Short Communication

Long-term Recreational Physical Activity and Breast Cancer in the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study

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Abstract

Our purpose was to study the association between long-term recreational physical activity and breast cancer in the Epidemiological Follow-up Study (NHEFS) of the first National Health and Nutrition Examination Survey (NHANES I, 1971–1975). The analytic cohort included 6160 women who were free of breast cancer at the first NHEFS follow-up in 1982–1984 and had interview data on recreational physical activity (low, moderate, and high) in 1982–1984 and 10 years earlier, in 1971–1975. We created categories of long-term (1982–1984 + 1971–1975) recreational physical activity: (a) consistently low; (*b*) moderate/inconsistent; and (*c*) consistently high. Data were analyzed using Cox proportional hazard regression models. A total of 138 women developed breast cancer between 1982–1984 and 1992. In women ≥50 years of age in 1982–1984, consistently high (*versus* consistently low) recreational physical activity was associated with a 67% reduction in breast cancer risk ($n = 96$ cases; relative risk, 0.33; 95% confidence interval, 0.14–0.82; P for trend = 0.03); in women <50 years of age ($n = 42$ cases), there was no association. Associations were not modified by body mass index or by weight gain as an adult. High recreational physical activity over the long-term may reduce breast cancer risk in women ≥50 years of age; in this sample, it did so regardless of weight history.

Introduction

Physical activity is a modifiable behavior with the potential to reduce the risk of breast cancer (1). Whereas some prospective studies have reported significant inverse associations (2–4), others have reported null findings for various groups (3, 5–7). Few have considered recreational physical activity measured over the long-term (2, 4) or effect modification by BMI (2–4), which may, in part, explain inconsistencies. Our purpose was to examine the association between long-term recreational physical activity and breast cancer, accounting for effect modification by BMI, in the Epidemiological Follow-up Study (NHEFS) of the First National Health and Nutrition Examination Survey (NHANES I, 1971–1975).

Materials and Methods

Data. The NHEFS, a prospective cohort study arising from NHANES I, is a nationally representative, cross-sectional, in-person interview and medical examination survey of the civilian, noninstitutionalized population of the United States conducted by the NCHS (8). The NHEFS cohort includes all participants in NHANES I, who were ages 24–75 years when interviewed in 1971–1975; participants were reinterviewed in 1982–1984 and have been followed for vital and health outcomes through 1992. Methodology of the NHEFS has been described by Cox *et al.* (9).

Analytic Cohort. We formed an analytic cohort using 1982–1984 as baseline. There was a single inclusion criterion: participants had to have complete data on recreational physical activity in both 1982–1984 and about 10 years earlier, at their NHANES I interview in 1971–1975. A total of 6445 women were interviewed in 1982–1984, including 138 who later developed breast cancer (median follow-up, 9.2 years; median age at diagnosis, 62 years); the 6160 women meeting the inclusion criteria formed our analytic cohort; all 138 cases of breast cancer were in this group.

Most cases of breast cancer were confirmed by computer matching; we used NCHS data tapes to compare diagnoses of breast cancer self-reported by participants with diagnoses reported in health care facility documents. Additionally, microfiche documents archived at the NCHS (Hyattsville, MD) were hand-searched by two authors, K. M. and R. B-B., to confirm diagnoses for which a computer match could not be made. To further confirm the accuracy of self-reported diagnoses of breast cancer, the microfiche documents were hand-searched for a random sample of 20 cases with information on diagnosis (including date) from self-reports and health care facility reports; there was 100% agreement between the two sources of information.

Questions on recreational physical activity in 1982–1984 and about 10 years earlier, in 1971–1975 were similar. In 1982–1984, NHEFS participants were asked: "In things you do for recreation, for example, sports, hiking, dancing, etc., do you

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[2] The abbreviations used are: BMI, body mass index; NHANES, National Health and Nutrition Examination Survey; NHEFS, NHANES I Epidemiologic Follow-up Study; RR, relative risk; CI, confidence interval; NCHS, National Center for Health Statistics.

get much exercise, moderate exercise, or little or no exercise?" In 1971–1975, NHANES I participants were asked: "Do you get much exercise in things you do for recreation (sports, or hiking, or anything like that), or hardly any exercise, or in between?" We categorized responses as low, moderate, and high and created summary categories to describe long-term recreational physical activity (*i.e.*, activity in 1982–1984 + 10 years earlier in 1971–1975). The summary categories, which were created to closely resemble those used in an earlier analysis by Thune *et al.* (2), were as follows : (*a*) consistently low, low at both times; (*b*) consistently high, high at both times or moderate at one time and high at the other; and (*c*) moderate/inconsistent, all other combinations.

Data on Other Risk Factors. In 1982–1984, weight was measured, and interview data were collected on live births, menstrual status, history of breast cancer in first-degree female relatives, use of hormone replacement therapy, and self-reported weight at age 25 years. In 1971–1975, height and weight were measured, and interview data were collected on education and age at menarche. BMI was calculated as kg/m^2.

We created the variable "adult weight change" (weight change from age 25 years to age at the 1982–1984 interview), which was categorized as follows: (*a*) lost ≥5.0 kg; (*b*) stable ± 4.99 kg; (*c*) gained 5.0–9.99 kg; (*d*) gained 10.0–19.99 kg; and (*e*) gained ≥20.0 kg. In selected analyses in which we excluded the lost ≥5 kg category (because weight may have been lost due to disease), we refer to this variable as "adult weight gain."

Statistical Analysis. Data were analyzed using Cox proportional hazard regression models. The response variable was age at breast cancer diagnosis or age at death, if breast cancer was the cause, and no other records were available ($n = 1$) (10). Women who did not develop breast cancer were censored at their last interview or date of death. To adjust for birth cohort effects, the baseline hazard was stratified by 5-year intervals of birth year.

We performed analyses using models variously adjusted for BMI in 1982–1984, BMI in 1971–1975, BMI at age 25 years, adult weight change, adult weight gain, and breast cancer risk factors (education, age at menarche, parity, menstrual status, and family history of breast cancer), stratified by age in 1982–1984 (<50 years and ≥50 years). The following interactions were considered: (*a*) BMI in 1982–1984 and long-term recreational physical activity; (*b*) adult weight gain and long-term recreational physical activity; and (*c*) hormone replacement therapy and weight gain. Tests of trend were performed using ordinal scores for categories of recreational physical activity and adult weight change.

The NHEFS has a complex design that involves sample weighting, stratification, and clustering (11). To account for the sample weighting, we included the following sample design variables (*i.e.*, variables used by NCHS to derive sample weights) in our final models: (*a*) age (<65 *versus* ≥65 years); (*b*) poverty census enumeration district (residence *versus* nonresidence); (*c*) family income (<$3,000, $3,000-$6,999, $7,000-$9,999, $10,000-$14,999, and $15,000+); and (*d*) race [black *versus* nonblack (Hispanics were included with whites; Ref. 12)]. Analyses were performed using SAS version 6.12 (SAS Institute, Cary, NC). All significance tests were two-tailed (5% level of significance).

Results

Demographics and Physical Activity Distribution. In 1982–1984, 15.3% of the analytic cohort were <40 years old, 26.7% were 40–49 years old, 21.5% were 50–59 years old, 14.3% were 60–69 years old, and 22.2% were ≥70 years old. Most (85%) were white.

Table 1 RR of breast cancer in women according to combined levels of recreational physical activity in 1982–1984 and about 10 years earlier, in 1971–75: NHEFS

Activity level	Person-years of observation	No. of cases	Multivariate-adjusted RR (95% CI)[a]
All women			
Consistently low	11,553	36	1.0
Moderate/inconsistent	30,429	86	0.92 (0.62–1.38)
Consistently high	8,799	16	0.58 (0.31–1.07)
P for trend			*0.107*
Women <50 yrs of age			
Consistently low	4,082	7	1.0
Moderate/inconsistent	13,856	25	1.07 (0.46–2.51)
Consistently high	4,582	10	1.19 (0.43–3.30)
P for trend			*0.732*
Women ≥50 yrs of age			
Consistently low	7,472	29	1.0
Moderate/inconsistent	16,574	61	0.87 (0.55–1.38)
Consistently high	4,218	6	0.33 (0.14–0.82)
P for trend			*0.026*

[a] Models were adjusted for height, BMI at age 25 years, adult weight change (age 25 years to age at 1982–1984 interview), and sample design variables. Results were similar in unadjusted models.

Levels of recreational physical activity (low, moderate, and high) were in the same categories in 1982–1984 and 10 years earlier (1971–1975) in 49% of the women; only 7% shifted between extreme categories (low to high or high to low). Consistently high recreational physical activity was more likely among women who were younger, had higher education, who ever took hormone replacement therapy, who weighed less, or who gained less weight as adults than their counterparts.

Recreational Physical Activity and Breast Cancer. Results were similar in adjusted and unadjusted models.

In women ≥50 years of age ($n = 96$ cases), consistently high recreational physical activity was associated with a significant reduction in breast cancer risk (RR, 0.33; 95% CI, 0.14–0.82; *P* for trend = 0.026; Table 1). Exclusion of women diagnosed within 1 year of their 1982–1984 interview resulted in a similar RR (0.37) and wider CI (0.15–0.91; $P = 0.048$). Table 2 presents results from models stratified by BMI in 1982–1984 and stratified by adult weight gain. Whereas there was some variation in RRs across strata, the CIs were wide. On formal testing using models that included interaction between physical activity and BMI in 1982–1984 or between physical activity and adult weight gain, it was determined that neither interaction was statistically significant (data not shown).

In women <50 years of age ($n = 42$ cases), there was no statistically significant association between consistently high recreational physical activity and breast cancer (Table 1).

Additional Analyses. We separately examined data on recreational physical activity from 1982–1984 and 1971–1975 in our analytic cohort. Using 1982–1984 data, the RRs for breast cancer according to level of recreational physical activity were as follows: (*a*) for all women, 1.00 (low = referent), 0.88 (0.61–1.27), and 0.71 (0.39–1.28), $P = 0.393$; and (*b*) for women ≥50 years of age in 1982–1984, 1.00, 0.82 (0.53–1.27), and 0.86 (0.44–1.69), $P = 0.519$. Using 1971–1975 data, the RRs for breast cancer were as follows: (*a*) for all women, 1.00, 0.98 (0.68–1.41), and 0.75 (0.43–1.31), $P = 0.395$; and (*b*) for women ≥50 years of age in 1971–1975, 1.00, 0.86 (0.56–1.31), and 0.39 (0.17–0.91), $P = 0.036$.

Table 2 RR of breast cancer in women ≥50 years of age according to combined levels of recreational physical activity in 1982–1984 and about 10 years earlier, in 1971–75, stratified by median BMI in 1982–1984 and by adult weight gain: NHEFS

Activity level	Multivariate-adjusted RR (95% CI)[a]				
	Median BMI (1982–1984)		Adult weight gain (kg; age 25 yrs to 1982–1984)		
	<25.1	≥25.1	Lost/Gained 4.9	Gained 5–19.9	Gained 20+
Consistently low	1.0	1.0	1.0	1.0	1.0
Moderate/inconsistent	0.97 (0.48–1.96)	0.83 (0.46–1.49)	0.61 (0.20–1.87)	1.12 (0.53–2.38)	0.86 (0.37–1.97)
Consistently high	0.40 (0.13–1.28)	0.26 (0.06–1.13)	0.43 (0.08–2.28)	0.45 (0.12–1.66)	0.32 (0.04–2.50)
P for trend	*0.158*	*0.085*	*0.284*	*0.343*	*0.314*

[a] Models were adjusted for sample design variables.

Table 3 RR of breast cancer in women according to adult weight change: NHEFS

Adult weight change (kg)	Person-years of observation	No. of cases	Multivariate-adjusted RR (95% CI)[a]
All women			
Lost 5.0+	2,589	12	2.91 (1.41–5.99)
Lost/gained 4.9	14,320	28	1 (*referent*)
Gained 5.0–9.9	9,662	20	1.00 (0.56–1.77)
Gained 10.0–19.9	13,193	42	1.53 (0.94–2.48)
Gained 20+	9,253	33	1.72 (0.94–2.89)
P for trend[b]			*0.275/0.015*
Women <50 yrs of age			
Lost 5.0+	899	1	1.63 (0.20–13.38)
Lost/gained 4.9	7,544	12	1.0
Gained 5.0–9.9	4,878	7	0.87 (0.34–2.21)
Gained 10.0–19.9	5,409	13	1.62 (0.72–3.60)
Gained 20+	3,428	8	1.88 (0.73–4.88)
P for trend[b]			*0.151/0.116*
Women ≥50 yrs of age			
Lost 5.0+	1,690	11	3.26 (1.44–7.38)
Lost/gained 4.9	6,776	16	1.0
Gained 5.0–9.9	4,784	13	1.08 (0.52–2.26)
Gained 10.0–19.9	7,784	29	1.56 (0.84–2.90)
Gained 20+	5,824	25	1.74 (0.91–3.30)
P for trend[b]			*0.568/0.054*

[a] Models were adjusted for height, BMI at age 25 years, physical activity in 1982–1984 + 1971–1975, and sample design variables.
[b] Tests of trend were performed including/excluding women who lost ≥5 kg.

We next examined data from 1971–1975 including all women (n = 315 cases) with information about recreational physical activity in 1971–1975 (*i.e.*, we did not exclude women without data on physical activity in 1982–1984 as done for our analytic cohort). The RRs of breast cancer were as follows: (*a*) for all women, 1.00, 0.96 (0.75–1.22), and 0.78 (0.54–1.13), P = 0.239; and (*b*) for women ≥ 50 years of age in 1971–1975 (n = 166 cases), 1.00, 0.93 (0.67–1.28), and 0.44 (0.23–0.84), P = 0.030.

Some of our analyses generated RR for adult weight gain (included as a confounder; Table 3). The RR of breast cancer for all women appears to be elevated in women who gained ≥10 kg and was nearly statistically significant for women ≥50 years of age.

Discussion

In this study, long-term recreational physical activity was associated with a substantially reduced risk of breast cancer in women ≥50 years of age. This is in agreement with other prospective studies (2, 4). Our study found no evidence of the effect modification by BMI demonstrated by Thune *et al.* (lean women had the greatest risk reduction; Ref. 2) or in a case-control study by Carpenter *et al.* (postmenopausal women with stable adult weight had reduced risk; Ref. 13). Rockhill *et al.* (4), using data from the large Nurses' Health Study, and Sesso *et al.* (3), in a prospective study of recent activity, also found no effect modification. Although we also studied the association between long-term recreational physical activity and breast cancer in women <50 years of age and found no association, there were few cases, and these results should be interpreted with caution.

A previous study using data from the 1971–1975 NHEFS with follow-up only through 1982–1984 found a suggestive but not statistically significant association between recreational physical activity and breast cancer risk in postmenopausal women [RR, 1.7 (referent = high activity; Ref. 5)]. We recalculated that RR using low activity as the referent to facilitate comparison with our results (recalculated RR, 0.59). When we performed a similar analysis with follow-up for an additional 10 years, through 1992, our RR was 0.44 and was statistically significant.

The major strength of our study was prospective data collection in a sample national in scope. The major limitations were relatively small numbers of breast cancer cases, crude assessment of recreational physical activity (low, moderate, and high), and inability to capture patterns between assessments. Due to small numbers of cases, we were unable to examine outcomes for alternative combinations of recreational physical activity categories, for example, inconsistent activity, a potentially prevalent pattern. In older women, among whom we had the greatest number of cases, results using the NHEFS three-category physical activity variable were comparable with results from larger studies having more detailed assessments of recreational physical activity. Similar congruence has been observed in other NHEFS studies using this variable (14–16), including one (14) that demonstrated significant correlation between physical activity and physiological measures related to fitness. Limited assessments of physical activity in surveys other than the NHEFS have been found to correlate with physiological parameters and to successfully rank-order participants (17).

The results of our study contribute to the consistency of the evidence linking long-term recreational physical activity to reduced risk of breast cancer in older women.

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