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Sedentary behavior, health-related quality of life and fatigue among breast cancer survivors

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Abstract

Background—Many cancer survivors experience declines in health-related quality of life (HRQOL) and increases in fatigue as a result of cancer and its treatment. Exercise is linked to improvements in these outcomes, but little is known about the role of sedentary behavior. In a large, ethnically-diverse cohort of breast cancer survivors, we examined the relationship between sedentary time, HRQOL, and fatigue, and examined if that relationship differed by recreational moderate-vigorous physical activity (MVPA) level.

Methods—Participants were 710 women diagnosed with stage 0-IIIa breast cancer in the Health, Eating, Activity, and Lifestyle Study. Women completed questionnaires at approximately 30-months postdiagnosis (sedentary time; recreational MVPA) and 41-months postdiagnosis (HRQOL; fatigue). In multivariate models, we regressed these outcomes linearly on quartiles of daily sedentary time, and a variable jointly reflecting sedentary time quartiles and MVPA categories (0; > and < 9 MET-hrs/wk).

Results—Sedentary time was not independently related to subscales or summary scores of HRQOL or fatigue. Additionally, comparisons of women with high vs. low (Q4:Q1) sedentary time by MVPA level did not result in significant differences in HRQOL or fatigue.

Conclusion—In this breast cancer survivor cohort, self-reported sedentary time was not associated with HRQOL or fatigue, 3.5 years postdiagnosis.

Keywords

health behavior; survivorship; epidemiology

Introduction

Improved prognosis based on early detection and new treatments for breast cancer has resulted in over 2.5 million women living with a personal history of breast cancer in the United States.^{1–2} As a result of cancer and its treatment, this growing population of cancer survivors face persistent physical and psychological challenges.³ For example, even five years after diagnosis, many survivors still experience impaired physical functioning,^{4–5} psychosocial distress^{6–7}, and fatigue⁸, the latter of which is often reported as the most frequent and distressing cancer symptom.⁹ Cancer diagnoses may prompt survivors to seek lifestyle change to improve long-term physical and psychological health and reduce dysfunction.¹⁰ Thus, it is important to understand modifiable factors that may impact these outcomes in order to develop better interventions for survivors.

There is strong evidence that exercise after a breast cancer diagnosis can improve survivors' HRQOL and fatigue.^{11–13} Less attention has been paid to sedentary time—prolonged periods of sitting or reclining without whole body movement like television watching. Many long-term breast cancer survivors not only fail to get enough exercise (e.g., recreational moderate-vigorous intensity physical activity (MVPA))¹⁴ but also spend the majority of their time sedentary.¹⁵ Being that too much sitting is increasingly becoming known as a distinct health behavior¹⁶ with its own negative health effects,¹⁷ there is a need for research in this area to inform behavioral interventions for survivors.

We previously reported that in the Health Eating Activity and Lifestyle (HEAL) study of breast cancer prognosis, three years after diagnosis, higher postdiagnosis recreational aerobic MVPA was associated with better HRQOL outcomes (including physical functioning¹⁸, vitality,¹⁹ social functioning¹⁹) and less fatigue.¹⁸ There is little known about the independent role sedentary time might have in affecting these outcomes among cancer survivors. The only study to date observed an inverse relationship between television watching time and HRQOL among colorectal cancer survivors²⁰.

To build on our previous research in the HEAL study^{18–19} and address this gap in the literature regarding sedentary behavior among breast cancer survivors, we investigated relationships between sedentary time, independently and stratified by recreational MVPA level, and subsequent HRQOL and fatigue among women with early-stage breast cancer.

Materials and Methods

Study participants

The HEAL study is a multi-ethnic prospective cohort study that has enrolled 1,183 women with first primary breast cancer drawn from Surveillance, Epidemiology, and End Results (SEER) population-based cancer registries in New Mexico, Los Angeles County, and Western Washington. The study was designed to determine whether lifestyle, hormones, and other exposures affect breast cancer prognosis. Details of the study have been published.^{21–23} We obtained written informed consent from all study participants. The study was approved by the institutional review board at each participating center, in accord with assurances filed with and approved by the US Department of Health and Human Services.

In New Mexico, we recruited 615 women aged 18 years or older, diagnosed with *in situ* to regional breast cancer between July 1996 and March 1999, and living in Bernalillo, Santa Fe, Sandoval, Valencia, or Taos counties. In Western Washington, we recruited 202 women between ages 40 and 64 years, diagnosed with *in situ* to regional breast cancer between September 1997 and September 1998, and living in King, Pierce, or Snohomish counties. The age range for the Washington patients was restricted due to other ongoing breast cancer studies. In Los Angeles County, we recruited 366 black women diagnosed with *in situ* to regional breast cancer between May 1995 and May 1998 who had participated in the Los Angeles portion of the Women's Contraceptive and Reproductive Experiences (CARE) Study or who had participated in a parallel case-control study of *in situ* breast cancer. The Women's CARE Study restricted eligibility to women ages 35 to 64 years at diagnosis.

Data for the current study derive from three self-report assessments of the HEAL cohort, at 6 months, 30-months, and 41-months postdiagnosis. A total of 819 participants completed the 41-month assessment. We excluded women who may have been receiving treatment for subsequent recurrences or new primaries that occurred before the 41-month assessment (n=58), because active treatment may be associated with changes in sedentary behavior, physical activity, and the physical symptoms in which we were interested. We further excluded women missing data on sedentary behavior (n=3), diet (n=12), and body mass index (BMI) (n=36). Our final sample included 710 women.

Data Collection

HRQOL and fatigue. At approximately 41-months postdiagnosis, we measured HRQOL using the SF-36 health survey, version 1, a 36 item, valid and reliable short-form instrument^{24–25} that is widely used among medically ill and healthy populations²⁶. The SF36® yields eight subscales (physical functioning, role-physical, bodily pain, general health, social functioning, role-emotional, mental health, vitality) and two component summary scores (physical and mental). For all scales, a higher score represents better functioning and well-being. All scales are standardized on a T-score metric, with a score of 50 representing the U.S. general population average (standard deviation= 10).

Given fatigue's complex, subjective, multicausal, multidimensional nature²⁷, we measured fatigue using the Piper Fatigue Scale²⁸ which has been shown to be a reliable and valid measure of subjective fatigue.²² The 22 items were coded into four scales, each with a range of 1–10): 1) *behavioral severity*: the observable behavioral changes in activities of daily living resulting from fatigue; 2) *affective meaning*: the emotional meaning attributed to fatigue; 3) *sensory*: the physical symptoms of fatigue; and 4) *cognitive/mood*: the mental and emotional symptoms related to fatigue. We changed the response time frame to assess fatigue over the past month rather than the past week to minimize the effect of acute situational events and to enhance our assessment of each survivor's general state of fatigue. The scale's four factor structure was confirmed in the HEAL cohort (Cronbach's alphas for the subscales ranged from 0.92–0.97).

Sedentary behavior—At the 30-month assessment, participants reported the number of hours they spent sitting while watching television or videos and while engaging in other sedentary pursuits (0, <1, 1–2, 3–4, 5–6, 7–8, 9+) during a typical 24-hour period on weekdays and weekends in the past year. To create an overall variable for continuous sitting time/day, we used the following formula ((weekday median daily time spent watching television + weekday median daily time spent in other sedentary pursuits)×5/7 + (weekend median time spent watching television + weekend median time spent in other sedentary pursuits)×2/7)). We classified daily sedentary time into quartiles (Q1–Q4). We did not have

direct evidence of validity or reliability of the sedentary behavior questions we developed and asked.

Physical activity—Given the associations we previously observed in HEAL for recreational MVPA with physical functioning¹⁸ fatigue,¹⁸ vitality,¹⁹ and social functioning¹⁹ we chose to focus on the recreational domain of MVPA for this analysis. At the 30-month assessment, we collected information on aerobic recreational MVPA in the last year using the Modifiable Activity Questionnaire developed by Kriska which has high validity and reliability.²⁹ Participants reported the type, duration, and frequency of recreational physical activities in a typical week in the past year (e.g., brisk walking, biking, dancing, swimming, jogging, etc.). We classified each activity according to its corresponding metabolic equivalent of task (MET) value in the “Compendium of Physical Activities.”³⁰ For all activities with MET values ≥ 3 , we summed the products of activity MET values and hours spent in each activity to arrive at MET-hrs/week spent in MVPA for each participant. For joint association analyses, similar to Irwin et al.³¹, we classified recreational physical activity into three categories (inactive: 0; somewhat active: >0 to <9 ; active: ≥ 9 MET-hours/week), with 9 MET-hours/week approximately equal to 150 min/week of moderate-intensity physical activity, and meeting the general population guidelines for health promotion.³²

Additional risk factors—Height was measured 6-months postdiagnosis and weight at 30-months postdiagnosis. BMI was calculated as weight (kg)/ height (m^2) and was categorized into the World Health Organization’s (WHO) BMI categories (underweight <18.5 ; normal: 18.5 to <25 ; overweight: 25 to <30 ; obese: 30 to <40 ; very obese: ≥ 40 kg/m^2). Because diet quality was associated with physical and mental functioning in HEAL²³ we considered diet in this analysis. At the 30-month assessment, women completed a 122-item self-administered food-frequency questionnaire (FFQ) developed and validated for the Women’s Health Initiative.³³ New Mexico participants reported their usual dietary intake for the previous year, whereas participants at the other two centers reported usual intake for the previous month. We measured diet quality with the Healthy Eating Index-2005^{34–37} which aligns with the U.S. Dietary Guidelines for Americans-2005 and uses an energy-adjusted density approach.³⁸ For each participant, we scored each component, calculated a total score (100 possible points), and classified scores into quartiles.

For participants’ breast cancer diagnoses, disease stage was obtained from cancer registry records, and detailed information on treatment and surgical procedures was obtained from cancer registry, physician, and hospital records. At 6-months postdiagnosis, information was collected on recruitment site, date of birth, race, and education level. At the 30-month assessment, participants reported current use of tamoxifen, anti-depressants, and anti-anxiety medications. They also reported physician-diagnosed medical conditions and whether any of their current activities of daily living were limited by any of these conditions. A comorbidity summary score was generated based on the number of activity-limiting comorbidities (0; 1; 2). Also at the 30-month assessment, participants reported their employment status and current smoking status. Menopausal status at 30-months postdiagnosis was determined from medical records, hormone levels, and questionnaires. We considered each of these potential confounders in model development.

Statistical Analysis

We calculated means, standard deviations, and frequencies of demographic, clinical, and health behavior characteristics of our study population by quartiles of daily sedentary time.

In multivariate linear regression models, we regressed self-reported HRQOL and fatigue on quartiles of daily sedentary time and a combined variable jointly reflecting quartiles of daily sedentary time and MET-h/week MVPA (0; >0 and <9; 9). We calculated adjusted least square means for all HRQOL subscale and summary scores as well as fatigue scores. We controlled for confounders that improved model fit for any outcome and changed the magnitude of the beta coefficients by at least 10% (postdiagnosis MVPA, postdiagnosis diet quality, number of activity-limiting comorbidities, postdiagnosis BMI, antidepressant use, menopausal status, and race). Age and treatment did not qualify as confounders but were retained in our models for comparability with the literature, and their inclusion did not alter estimates obtained. We also analyzed data only among women diagnosed with invasive breast cancer (n=533), and associations were similar, so we report on the entire sample (n=710).

In analyses of sedentary time, we also explored whether any observed associations differed by MVPA, BMI, or race/ethnicity, by examining likelihood ratio tests for both the interaction of sedentary time with these factors ($\alpha=0.05$) and the difference in model fit of full and reduced models.

All statistical analyses were conducted using SAS (version 9.2, Cary, NC) and used an alpha of 0.05.

Results

Women with higher daily sedentary time were more likely to be White, have higher BMIs, have lower recreational MVPA, and not be current users of antidepressants (Table 1). Sedentary time was only weakly correlated with recreational physical activity ($r=0.09$) (data not shown). Women with higher sedentary time did not have significantly different scores for self-reported overall physical HRQOL ($p_{\text{trend}}=0.771$), physical functioning ($p_{\text{trend}}=0.513$), role-physical ($p_{\text{trend}}=0.719$), bodily pain ($p_{\text{trend}}=0.352$), general health ($p_{\text{trend}}=0.530$), overall mental HRQOL ($p_{\text{trend}}=0.703$), vitality ($p_{\text{trend}}=0.744$), social functioning ($p_{\text{trend}}=0.625$), role-emotional ($p_{\text{trend}}=0.936$), mental health ($p_{\text{trend}}=0.724$), or dimensions of fatigue (behavioral severity: $p_{\text{trend}}=0.180$; affective meaning: $p_{\text{trend}}=0.988$; sensory: $p_{\text{trend}}=0.828$; cognitive: $p_{\text{trend}}=0.738$) (Table 2). The associations between sedentary time, HRQOL and fatigue among survivors did not differ by recreational MVPA level (Tables 3a and 3b) or by BMI or race (data not shown).

Discussion

Our study fills an important gap in the literature by investigating how self-reported sedentary time, both independently and stratified by physical activity level, relates to subsequent HRQOL and fatigue among breast cancer survivors. Our data suggest that self-reported sedentary time is not independently related to long-term survivors' HRQOL or symptoms of fatigue. Further, the null associations between sedentary time, HRQOL, and fatigue did not vary by recreational MVPA level.

It is important to understand findings within the context of established cut-offs as well as existing literature. Different criteria have been used in the literature to indicate the minimally important difference (MID) in the SF-36 necessary to signify a meaningful or clinical effect.³⁹ Cohen's (1992) criteria suggest that a small effect is indicated by a 0.20 SD and a 0.50 SD is a medium effect size.⁴⁰ There is support in the literature that MIDs fall within this range.^{41–42} We observed between 0.1 and 0.7 point differences in HRQOL scores for those in Q4 vs. Q1 of sedentary time. Not surprisingly, these non-significant differences are also not meaningful. There are no published guidelines on MIDs for the Piper Fatigue Scale,

but differences in fatigue scores for those in Q4 vs. Q1 of sedentary time were small (0–0.3) and non-significant. Among older adults without cancer, gradual and inverse relationships have been observed between sedentary behavior and scores on most of the SF-36 scales.⁴³ Being that these outcomes were not related to sedentary time but were strongly related to recreational MVPA among HEAL breast cancer survivors^{18–19}, it is possible that after cancer and its treatment, recreational MVPA has stronger effects than sedentary time on biologically-relevant pathways affecting physical and mental health.

Key strengths of this study included our large, diverse group of survivors recruited through population-based cancer registries, comprehensive data on covariates related to sedentary behavior and our outcomes of interest, and validated, commonly-used self-report outcome measures. It may be that the multidimensional Piper fatigue scale captures a different construct than do the four items on vitality subscale of the SF-36, and our study had the advantage of looking at both of these constructs for the first time in relation to sedentary behavior.

The results of this study should be interpreted in the context of its limitations. Our results are only generalizable to women who have completed treatment, survived at least 41 months after diagnoses of breast cancer, and have similar demographic, clinical, and behavioral characteristics. Due to the study design, we were also not able to capture whether participants' active and sedentary behavior changed between the 30-month postdiagnosis exposure assessment and the 41-month postdiagnosis outcome assessment, nor whether their HRQOL or fatigue changed in that timeframe.

First, if a weak or moderate association between sedentary behavior and these cancer-related comorbidities truly exists, there are a few explanations for our null results. First, measurement error from misclassification of self-reported sedentary behavior may have precluded us from observing a moderate or weak association. Our measure of sedentary behavior assessed only time spent television/video watching and time spent in all other sedentary pursuits. While the former may account for up to 50% of sedentary time⁴⁴ and is the most common domain measured in the literature⁴⁵, the latter may be cognitively challenging for participants to recall. Second, like most studies, we chose to assess HRQOL and fatigue using patient self-administered questionnaires,²⁶ and it is possible that sedentary behavior might have a different association with objectively-measurable aspects of HRQOL, like physical functioning.

Third, sedentary behavior may not have as strong of a role, independently or jointly, in reducing the risk of physical or mental comorbidities 41-months into the cancer experience as it might in the acute period during or after treatment. In HEAL, survivors reported substantially worse physical functioning than the general population,⁴⁶ and a large proportion of survivors (40%) reported experiencing fatigue.⁴⁷ Nevertheless, if HRQOL and symptoms are worse during or right after treatment, the relationship between sedentary behavior and outcomes may differ by timing along the cancer continuum and we were not able to examine this in our study. Last, a ceiling effect could also explain our null findings, as survivors in our study did not score extremely poorly on HRQOL or fatigue measures.

Even if sedentary time is not a strong predictor of HRQOL or fatigue, it remains possible that it might be an important, independent indicator of other health outcomes after cancer, like survival and metabolic biological factors associated with survival. Among adults without cancer, irrespective of participation in MVPA, higher levels of objectively-measured sedentary time have been associated with biomarkers of postmenopausal breast cancer risk—BMI, waist circumference, C-reactive protein, fasting insulin, and insulin resistance⁴⁸—and mortality^{49–52}. Among a nationally representative sample of breast cancer

survivors, objectively-measured sedentary behavior has been associated with overall and abdominal obesity.¹⁵

In this cohort of breast cancer survivors, self-reported sedentary time was not associated with HRQOL or fatigue, 3.5 years postdiagnosis. To improve our understanding of public health benefits for survivors associated with reducing sedentary time, longitudinal studies on this topic are needed. Future research may benefit from recruiting survivors with poorer HRQOL, including validated self-report measures of sedentary time that span multiple domains (home, workplace, transportation, social settings), and complementing self-report questionnaires or recalls with objective monitoring of sedentary time.

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Table 1

Demographic, Clinical, and Lifestyle Characteristics of 710 Breast Cancer Survivors in the Health, Eating, Activity, and Lifestyle Study

Characteristic	Quartile of daily sedentary time						p-value ^f	
	Quartile 1 (0.8-4.2h/day)		Quartile 2: 4.3-5.7h/day		Quartile 3: 5.8-8.2h/day			Quartile 4: 8.3-19 h/day
	N	%	N	%	N	%	N	%
Number of participants	177		178		177		178	
Age ^f								
Mean (SE)		56.4(0.7)		59.2 (0.8)		57.4 (0.7)		57.8 (0.7)
Race/Ethnicity								
White, non-Hispanic	87	49	100	56	109	62	124	70
Hispanic	23	13	19	11	21	12	15	8
Black, non-Hispanic	64	36	57	32	40	23	31	17
American Indian, Asian, Other	3	2	2	1	7	4	8	4
Menopausal status								
Premenopausal	68	38	50	28	60	34	60	34
Postmenopausal	99	56	118	66	108	61	113	63
Undetermined	10	6	10	6	9	5	5	3
Treatment								
Surgery only	58	33	56	31	44	25	66	37
+ radiation	53	30	70	39	77	44	66	37
+ chemotherapy	22	12	14	8	17	10	16	9
+ radiation and chemotherapy	44	25	38	21	39	22	30	17
Use of antidepressants								
No	146	82	162	91	141	80	148	83
Yes	31	18	16	9	36	20	30	17
Number of activity-limiting comorbidities								
None	141	80	125	70	131	74	133	75
One	29	16	34	19	29	16	30	17
Two or more	7	4	19	11	17	10	15	8
HEI-2005 score (100 points possible)								
Mean (SE)		67.2(0.9)		65.3 (0.9)		64.9 (0.8)		65.6 (0.8)

Characteristic	Quartile of daily sedentary time						<i>p</i> -value ^f		
	Quartile1(0.8-4.2h/day)		Quartile2:4.3-5.7h/day		Quartile3:5.8-8.2h/day			Quartile 4: 8.3-19 h/day	
	N	%	N	%	N	%		N	%
MET-hours/week of postdiagnosis recreational MVPA									
Mean (SE)		15.2(1.7)		13.0 (1.3)		9.8 (1.1)		11.4 (1.3)	0.027
BMI									
Mean (SE)		27.4(0.4)		27.6 (0.5)		29.0 (0.5)		28.4 (0.5)	0.048

1 2 test for categorical variables, trend test for continuous variables

Table 2

Multivariate-adjusted HRQOL and fatigue scores¹ by quartiles of sedentary time²

	Quartile of daily sedentary time ²				P-trend
	Q1	Q2	Q3	Q4	
N	177	178	177	178	
Physical summary score	40.6 (1.2)	40.0 (1.20)	40.2 (1.2)	40.7 (1.2)	0.771
Physical functioning	39.1 (1.2)	38.5 (1.2)	38.2 (1.1)	38.5 (1.2)	0.513
Role-physical	39.9 (1.5)	39.6 (1.5)	40.5 (1.4)	40.1 (1.5)	0.719
Bodily pain	44.6 (1.4)	43.7 (1.4)	44.3 (1.3)	45.3 (1.4)	0.352
General health	42.9 (1.3)	42.3 (1.3)	42.7 (1.2)	43.3 (1.3)	0.530
Mental summary score	46.2 (1.4)	45.7 (1.4)	46.7 (1.4)	46.3 (1.4)	0.703
Vitality	44.6 (1.4)	44.6 (1.4)	45.6 (1.3)	44.7 (1.4)	0.744
Social functioning	43.3 (1.4)	42.6 (1.4)	43.0 (1.3)	43.7 (1.4)	0.625
Role-emotional	41.8 (1.6)	42.1 (1.6)	42.3 (1.5)	42.0 (1.6)	0.936
Mental health	46.6 (1.3)	45.3 (1.3)	46.8 (1.3)	46.5 (1.3)	0.724
Fatigue-behavioral severity	3.7 (0.4)	3.7 (0.4)	3.6 (0.3)	3.4 (0.4)	0.180
Fatigue-affective meaning	4.2 (0.4)	4.5 (0.4)	4.3 (0.4)	4.3 (0.4)	0.988
Fatigue-sensory	5.1 (0.3)	5.2 (0.3)	4.9 (0.3)	5.1 (0.3)	0.828
Fatigue-cognitive	4.8 (0.3)	4.7 (0.3)	4.5 (0.3)	4.7 (0.3)	0.738

¹Least square means and standard deviations from linear regression models adjusted for age, treatment, postdiagnosis recreational physical activity, diet quality, postdiagnosis body mass index, number of activity-limiting comorbidities, antidepressant use, race, and menopausal status

²Q1: 0.8-4.2 h/day; Q2: 4.3-5.7 h/day; Q3: 5.8-8.2 h/day; Q4: 8.3-19 h/day

Table 3

a: Multivariate-adjusted HRQOL and fatigue scores ^f by quartiles of sedentary time and recreational moderate-vigorous physical activity levels						
N	Pattern of active and sedentary behavior	Physical component summary score	Physical functioning	Role-physical	Bodily pain	General health
9 MET-h/wk recreational MVPA						
85	sedentary time Q1	41.9 (1.3)	42.6 (1.2)	39.1 (1.5)	44.0 (1.5)	44.7 (1.3)
75	sedentary time Q2	42.4 (1.3)	41.6 (1.3)	40.5 (1.6)	44.7 (1.5)	44.7 (1.4)
59	sedentary time Q3	40.9 (1.4)	40.0 (1.4)	41.0 (1.7)	43.4 (1.6)	44.2 (1.5)
61	sedentary time Q4	43.0 (1.4)	42.3 (1.4)	40.1 (1.7)	44.4 (1.7)	45.9 (1.5)
	<i>p</i> -contrast Q4:Q1	0.443	0.786	0.314	0.831	0.443
>0 and <9 MET-h/wk recreational MVPA						
64	sedentary time Q1	41.4 (1.4)	39.1 (1.3)	41.4 (1.6)	44.7 (1.6)	43.5 (1.4)
76	sedentary time Q2	40.2 (1.3)	39.9 (1.3)	39.6 (1.6)	42.3 (1.5)	43.0 (1.4)
80	sedentary time Q3	41.1 (1.2)	39.6 (1.2)	40.7 (1.5)	44.4 (1.4)	44.1 (1.3)
78	sedentary time Q4	40.2 (1.3)	37.9 (1.3)	39.7 (1.5)	44.9 (1.5)	43.4 (1.3)
	<i>p</i> -contrast Q4:Q1	0.400	0.426	0.361	0.918	0.969
0 MET-h/wk recreational PA						
28	sedentary time Q1	40.6 (1.8)	37.8 (1.8)	41.4 (2.1)	44.7 (2.1)	43.3 (1.9)
27	sedentary time Q2	37.2 (1.8)	33.3 (1.8)	39.3 (2.2)	43.3 (2.1)	39.9 (1.9)
38	sedentary time Q3	38.7 (1.6)	35.5 (1.6)	40.7 (1.9)	43.9 (1.9)	41.3 (1.7)
39	sedentary time Q4	40.2 (1.6)	37.2 (1.5)	40.9 (1.9)	46.1 (1.8)	43.4 (1.7)
	<i>p</i> -contrast Q4:Q1	0.871	0.761	0.828	0.594	0.959

b: Multivariate-adjusted HRQOL and fatigue scores ^f by quartiles of sedentary time and recreational moderate-vigorous physical activity levels								
N	Pattern of active and sedentary behavior	Mental component summary score	Vitality	Social functioning	Role-emotional	Mental health	Fatigue-behavioral severity	Fatigue-affective meaning
9 MET-h/wk recreational MVPA								
85	sedentary time Q1	46.3 (1.5)	46.2 (1.4)	43.3 (1.4)	42.5 (1.6)	47.1 (1.4)	3.7 (0.4)	4.3 (0.4)
75	sedentary time Q2	45.6 (1.6)	46.4 (1.5)	42.5 (1.5)	43.8 (1.7)	44.6 (1.4)	3.5 (0.4)	4.5 (0.5)

b: Multivariate-adjusted HRQOL and fatigue scores¹ by quartiles of sedentary time and recreational moderate-vigorous physical activity levels

N	Pattern of active and sedentary behavior	Mental component summary score	Vitality	Social functioning	Role-emotional	Mental health	Fatigue-behavioral severity	Fatigue-affective meaning	Fatigue-sensory	Fatigue-cognitive
59	sedentary time Q3	47.3 (1.6)	47.5 (1.6)	42.5 (1.6)	43.2 (1.8)	47.4 (1.5)	3.4 (0.4)	4.0 (0.5)	4.9 (0.4)	4.5 (0.3)
61	sedentary time Q4	45.9 (1.7)	45.2 (1.6)	45.7 (1.6)	41.9 (1.9)	46.2 (1.5)	3.0 (0.4)	4.1 (0.5)	5.0 (0.4)	5.0 (0.3)
	<i>p</i> -contrast Q4:Q1	0.809	0.572	0.153	0.786	0.577	0.144	0.736	0.884	0.785
>0 and <9 MET-h/wk recreational MVPA										
64	sedentary time Q1	45.2 (1.6)	43.6 (1.6)	43.3 (1.6)	41.8 (1.8)	45.7 (1.5)	4.0 (0.4)	4.2 (0.5)	5.4 (0.4)	4.8 (0.3)
76	sedentary time Q2	45.7 (1.5)	44.2 (1.5)	42.9 (1.5)	41.4 (1.7)	46.3 (1.4)	3.6 (0.4)	4.3 (0.4)	5.6 (0.3)	4.9 (0.3)
80	sedentary time Q3	47.0 (1.4)	46.2 (1.4)	44.1 (1.4)	42.1 (1.6)	47.3 (1.3)	3.5 (0.4)	4.3 (0.4)	4.9 (0.3)	4.6 (0.3)
78	sedentary time Q4	46.2 (1.5)	44.7 (1.5)	42.0 (1.5)	42.0 (1.7)	46.7 (1.4)	3.5 (0.4)	4.3 (0.4)	5.4 (0.3)	5.0 (0.3)
	<i>p</i> -contrast Q4:Q1	0.588	0.506	0.417	0.924	0.505	0.195	0.839	0.820	0.688
0 MET-h/wk recreational PA										
28	sedentary time Q1	46.0 (2.1)	42.9 (2.1)	43.6 (2.0)	42.0 (2.3)	46.8 (1.9)	3.1 (0.5)	3.8 (0.6)	5.0 (0.5)	5.2 (0.4)
27	sedentary time Q2	44.6 (2.2)	39.5 (2.1)	41.5 (2.1)	41.6 (2.4)	44.0 (2.0)	4.6 (0.5)	5.1 (0.6)	5.9 (0.5)	5.1 (0.4)
38	sedentary time Q3	45.0 (1.9)	40.2 (1.8)	41.3 (1.8)	43.0 (2.1)	44.8 (1.7)	4.0 (0.5)	4.5 (0.6)	5.6 (0.4)	5.1 (0.4)
39	sedentary time Q4	47.0 (1.8)	43.1 (1.8)	44.0 (1.8)	43.8 (2.0)	46.7 (1.7)	3.6 (0.5)	4.4 (0.5)	5.2 (0.4)	4.5 (0.4)
	<i>p</i> -contrast Q4:Q1	0.692	0.931	0.856	0.527	0.983	0.350	0.370	0.722	0.153

¹Least square means from linear regression models adjusted for age, treatment, postdiagnosis diet quality, postdiagnosis body mass index, number of activity-limiting comorbidities, antidepressant use, race, and menopausal status