Beyond Recreational Physical Activity: Examining Occupational and Household Activity, Transportation Activity, and Sedentary Behavior in Relation to Postmenopausal Breast Cancer Risk

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Objectives. We prospectively examined nonrecreational physical activity and sedentary behavior in relation to breast cancer risk among 97 039 postmenopausal women in the National Institutes of Health–AARP Diet and Health Study.

Methods. We identified 2866 invasive and 570 in situ breast cancer cases recorded between 1996 and 2003 and used Cox proportional hazards regression to estimate multivariate relative risks (RRs) and 95% confidence intervals (CIs).

Results. Routine activity during the day at work or at home that included heavy lifting or carrying versus mostly sitting was associated with reduced risk of invasive breast cancer (RR = 0.62; 95% CI = 0.42, 0.91; P_{trend} = .024).

Conclusions. Routine activity during the day at work or home may be related to reduced invasive breast cancer risk. Domains outside of recreation time may be attractive targets for increasing physical activity and reducing sedentary behavior among postmenopausal women. (*Am J Public Health.* 2010;100: 2288–2295. doi:10.2105/AJPH.2009.180828)

Adult women in the United States aged 50 to 69 years spend on average about 8 waking hours per day being inactive.[1] Recreational physical activity has an established relation to reduced risk of postmenopausal breast cancer[2–4] as well as preventing weight gain, type 2 diabetes, metabolic syndrome, high blood pressure, coronary heart disease, stroke, and early death.[3]

However, the relationship between postmenopausal breast cancer and physical activity outside of recreation time, in the domains of home, occupation, and transportation,[5] has been examined less extensively. Occupational cohort studies[6–8] lack ideal control for potential confounding variables, but they have tended to support an inverse relationship between nonrecreational physical activity and breast cancer. In some prospective cohort studies, women who, on average, engaged in higher levels of household activity each week had lower risk of invasive breast cancer[9,10]; in others, however, no relationship was observed between risk of invasive breast cancer and either nonrecreational[11,12] or occupational physical activity.[9,13,14]

At present, the extent to which sedentary behavior is associated with breast cancer risk has not been examined prospectively. Sedentary behavior is ubiquitous in the daily routines of modern adults[15] and has emerged as a new focus for research on physical activity and health.[16–21] It has been proposed that too much sitting may be distinct from too little moderate–vigorous recreational physical activity.[19] Sedentary behavior may independently reduce overall energy expenditure,[22] leading to adverse effects on insulin sensitivity, fat storage,[23] and estrogen metabolism,[24] pathways that are relevant to breast cancer development.

The study of nonrecreational physical activity and sedentary behavior in relation to breast cancer could prove fruitful because these exposures have been related to risk of other chronic conditions among women and may work through similar pathways. Independent of recreational moderate–vigorous physical activity, standing and walking around the home have been inversely associated with chronic conditions such as obesity and diabetes,[25] and walking and bicycling to work have been inversely associated with all-cause mortality[26–28] and obesity.[29] Sedentary behavior has been positively associated with obesity,[30,31] weight gain,[25] diabetes,[30] all-cause mortality,[32–34] cardiovascular disease mortality,[32–34] cancer mortality,[32] and mortality from other causes.[32] Among women, television watching has been positively associated with increases in obesity and diabetes.[15] Breaks in sedentary behavior have been associated cross-sectionally with beneficial changes in biomarkers of metabolic risk such as waist circumference, adiposity, triglycerides, and 2-hour plasma glucose.[35]

We explored the associations of occupational and household activity, transportation activity (i.e., walking or bicycling to work), and sedentary behavior in relation to breast cancer risk in the National Institutes of Health (NIH)–AARP Diet and Health Study. We hypothesized that (1) occupational and household activity and transportation activity are inversely associated with risk of invasive breast cancer and (2) sedentary behavior is positively associated with risk of invasive breast cancer. We planned a priori to explore these hypotheses for in situ breast cancer as well.

METHODS

The NIH–AARP Diet and Health Study[36] was initiated in 1995 and 1996 with the mailing of a self-administered questionnaire to 3.5 million AARP members aged 50 to 71 years from 6 US states (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and 2 metropolitan areas (Atlanta, Georgia, and Detroit, Michigan). In 1996 and 1997, a second questionnaire was sent to selected respondents who did not have self-reported breast, prostate, or colorectal cancer at baseline to collect more detailed information on risk factors for cancer (e.g., recreational physical activity, occupational and household activity, transportation activity, sedentary behavior, and reproductive factors).

Among the 566 402 respondents who filled out the baseline survey in satisfactory detail and consented to be in the study, 226 733 were women. Of those women, 138 057 completed the second questionnaire as well, and 129 095 had known postmenopausal status. Of those with known postmenopausal status, we excluded women who indicated they were proxies for the intended respondents on the baseline questionnaire or second questionnaire (n=1505). Because women with prevalent cancer at baseline (or second questionnaire) may have recently altered their physical activity behavior patterns subsequent to cancer diagnosis, we also excluded those with prevalent or self-reported cancer other than nonmelanoma skin cancer at the baseline questionnaire or the second questionnaire (n=8699). We also excluded women whose death record listed cancer as cause of death but who had no confirming cancer registry record (n=721).

We further excluded women who were missing data on nonrecreational physical activity or sedentary behavior (n=4894) or covariate data (n=12 601) (because of possible biased estimation of relative risks [RRs] when correcting for missing values of confounding variables[37,38]), as well as women with extreme values of body mass index (BMI; n=2890) or energy intake (n=656). Extreme values were defined as log-transformed values of 2 or more interquartile ranges below the 25th percentile or above the 75th percentile. After exclusions, our analytic cohort consisted of 97 039 women. Postmenopausal women who were excluded from the study because of missing or outlier data did not differ substantially from those women who were included in terms of probability of invasive (3.0% vs 2.7%) or in situ breast cancer (0.5% vs 0.6%).

Cancer Ascertainment

In 2007, incident breast cancer cases through December 31, 2003, were identified through linkage with 11 state cancer registry databases, certified by the North American Association of Central Cancer Registries as meeting the highest standards for data quality.[36] The case ascertainment method used in the study identified 90% of cancer cases in our cohort.[39]

For each incident breast cancer case, dates of diagnosis and tumor characteristics were obtained from the cancer registries. We considered as incident first primary breast cancer cases those that were invasive or in situ and that were also the first malignancy diagnosed during the follow-up period (though December 31, 2003), if multiple cancers were diagnosed in the same participant.

Assessment of Nonrecreational Physical Activity, Sedentary Behavior, and Covariates

On the baseline questionnaire, participants in our cohort were also asked to select their current level of routine activity during the day at work (or at home, if they did not work) from 5 options: sitting all day; sitting and a little walking; standing or walking, but no lifting; lifting or carrying light loads, or climbing stairs often; and heavy lifting or carrying. On the second questionnaire, participants reported the total number of years they walked or biked to work for most days of the week (0, <1, 1–2, 3–5, 6–9, or ≥10). Participants also were asked to report the number of hours spent sitting while watching television or videos (0, <1, 1–2, 3–4, 5–6, 7–8, or ≥9) and spent sitting overall (<3, 3–4, 5–6, 7–8, or ≥9) in a typical 24-hour period during the last year. Hours spent watching television or videos and hours spent sitting were not mutually exclusive. Because of modest case numbers, we collapsed the "0" and "<1 year" categories for walking or biking to work and the "0," "<1 hour/day," and "1–2 hours/day" categories for television or video watching. These choices of reference categories had little effect on overall trend estimates. For use in subanalyses, we also classified each participant's television watching and overall sitting as a percentage of her waking time, using the following formula: (median hours per day spent watching television or videos)/(24–median hours spent sleeping–median hours spent napping).

We assessed all covariates by self-administered questionnaire. In particular, participants were queried about current height and weight, and BMI was calculated from these data. Participants also reported how often (never, rarely, >0 but <1 h/wk, 1–3 h/wk, 4–7 h/wk, or >7 h/wk) over the past 10 years they typically spent in moderate–vigorous recreational physical activity (e.g., biking, fast walking, aerobics, jogging, running). We collapsed the lowest 3 dose levels of this variable into a category called "<1 h/wk" and the highest 2 dose levels into a category called "≥4 h/wk" because of similarities in the RRs associated with these levels, respectively. Use of these condensed variables as covariates did not result in changes to overall associations.

We did not have direct evidence of the validity or reliability of the questions that we asked regarding nonrecreational activity and sedentary behavior; however, our questions were similar to questions from measures with reasonable validity and reliability that included assessment on occupational and household routine activity,[40–44] television watching,[45] sitting,[46,47] and recreational moderate–vigorous activity.[41–44]

Statistical Analysis

We estimated RRs and 2-sided 95% CIs with Cox proportional hazards models using the SAS PROC PHREG procedure (version 9.1.3; SAS Institute, Cary, NC). We calculated person-years of follow-up time from the date the second questionnaire was received and scanned until the date of a cancer diagnosis, death, or the end of follow-up (December 31, 2003), whichever occurred first. We evaluated the proportional hazards assumption by modeling interaction terms of our exposures and time, and found no significant interactions. We performed the test for linear trend across categories of occupational and household activity, transportation activity, and sedentary behavior by assigning participants the median value of their categories and entering it as a continuous term in a regression model.

Our final multivariate model included covariates with previously established associations with breast cancer risk that also remained statistically significant in our multivariate model: age, family history of breast cancer, recreational moderate–vigorous physical activity, energy intake, alcohol consumption, education, race/ethnicity, smoking, menopausal hormone therapy, number of breast biopsies, and a combined variable for parity and age at birth of first child. Although P_{trend} values became less significant as more adjustment was done, adjusting for covariates (besides age) did not affect the nonrecreational physical activity or sedentary behavior risk estimates we obtained in this analysis. Although not included in the final models, history of mammography screening in the past 3 years also did not act as a confounder. Because it is possible that the potential effects of nonrecreational physical activity or sedentary behavior on breast cancer are mediated in part by BMI, we report on and discuss our models that did not adjust for BMI. Separate multivariate models controlling for BMI are presented for the readers' knowledge.

We planned a priori to test for interactions with recreational moderate–vigorous physical activity level, BMI, education level, estrogen receptor (ER) status and estrogen-progesterone receptor (ER/PR) status of tumors, use of menopausal hormone therapy, and 3-way interactions with moderate–vigorous recreational physical activity and BMI. To determine whether presentation of stratified analyses was necessary, we used the significance of the likelihood ratio tests for interaction variables as well as the difference in model fit by log-likelihood differences of full and nested models. We performed separate analyses restricted to invasive cancers to test for heterogeneity of effects by tumors' ER status (ER– or ER+) and ER/PR status (ER+/PR+, ER+/PR–, ER–/PR+, or ER–/PR–) and compared the test of trend for each outcome using Cochran's Q statistic.[48]

RESULTS

Age-adjusted participant characteristics by lowest and highest categories of routine activity during the day at work or home, years walking and biking to work, hours per day spent watching television or videos, and hours per day spent sitting are provided in Table 1. All comparisons among this large sample were statistically significant at $P < .05$ unless otherwise indicated. Compared with women who routinely spent all day sitting and women who had spent less than 1 year routinely walking or biking to work, women who engaged in heavy lifting or carrying as routine activity during the day and women who had spent 10 or more years routinely walking or biking to work, respectively, were less likely to have ever been smokers or to be physically inactive during recreation. Women who performed heavy lifting or carrying also had lower BMIs on average. Compared with women who spent less than 3 hours a day watching television and women who spent less than 3 hours a day sitting, women watching television or sitting for 9 or more hours per day were more likely to have a BMI greater than 25 kg/m^2, to be physically inactive during recreation, and to have ever smoked. Women with the highest levels of nonrecreational physical activity or sedentary behavior were less likely to currently use menopausal hormone therapy.

Participants' recreational moderate–vigorous physical activity level typical of the past 10 years was positively correlated with higher levels of routine activity during the day at work or home ($\rho = 0.24$) and with years spent walking or biking to work ($\rho = 0.05$) and negatively correlated with hours spent watching television or videos ($\rho = -0.09$) and hours spent sitting ($\rho = -0.17$; Table 2). Routine activity during the day at work or home was moderately correlated with hours spent sitting ($\rho = -0.47$).

As shown in Table 3, compared with women who sat all day, women who routinely did heavy lifting or carrying during the day had a relative risk (RR) of invasive breast cancer of 0.62 (95% CI = 0.42, 0.91). Because routine activity during the day was measured on the baseline questionnaire, we performed subanalyses using person-years since baseline (with prevalent cancer and proxy exclusions relevant only to that questionnaire), and results were similar. Compared with women who walked or biked to work less than 1 year, women who reported walking or biking to work for 10 or more years had a relative risk of invasive breast cancer of 0.86 (95% CI = 0.67, 1.11). In a sensitivity analysis, we combined the categories of walking or biking for 6 to 9 years and for 10 or more years, and the relative risk of invasive breast cancer for women who were active commuters for 6 or more years was 0.80 (95% CI = 0.65, 0.98; $P_{\text{trend}} = .06$).

Compared with women who watched less than 3 hours of television or videos per day and women who sat for less than 3 hours per day on average, women who watched 9 or more hours of television per day and women who sat for 9 or more hours per day had a relative risk of invasive breast cancer of 1.17 (95% CI = 0.93, 1.47) and 1.12 (95% CI = 0.95, 1.31), respectively. The results remained null when television watching and sitting variables were classified as a proportion of waking time.

Compared with women who reported sitting all day and women who routinely walked or biked to work for less than 1 year, women who did heavy lifting and carrying during the day and women who walked or biked to work for 10 or more years had a relative risk of in situ breast cancer of 1.21 (95% CI = 0.56, 2.61) and 0.92 (95% CI = 0.53, 1.60), respectively (Table 4).

Compared with women who watched less than 3 hours of television per day and women who sat for less than 3 hours per day on average, women who watched television for 9 or more hours per day and women who sat for 9 or more hours per day had a relative risk of in situ breast cancer of 1.04 (95% CI = 0.58, 1.88) and 1.15 (95% CI = 0.80, 1.65), respectively. The results were similar when television watching and sitting variables were classified as percentage of waking time. Combined analyses of in situ and invasive breast cancer yielded results similar to those for invasive breast cancer (data not shown).

Overall, additional adjustment for BMI in models for invasive and in situ breast cancer resulted in modest attenuation of associations (Tables 3 and 4). We found no evidence for effect modification of associations by recreational moderate–vigorous physical activity level, BMI, education level, use of menopausal hormone therapy, or the ER or ER/PR status of tumors (data not shown).

DISCUSSION

Our results suggest that independent of recreational moderate–vigorous physical activity level, increases in routine activity during the day at work or home and, possibly, active commuting may be protective against invasive but not in situ breast cancer. Women who reported engaging in heavy lifting or carrying as routine activity during the day at work or home had a 38% risk reduction for invasive breast cancer compared with those who reported sitting all day. We even observed this benefit (16% risk reduction) among women who reported "sitting, a little walking" (i.e., less sitting). Although the trend did not reach statistical significance, the association we observed for invasive breast cancer and transportation activity (walking or biking to work for 6 or more years compared with less than 1

TABLE 1—Age-Adjusted Characteristics of Postmenopausal Women by Lowest and Highest Categories of Occupational and Household Activity, Transportation Activity, and Sedentary Behavior: National Institutes of Health–AARP Diet and Health Study, 1996–2003

	Routine Activity During Day at Work or at Home		Years Spent Walking or Biking to Work		Television or Video Watching		Sitting	
	Sitting all Day	Heavy Lifting or Carrying	<1 Year	≥10 Years	<3 H/Day	≥9 Hours/Day	<3 Hours/Day	≥9 Hours/Day
No.	7693	1467	85311	2475	33652	2687	20760	7550
Age, y	63	63	63	63	63	63	63	63
Body mass index, kg/m^2	29	26	27	26*	25	29	26	28
Energy intake, kcal/day	1552	1751	1543	1643	1512	1727	1565	1589*
Alcohol intake, g/day	6	7	6	6	6	6*	6	6
Under 1 h of recreational moderate–vigorous physical activity/wk, %	48	11	25	20	21	38	18	42
Ever smoker, %	61	53	54	50	50	64	50	61
College graduate, %	32	21	33	34	46	16	32	34
White, %	94	93	93	91	95	86	91	95
Family history of breast cancer, %	13	14*	13	14*	14	13	13	13*
Nulliparous, %	16	14	14	24	14	14	12	18
Ever had a breast biopsy, %	24	23	24	21	24	24*	24	23*
Current menopausal hormone therapy use, %	43	38*	47	37	51	36	46	44

Note. Age-adjusted means are used for continuous variables and age-adjusted percentages for categorical variables; all are significant at $P < .05$ unless otherwise specified. The total number of participants was 97 039.
*$P > .05$.

year) was in the same direction (14% risk reduction).

Long-term physical activity in the domains of occupation, home, and transportation could lower the risk of postmenopausal breast cancer through the pathways of BMI, estrone, insulin resistance, and C-reactive protein, with BMI and estrone being most convincingly (or probably) associated with both physical activity and risk.[49] Sedentary behavior may affect breast cancer risk through physiological mechanisms different from those that make recreational or nonrecreational physical activity beneficial,[16,32,50,51] such as altered glucose tolerance[52] or lipoprotein lipase activity.[50] We observed that nonrecreational physical activity was related to invasive but not in situ breast cancer in our study. This could suggest that nonrecreational physical activity may be important specifically for preventing breast tumors that are invasive or likely to become invasive. Alternately, the lack of statistical significance for relationships with in situ breast cancer could reflect the lower in situ case numbers. More research is needed to understand the descriptive epidemiology and biology of in situ breast cancer.[53]

The benefit we observed for routine activity during the day at home or work is consistent with the reduced RR of postmenopausal breast cancer observed in the French E3N Cohort[10]

TABLE 2—Spearman Rank Correlations Between Occupational and Household Activity, Transportation Activity, Sedentary Behavior, and Recreational Physical Activity: National Institutes of Health–AARP Diet and Health Study, 1996–2003

	Level of Routine Activity During Day at Work or Home	Years Walked or Biked to Work	Television or Video Watching, Hours/Day	Sitting, Hours/Day
Recreational moderate–vigorous physical activity	0.24	0.05	–0.09	–0.17
Level of routine activity during day at work or home		0.03	–0.06	–0.47
Years walked or biked to work			–0.01	0.003
Television or video watching, h/day				0.23

Note. All correlations are significant at $P < .001$, except between years walked or biked to work and hours per day sitting ($P = .231$). The total number of participants was 97 039.

TABLE 3—Occupational and Household Activity, Transportation Activity, and Sedentary Behavior in Relation to Invasive Breast Cancer Incidence Among Postmenopausal Women: National Institutes of Health–AARP Diet and Health Study, 1996–2003

	No. Person-Years	No. Cases	Age-Adjusted RR (95% CI)	P_{trend}	Multivariate 1 RR (95% CI)[a]	P_{trend}	Multivariate 2 RR (95% CI)[b]	P_{trend}
Occupational and Household Activity								
Routine activity during the day				.003		.024		.092
Sitting all day	49 144	258	1.00		1.00		1.00	
Sitting and a little walking	206 859	933	0.84 (0.73, 0.96)		0.84 (0.73, 0.97)		0.86 (0.75, 0.99)	
Standing or walking, no lifting	251 087	1132	0.81 (0.71, 0.93)		0.83 (0.72, 0.95)		0.86 (0.74, 0.98)	
Lifting or carrying light loads, or climbing stairs often	115 128	514	0.80 (0.69, 0.93)		0.83 (0.71, 0.96)		0.86 (0.74, 1.00)	
Heavy lifting or carrying	9 775	29	0.55 (0.38, 0.81)		0.62 (0.42, 0.91)		0.64 (0.43, 0.94)	
Transportation Activity								
Years walked or biked to work				.051		.081		.084
< 1	555 972	2540	1.00		1.00		1.00	
1–2	24 197	110	1.00 (0.83, 1.21)		0.99 (0.82, 1.20)		0.99 (0.82, 1.20)	
3–5	25 376	120	1.03 (0.86, 1.23)		1.03 (0.86, 1.24)		1.03 (0.86, 1.24)	
6–9	10 357	33	0.69 (0.49, 0.97)		0.69 (0.49, 0.98)		0.70 (0.50, 0.98)	
≥ 10	16 090	63	0.84 (0.65, 1.08)		0.86 (0.67, 1.11)		0.86 (0.67, 1.11)	
Sedentary Behavior								
Television or video watching, h/day				.303		.493		.935
< 3	220 736	1013	1.00		1.00		1.00	
3–4	272 210	1243	0.97 (0.89, 1.05)		1.02 (0.94, 1.11)		1.00 (0.92, 1.09)	
5–6	103 031	438	0.89 (0.80, 0.99)		0.96 (0.86, 1.08)		0.93 (0.83, 1.05)	
7–8	18 990	90	0.99 (0.80, 1.23)		1.08 (0.87, 1.34)		1.04 (0.84, 1.30)	
≥ 9	17 025	82	1.03 (0.82, 1.28)		1.17 (0.93, 1.47)		1.12 (0.89, 1.41)	
Sitting, h/day				.006		.101		.243
< 3	136 447	564	1.00		1.00		1.00	
3–4	186 096	856	1.11 (0.99, 1.23)		1.08 (0.97, 1.20)		1.07 (0.96, 1.19)	
5–6	171 157	803	1.14 (1.03, 1.27)		1.10 (0.98, 1.22)		1.08 (0.97, 1.20)	
7–8	89 698	419	1.17 (1.03, 1.33)		1.11 (0.97, 1.26)		1.08 (0.95, 1.23)	
≥ 9	48 594	224	1.19 (1.02, 1.39)		1.12 (0.95, 1.31)		1.08 (0.92, 1.27)	

Note. RR = relative risk; CI = confidence interval. Person-years are rounded to the nearest whole number. The total number of participants was 97 039.
[a]Adjusted for age, energy intake (kilocalories per day), recreational moderate–vigorous physical activity (0, 1–3, or ≥ 4 h/wk), parity or age at first live birth (never, < 20, < 25, < 30, or ≥ 30 years), menopausal hormone therapy use (never, current, or former), number of breast biopsies (0, 1, 2, or 3), smoking (ever or never), alcohol intake in grams per day (0, < 5, < 15, < 30, or ≥ 30), race (White, Black, or other), education (< 12 y, high school graduate, some college, or college graduate).
[b]Adjusted for same covariates as in multivariate 1 plus body mass index (continuous).

for high versus low levels of light household activity per week (RR=0.82; 95% CI=0.61, 1.11; $P_{trend}<.05$), the European Prospective Investigation Into Cancer and Nutrition[9] (RR=0.81; 95% CI=0.70, 0.93; $P_{trend}=.001$), and various occupational cohort studies,[6–8] but not other prospective cohort studies of nonrecreational physical activity[11,12] or occupational activity.[9,13,14] In our study, the protective effects of routine activity during the day were not confounded by or modified by the education level of the women.

The direction of the relationship between active commuting and invasive breast cancer is consistent with results from a large Finnish cohort study.[54] Although the use of active transportation (i.e., walking or biking) is much less prevalent in the United States than in Europe,[29] currently, 6% of adults in the United States are considered regularly active (≥5 days per week, ≥30 minutes per day) by walking to work.[55] More detailed research with a focus on dose (i.e., duration in minutes and miles, average frequency per week, intensity or pace, and type of route [e.g., hilly, flat]) is needed to understand whether active transportation, including walking to a transit stop,[29] is associated with decreased invasive breast cancer incidence.

As associations of sedentary activities when reported for other chronic disease outcomes have been meaningful,[25,30,32] we cannot rule out the presence of a moderate or weak association between sedentary behavior and invasive breast cancer, which may have been masked by measurement error in the assessment of sedentary behavior. Although the number of hours women spent sitting was not statistically significantly related to invasive breast cancer, the difference between the magnitude of this finding (RR=1.12) and findings for increased levels of routine activity during the day at work or home (which captured a range of activities, including

TABLE 4—Occupational and Household Activity, Transportation Activity, and Sedentary Behavior in Relation to In Situ Breast Cancer Incidence Among Postmenopausal Women: National Institutes of Health–AARP Diet and Health Study, 1996–2003

	No. Person-Years	No. Cases	Age-Adjusted RR (95% CI)	P_{trend}	Multivariate 1 RR (95% CI)[a]	P_{trend}	Multivariate 2 RR (95% CI)[b]	P_{trend}
Occupational and Household Activity								
Routine activity during the day				.333		.644		.79
Sitting all day	49 144	39	1.00		1.00		1.00	
Sitting and a little walking	206 859	209	1.27 (0.90, 1.78)		1.26 (0.89, 1.78)		1.28 (0.91, 1.81)	
Standing or walking, no lifting	251 087	216	1.07 (0.76, 1.51)		1.08 (0.76, 1.53)		1.11 (0.78, 1.58)	
Lifting or carrying light loads, or climbing stairs often	115 128	98	1.06 (0.73, 1.54)		1.11 (0.76, 1.62)		1.15 (0.78, 1.68)	
Heavy lifting or carrying	9 775	8	1.03 (0.48, 2.19)		1.21 (0.56, 2.61)		1.25 (0.58, 2.68)	
Transportation Activity								
Years walked or biked to work				.43		.57		.576
< 1	555 972	511	1.00		1.00		1.00	
1–2	24 197	17	0.77 (0.47, 1.24)		0.77 (0.47, 1.25)		0.76 (0.47, 1.24)	
3–5	25 376	21	0.90 (0.58, 1.39)		0.92 (0.59, 1.42)		0.92 (0.59, 1.42)	
6–9	10 357	8	0.84 (0.42, 1.69)		0.87 (0.43, 1.75)		0.87 (0.43, 1.76)	
≥ 10	16 090	13	0.88 (0.51, 1.52)		0.92 (0.53, 1.60)		0.92 (0.53, 1.61)	
Sedentary Behavior								
Television or video watching, h/day				.427		.037		.063
< 3	220 736	187	1.00		1.00		1.00	
3–4	272 210	247	1.07 (0.88, 1.29)		1.18 (0.97, 1.43)		1.16 (0.95, 1.41)	
5–6	103 031	103	1.18 (0.92, 1.50)		1.36 (1.06, 1.75)		1.32 (1.03, 1.71)	
7–8	18 990	21	1.30 (0.83, 2.05)		1.54 (0.98, 2.44)		1.50 (0.95, 2.38)	
≥ 9	17 025	12	0.83 (0.46, 1.49)		1.04 (0.58, 1.88)		1.01 (0.56, 1.83)	
Sitting, h/day				.117		.244		.32
< 3	136 447	104	1.00		1.00		1.00	
3–4	186 096	167	1.18 (0.92, 1.50)		1.15 (0.90, 1.47)		1.14 (0.89, 1.46)	
5–6	171 157	170	1.31 (1.02, 1.67)		1.26 (0.99, 1.61)		1.24 (0.97, 1.59)	
7–8	89 698	85	1.25 (0.94, 1.67)		1.19 (0.89, 1.60)		1.17 (0.88, 1.57)	
≥ 9	48 594	44	1.20 (0.84, 1.72)		1.15 (0.80, 1.65)		1.12 (0.78, 1.61)	

Note. RR = relative risk; CI = confidence interval. Person-years are rounded to the nearest whole number. The total number of participants was 97 039.
[a]Adjusted for age, energy intake (kilocalories per day), recreational moderate–vigorous physical activity (0, 1–3, or ≥ 4 h/wk), parity or age at first live birth (never, < 20, < 25, < 30, or ≥ 30 years), menopausal hormone therapy use (never, current, or former), number of breast biopsies (0, 1, 2, or 3), smoking (ever or never), alcohol intake in grams per day (0, < 5, < 15, < 30, or ≥ 30), race (White, Black, or other), education (< 12 y, high school graduate, some college, or college graduate).
[b]Adjusted for same covariates as in multivariate 1 plus body mass index (continuous).

"mostly sitting all day" as the comparison category) is small.

Our study had several strengths, including its large prospective nature and our ability to control for many important confounders. In addition, our question on routine activity captured a range of common daily behaviors that may be important determinants of energy expenditure.

Relative to the US population, participants in our study were more likely to be White and to have had a college education. Our findings may therefore not apply to all US women. The primary limitation of our study is that potential error in the assessment of occupational or household activity, transportation activity, and sedentary behavior could attenuate RRs. In addition to the problem of possible error in recall, we lacked detailed information on intensity, length of bouts, or frequency of routine occupational or household activity and active commuting, which precludes us from determining a true dose for these behaviors that could inform recommendations. We also had no information on the historical time frame of active commuting behavior. However, these limitations in the measurement of our exposures are not unique to our study.[21] To date, measurements of duration and intensity of all domains of physical activity and sedentary behavior have rarely been included in prospective or cross-sectional population studies, possibly because of the time and effort required of survey respondents.[56] Comprehensive questionnaires that capture these characteristics and have known measurement properties are needed to better understand the links between nonrecreational physical activity, sedentary behavior, and disease outcomes.[57]

Our data provide evidence that routine activity during the day at work or home may be related to reduced risk of invasive breast cancer. Given that many postmenopausal women may not be capable of meeting US physical activity guidelines for cancer prevention through recreational moderate–vigorous physical activity alone, domains outside of recreation time may be attractive targets for increasing physical activity and reducing sedentary behavior. ■

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Contributors

S.M. George was the primary author and was responsible for completing all analyses, interpreting data, and drafting and revising the article, in consultation with all authors and most closely with M.F. Leitzmann. All authors provided written comments on drafts of the article, with additional analyses and revisions made as a result of such feedback. A.R. Hollenbeck, A. Schatzkin, and M.F. Leitzmann provided substantial contributions to the cohort study conception and design. All authors gave final approval of the version to be published.

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Human Participant Protection

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