)
p Trend			0.02			0.64
Vigorous hr/wk referent year						
None	122	135	1.00	135	140	1.00
< 1 hr/wk	162	192	1.08 (0.78, 1.50)	98	99	1.05 (0.72, 1.54)
1–2.9 hr/wk	110	105	0.84 (0.58, 1.22)	54	41	0.71 (0.43, 1.15)
≥3 hr/wk	97	103	0.85 (0.58, 1.25)	43	47	0.92 (0.55, 1.52)
p Trend			0.22			0.41
Lifetime total activity score						
0–3	68	85	1.00	94	76	1.00
4–6	142	149	0.78 (0.52, 1.17)	99	114	1.49 (0.98, 2.26)
7–9	208	228	0.84 (0.57, 1.22)	103	107	1.21 (0.80, 1.84)
10–12	73	73	0.70 (0.44, 1.12)	34	30	0.97 (0.53, 1.76)
p Trend			0.26			0.90
Lifetime vigorous hr/wk						
None	20	31	1.00	42	36	1.00
< 1 hr/wk	151	148	0.66 (0.36, 1.23)	106	104	1.15 (0.67, 1.96)
1–2.9 hr/wk	168	186	0.73 (0.40, 1.34)	102	107	1.19 (0.70, 2.03)
≥3 hr/wk	152	170	0.69 (0.37, 1.27)	80	80	1.09 (0.62, 1.90)
p Trend			0.68			0.84
Total MET hr/wk at age 30						

	Non-Hispanic white			Hispanic/American Indian		
	Controls	Cases		Controls	Cases	
	No.	No.	OR (95% CI)*	No.	No.	OR (95% CI)
<5 hr/wk	52	81	1.00	68	76	1.00
5–14.9 hr/wk	90	73	0.54 (0.33, 0.86)	67	66	0.91 (0.56, 1.48)
15–29.9 hr/wk	97	104	0.70 (0.45, 1.10)	54	57	0.90 (0.54, 1.49)
≥30 hr/wk	224	255	0.70 (0.47, 1.05)	121	113	0.82 (0.53, 1.26)
p Trend			0.49			0.37
Vigorous hr/wk at age 30						
None	110	135	1.00	113	121	1.00
< 1 hr/wk	99	90	0.73 (0.49, 1.07)	66	60	0.84 (0.54, 1.31)
1–2.9 hr/wk	113	122	0.87 (0.60, 1.25)	46	59	1.19 (0.74, 1.91)
≥3 hr/wk	141	165	0.86 (0.61, 1.22)	85	71	0.75 (0.49, 1.14)
p Trend			0.62			0.35
Total MET hr/wk at age 15						
< 15 hr/wk	135	154	1.00	116	112	1.00
15–39.9 hr/wk	124	138	1.01 (0.72, 1.42)	69	78	1.25 (0.81, 1.92)
40–89.9 hr/wk	125	132	0.95 (0.67, 1.34)	77	78	1.08 (0.71, 1.65)
≥90 hr/wk	105	108	0.90 (0.62, 1.29)	67	57	0.86 (0.55, 1.35)
p Trend			0.53			0.60
Vigorous hr/wk at age 15						
None	134	146	1.00	106	116	1.00
< 1 hr/wk	71	72	0.97 (0.64, 1.46)	52	39	0.66 (0.40, 1.10)
1–2.9 hr/wk	101	113	1.06 (0.74, 1.52)	55	57	0.93 (0.58, 1.48)
≥3 hr/wk	183	201	1.04 (0.76, 1.43)	115	113	0.89 (0.61, 1.30)
p Trend			0.75			0.70

CI = confidence interval; MET = metabolic equivalent of the task (value); OR = odds ratio.

*ORs and 95% CIs adjusted for age, center, parity, body mass index, and energy intake.

TABLE 3

Association between breast cancer and physical activity among postmenopausal women recently exposed to hormones

	Non-Hispanic white			Hispanic/American Indian		
	Controls	Cases		Controls	Cases	
	No.	No.	OR (95% CI)*	No.	No.	OR (95% CI)
Total MET hr/wk referent year						
<5hr/wk	168	173	1.00	97	81	1.00
5–14.9 hr/wk	185	168	0.86 (0.63, 1.16)	96	69	0.84 (0.54, 1.31)
15–29.9 hr/wk	174	151	0.79 (0.58, 1.08)	58	50	1.00 (0.61, 1.66)
≥30 hr/wk	178	204	0.99 (0.73, 1.35)	79	69	0.99 (0.62, 1.56)
p Trend			0.89			0.91
Vigorous hr/wk referent year						
None	259	279	1.00	145	120	1.00
<1 hr/wk	233	205	0.72 (0.55, 0.94)	101	80	0.95 (0.64, 1.42)
1–2.9 hr/wk	114	126	0.89 (0.65, 1.22)	45	38	1.01 (0.59, 1.71)
≥3 hr/wk	99	86	0.71 (0.50, 1.01)	39	31	0.89 (0.51, 1.56)
p Trend			0.09			0.75
Lifetime total activity score						
0–3	125	138	1.00	90	74	1.00
4–6	240	203	0.72 (0.53, 0.99)	105	88	1.01 (0.66, 1.56)
7–9	216	239	0.95 (0.69, 1.30)	105	79	0.85 (0.54, 1.32)
10–12	124	116	0.75 (0.52, 1.07)	30	28	1.06 (0.56, 1.99)
p Trend			0.49			0.72
Lifetime vigorous hr/wk						
None	68	58	1.00	42	39	1.00
< 1 hr/wk	222	224	1.15 (0.77, 1.72)	108	98	1.12 (0.65, 1.92)
1–2.9 hr/wk	233	227	1.03 (0.68, 1.54)	108	72	0.76 (0.44, 1.32)
≥3 hr/wk	182	187	1.07 (0.71, 1.64)	72	60	0.93 (0.52, 1.66)
p Trend			0.88			0.36
Total MET hr/wk at age 50						

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	Non-Hispanic white			Hispanic/American Indian		
	Controls	Cases		Controls	Cases	
	No.	No.	OR (95% CI)*	No.	No.	OR (95% CI)
<5 hr/wk	104	81	1.00	58	52	1.00
5–14.9 hr/wk	128	139	1.35 (0.92, 1.98)	65	42	0.61 (0.35, 1.09)
15–29.9 hr/wk	111	106	1.15 (0.77, 1.71)	46	39	0.94 (0.52, 1.72)
≥30 hr/wk	211	240	1.36 (0.96, 1.93)	64	42	0.60 (0.33, 1.07)
p Trend			0.20			0.22
Vigorous hr/wk at age 50						
None	209	210	1.00	108	94	1.00
< 1 hr/wk	132	134	1.00 (0.73, 1.37)	59	35	0.68 (0.40, 1.16)
1–2.9 hr/wk	92	89	0.89 (0.63, 1.28)	37	25	0.79 (0.43, 1.44)
≥3 hr/wk	119	131	1.01 (0.73, 1.39)	29	21	0.71 (0.37, 1.38)
p Trend			0.87			0.23
Total MET hr/wk at age 30						
<5 hr/wk	129	124	1.00	94	71	1.00
5–14.9 hr/wk	124	134	1.19 (0.83, 1.70)	63	52	1.11 (0.67, 1.83)
15–29.9 hr/wk	118	117	1.01 (0.70, 1.46)	60	44	1.01 (0.60, 1.69)
≥30 hr/wk	331	319	0.99 (0.73, 1.34)	109	101	1.20 (0.78, 1.85)
p Trend			0.60			0.46
Vigorous hr/wk at age 30						
None	236	243	1.00	132	125	1.00
< 1 hr/wk	128	134	1.02 (0.75, 1.39)	80	44	0.63 (0.40, 1.00)
1–2.9 hr/wk	147	123	0.76 (0.56, 1.04)	50	40	0.84 (0.51, 1.39)
≥3 hr/wk	189	194	0.90 (0.68, 1.19)	64	58	0.88 (0.56, 1.38)
p Trend			0.24			0.54
Total MET hrs/week at age 15						
<15 hr/wk	185	225	1.00	114	100	1.00
15–39.9 hr/wk	174	144	0.70 (0.52, 0.95)	64	63	1.15 (0.73, 1.81)
40–89.9 hr/wk	157	152	0.80 (0.59, 1.08)	73	45	0.73 (0.45, 1.17)
≥90 hr/wk	185	172	0.74 (0.55, 0.99)	77	60	0.88 (0.56, 1.38)

	Non-Hispanic white			Hispanic/American Indian		
	Controls	Cases		Controls	Cases	
	No.	No.	OR (95% CI)*	No.	No.	OR (95% CI)
p Trend			0.07			0.31
Vigorous hr/wk at age 15						
None	217	237	1.00	121	107	1.00
<1 hr/wk	69	83	1.07 (0.73, 1.55)	30	29	1.23 (0.68, 2.24)
1–2.9 hr/wk	137	117	0.80 (0.59, 1.10)	53	51	1.13 (0.70, 1.85)
≥3 hr/wk	277	255	0.79 (0.61, 1.02)	122	81	0.79 (0.53, 1.19)
p Trend			0.04			0.29

CI = confidence interval; MET = metabolic equivalent of the task (value); OR = odds ratio.

* ORs and 95% CIs adjusted for age, center, parity, body mass index, and energy intake.

TABLE 4

Association between breast cancer and physical activity among postmenopausal women not recently exposed to hormones

	Non-Hispanic white			Hispanic/American Indians		
	Controls	Cases		Controls	Cases	
	No.	No.	OR (95% CI)*	No.	No.	OR (95% CI)
Total MET hr/wk referent year						
<5 hr/wk	107	88	1.00	98	80	1.00
5–14.9 hr/wk	95	67	0.92 (0.60, 1.41)	50	45	0.82 (0.48, 1.41)
15–29.9 hr/wk	82	58	0.93 (0.59, 1.46)	50	32	0.58 (0.32, 1.04)
≥30 hr/wk	98	61	0.83 (0.53, 1.30)	43	22	0.47 (0.25, 0.89)
p Trend			0.46			<0.01
Vigorous hr/wk referent year						
None	168	123	1.00	138	116	1.00
<1 hr/wk	97	80	1.20 (0.81, 1.78)	45	36	0.87 (0.51, 1.49)
1–2.9 hr/wk	76	41	0.79 (0.50, 1.25)	36	16	0.43 (0.22, 0.85)
≥3 hr/wk	41	30	1.00 (0.58, 1.73)	22	11	0.58 (0.26, 1.30)
p Trend			0.64			0.02
Lifetime Total Activity Score						
0–3	88	84	1.00	85	71	1.00
4–6	96	74	0.82 (0.53, 1.27)	75	61	0.89 (0.55, 1.45)
7–9	134	79	0.60 (0.39, 0.91)	56	35	0.70 (0.40, 1.22)
10–12	64	37	0.60 (0.36, 1.02)	25	12	0.52 (0.23, 1.16)
p Trend			0.01			0.07
Lifetime vigorous hr/wk						
None	38	27	1.00	49	42	1.00
< 1 hr/wk	121	110	1.25 (0.71, 2.22)	82	70	0.82 (0.47, 1.42)
1–2.9 hr/wk	115	71	0.86 (0.47, 1.55)	70	47	0.67 (0.37, 1.20)
≥3 hr/wk	108	66	0.81 (0.44, 1.47)	40	20	0.48 (0.23, 1.00)
p Trend			0.07			0.03
Total MET hr/wk at age 50						

	Non-Hispanic white			Hispanic/American Indians		
	Controls	Cases		Controls	Cases	
	No.	No.	OR (95% CI)*	No.	No.	OR (95% CI)
<5 hr/wk	63	57	1.00	75	67	1.00
5–14.9 hr/wk	74	64	1.04 (0.63, 1.73)	44	33	0.81 (0.45, 1.46)
15–29.9 hr/wk	82	42	0.61 (0.36, 1.04)	35	26	0.87 (0.46, 1.65)
≥30 hr/wk	146	97	0.76 (0.48, 1.21)	74	43	0.61 (0.36, 1.04)
p Trend			0.10			0.08
Vigorous hr/wk at age 50						
None	127	107	1.00	130	111	1.00
< 1 hr/wk	86	66	0.99 (0.64, 1.51)	38	27	0.69 (0.38, 1.24)
1–2.9 hr/wk	71	31	0.52 (0.31, 0.86)	32	16	0.53 (0.27, 1.06)
≥3 hr/wk	79	55	0.82 (0.52, 1.28)	26	15	0.61 (0.29, 1.28)
p Trend			0.11			0.04
Total MET hr/wk at age 30						
<5 hr/wk	74	73	1.00	89	62	1.00
5–14.9 hr/wk	72	53	0.77 (0.47, 1.26)	32	35	1.48 (0.80, 2.73)
15–29.9 hr/wk	58	45	0.75 (0.44, 1.26)	36	26	1.09 (0.58, 2.05)
≥30 hr/wk	177	102	0.56 (0.37, 0.85)	83	56	1.01 (0.62, 1.66)
p Trend			<0.01			0.90
Vigorous hr/wk at age 30						
None	143	116	1.00	133	102	1.00
<1 hr/wk	78	51	0.86 (0.56, 1.35)	29	29	1.18 (0.65, 2.16)
1–2.9 hr/wk	68	41	0.73 (0.46, 1.17)	33	23	0.82 (0.44, 1.53)
≥3 hr/wk	92	65	0.86 (0.57, 1.30)	44	25	0.71 (0.39, 1.27)
p Trend			0.33			0.23
Total MET hr/wk at age 15						
<15 hr/wk	101	104	1.00	97	68	1.00
15–39.9 hr/wk	96	46	0.46 (0.29, 0.73)	47	40	1.23 (0.71, 2.13)
40–89.9 hr/wk	84	61	0.66 (0.43, 1.03)	43	31	1.05 (0.59, 1.88)
≥90 hr/wk	99	62	0.57 (0.37, 0.88)	51	39	1.10 (0.63, 1.90)

	Non-Hispanic white			Hispanic/American Indians		
	Controls	Cases		Controls	Cases	
	No.	No.	OR (95% CI)*	No.	No.	OR (95% CI)
p Trend			0.03			0.79
Vigorous hr/week at age 15						
None	115	96	1.00	100	83	1.00
<1 hr/wk	39	40	1.27 (0.74, 2.16)	32	16	0.59 (0.30, 1.19)
1–2.9 hr/wk	71	39	0.66 (0.40, 1.07)	34	28	1.07 (0.58, 1.96)
≥3 hr/wk	155	98	0.74 (0.51, 1.09)	72	50	0.84 (0.51, 1.37)
p Trend			0.05			0.62

CI = confidence interval; MET = metabolic equivalent of the task (value); OR = odds ratio.

*ORs and 95% CIs adjusted for age, center, parity, body mass index, and energy intake.

TABLE 5

Associations between lifetime activity score, HRT use, aspirin/NSAID use, and body size with breast cancer risk in postmenopausal women

	Non-Hispanic white			Hispanic/American Indian		
	0–4	5–8	9–12	0–4	5–8	9–12
Lifetime activity score	**OR (95% CI)***	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Recent hormone exposure						
Yes	1.00	0.97 (0.75, 1.25)	0.98 (0.74, 1.30)	1.00	1.00 (0.70, 1.45)	1.12 (0.69, 1.81)
No	0.87 (0.62, 1.22)	0.85 (0.62, 1.17)	0.49 (0.33, 0.73)	1.28 (0.86, 1.91)	1.11 (0.72, 1.71)	0.86 (048, 1.57)
p Interaction			0.01			0.47
No recent hormone exposure						
Aspirin/NSAID use						
Ever	1.00	0.67 (0.36, 1.25)	0.37 (0.19, 0.75)	1.00	1.20 (0.50, 2.91)	1.09 (0.38, 3.19)
Never	0.60 (0.34, 1.04)	0.73 (0.43, 1.23)	0.41 (0.23, 0.76)	1.69 (0.81, 3.54)	1.37 (0.63, 2.99)	0.95 (0.36, 2.49)
p Interaction			0.07			0.64
Referent year BMI (kg/m^2)						
<25	1.00	0.78 (0.40, 1.52)	0.59 (0.28, 1.22)	1.00	1.48 (0.54, 4.11)	0.26 (0.06, 1.14)
25–29.9	1.36 (0.70, 2.64)	1.50 (0.79, 2.85)	0.72 (0.34, 1.53)	0.53 (0.24, 1.17)	0.74 (0.32, 1.71)	0.63 (0.20, 2.05)
≥30	1.37 (0.69, 2.71)	1.45 (0.76, 2.76)	0.75 (0.35, 1.64)	1.00 (0.46, 2.17)	0.49 (0.21, 1.11)	0.61 (0.23, 1.64)
p Interaction			0.72			0.04
Weight gain between age 15 and referent year (kg)						
≤10	1.00	0.84 (0.40, 1.78)	0.49 (0.20, 1.20)	1.00	1.89 (0.58, 6.18)	0.15 (0.03, 0.86)
10.1–20.0	0.63 (0.28, 1.41)	0.82 (0.38, 1.77)	0.56 (0.25, 1.27)	0.61 (0.23, 1.60)	0.76 (0.27, 2.14)	1.22 (0.28, 5.27)
>20.0	1.55 (0.78, 3.08)	1.21 (0.62, 2.36)	0.71 (0.33, 1.49)	0.92 (0.38, 2.22)	0.57 (0.23, 1.41)	0.69 (0.24, 2.02)
p Interaction			0.43			0.05

BMI = body mass index; CI = confidence interval; NSAID = nonsteroidal anti-inflammatory drug(s); OR = odds ratio.

* ORs and 95% CIs adjusted for age, center, parity, BMI (except BMI models), and energy intake.