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Correlates of physical activity among older breast cancer survivors: Findings from the Women's Health Initiative LILAC study

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Abstract

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Declaration of Competing Interest

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Introduction: Physical activity can attenuate cancer-related declines in physical functioning, improve emotional well-being, and prolong survival among older (≥65 years) breast cancer survivors. However, factors associated with physical activity among older breast cancer survivors are not well-understood.

Materials and methods: Participants were enrolled in the Women's Health Initiative (WHI) Life and Longevity After Cancer (LILAC) study. Descriptive statistics, multiple linear regression, and relative risk [RR] regression were used to assess the association of demographic, clinical, physical and psychosocial variables with the total duration of and participation in physical activity among postmenopausal breast cancer survivors. Age-specific correlates (65–74 years vs. 75–84 years vs. ≥85 years) of physical activity were also examined.

Results: The majority of participants (n = 3710, mean age = 78.8 ± 5.9) were white (90.7%) and had in situ/localized breast cancer (78.9%). Women who had higher education (RR = 1.47 for graduate/professional school versus high school or less, 95% CI: 1.32, 1.63), higher self-rated health (RR = 1.04 for 10 point increase, 95% CI:1.02, 1.07), higher physical functioning (RR = 1.03 for 5 point increase, 95% CI: 1.02, 1.04), and higher social support (RR = 1.41 for social support all of the time versus none of the time, 95% CI: 1.01, 1.96), were more likely to engage in any physical activity. Similar results were observed for duration of physical activity. Among women aged <75, radiation therapy, but not chemotherapy, was associated with longer duration of total physical activity (adjusted difference = 19.7 min/week, 95% CI: 6.1, 33.3), but was not associated with duration among older women. The association between pain and duration of moderate/strenuous activity also differed with age: among women aged <75, those with moderate pain averaged fewer minutes of moderate/strenuous physical activity than those with no pain (adjusted difference:−14.4 min/week, 95% CI:−28.5, −0.1). However, among women aged ≥85, those with moderate pain averaged more minutes of moderate/strenuous physical activity per week than those with no pain (adjusted difference:16.6 min/week; 95% CI:2.9, 30.3).

Discussion: Multiple factors were associated with physical activity among older breast cancer survivors in the WHI. Future physical activity interventions should focus on age-related (e.g., comorbidities) and treatment-related factors (e.g., radiation) as well as certain subgroups, such as women with higher symptom burden.

Keywords

Geriatric oncology; Physical activity; Breast cancer; cancer survivorship; Older adults

1. Introduction

Survival after a breast cancer diagnosis has improved, due to advancements in screening practices, which leads to earlier detection, and more effective cancer therapies. The five-year survival is near 100% for early stage breast cancer, and over 90% for all stages combined [1,2]. Improved survival has led to a significant increase in numbers of breast cancer survivors, with more than half of all United States' breast cancer survivors (≈3.1 million) aged ≥65 years [3]. Older breast cancer survivors (age ≥ 65 years) are unique because they often have age-related declines in physical functioning, higher incidence and severity of comorbid illnesses, and reduced social and economic resources [4,5].

National guideline panels (e.g., The American Cancer Society, the American College of Sports Medicine), all recommend that cancer survivors participate in aerobic and resistance exercise regularly [6-9]. Physical activity benefits cancer survivors both physically and psychologically; it may alleviate psychosocial distress, improve body image, and help to manage symptoms such as fatigue, anxiety, and depression that manifest as a result of cancer and its treatment [10-14]. These benefits seem to extend to all types of physical activity, including light-intensity activites [15]. The majority of breast cancer survivors (65–75%) receive medical provider clearance to engage in exercise programs [16], yet only 20–54% of breast cancer survivors meet physical activity guidelines [9,13,17,18].

Very few studies have examined factors associated with physical activity among older breast cancer survivors [19]. This is concerning given that older age is significantly associated with lower physical activity [20]. A number of studies have found cancer survivors are less likely to engage in physical activity [21,22] and more likely to be sedentary than their peers [23,24], although contrary evidence does exist [25-29]. It has also been reported that sedentary levels are twice as high among older breast cancer survivors as compared to younger breast cancer survivors [30]. This highlights the need for a greater understanding of factors that impact the physical activity of older survivors, which will ultimately inform ideal interventions to improve physical activity levels in this growing population.

A prerequisite to developing successful physical activity interventions for older breast cancer survivors is to identify modifiable correlates of physical activity [31]. Available evidence suggests that functional limitations, type (strength vs. aerobic) [32-34], and motivation (cardiovascular health vs. weight management) for physical activity [35,36] as well as perceived risk of injury, differ by survivors' age [33,37,38]. It is also posited that the motivation, self-efficacy, and barriers to physical activity differ by survivors' socioeconomic status, social support, or chronic conditions [39-41].

The primary objective of this study was to examine comprehensive factors (e.g., demographic, lifestyle, physical, psychosocial, and clinical) related to frequency and duration of physical activity among a well-characterized sample of older breast cancer survivors in the U.S. A secondary objective was to determine the extent to which factors associated with physical activity among older breast cancer survivors vary by age (65–74 years vs. 75–84 years vs. ≥85 years). Three hypotheses were tested: 1) The majority of older (≥65 years) breast cancer survivors will have physical activity levels under the recommended guidelines; 2) Older age, higher severity of physical and psychological symptoms, higher cancer stage at diagnosis, poorer quality of life, and lower social support will be associated with lower levels of physical activity among older breast cancer survivors and; 3) The severity of physical and psychological symptoms will be associated with lower levels of physical activity in the oldest age group compared to the younger age group.

2. Materials and methods

This study used data from the Women's Health Initiative (WHI) study and the subsequent WHI Life and Longevity After Cancer (LILAC) ancillary study, funded by the National Cancer Institute. Briefly, WHI was initiated in 1993, with the goal to evaluate approaches to

prevent some cancers, heart disease, and osteoporotic fractures in 161,000 postmenopausal women [42-44]. Between 1993 and 1998, postmenopausal women, aged 50–79 years, were recruited from 40 clinical sites across the US into one or more randomized clinical trials (WHI-CT, n = 68,132) or an observational study (WHI-OS, n = 93,676). The WHI-CTs ended in 2004 and 2005, and all CT and OS participants were invited to continue survey-based follow-up in the WHI Extension Study 1 (2005–2010), Extension Study 2 (2010–2015), and Extension Study 3 (2015–2020). Beginning in 2013, the WHI LILAC Study enrolled WHI participants diagnosed with select cancers after WHI enrollment [45]. The WHI LILAC Study expanded the existing WHI data to support studies of cancer outcomes, participant survivorship, and molecular epidemiology. LILAC participants were surveyed annually about their cancer treatments, recurrences, medications, symptoms, social support, mental and physical functioning, quality of life, unmet needs, and finances.

Participants eligible to be included in this paper were LILAC participants with a diagnosis of breast cancer, who had completed the LILAC baseline (Form 340) and either the question regarding frequency of mild activity or frequency of moderate-to-strenuous activity at 1-year follow-up (Form 370). There were 3710 women who met these criteria. Breast cancer was chosen because it is the most prevalent solid tumor cancer in the WHI LILAC dataset and among US women [2]. Fred Hutchinson Cancer Research Center's Institutional Review Board approved all materials used in data collection. All participants in the WHI LILAC and WHI provided written informed consent.

2.1. Measures

Self-reported physical activity was assessed by the total duration (minutes/week) of and participation in mild and moderate or strenuous intensities of recreational physical activity on the LILAC one year follow-up survey (Form 370). Participants were asked, “How often each week (7 days) do you usually do moderate or strenuous exercise? For example, biking outdoors, using an exercise machine, aerobics, swimming, dancing, jogging, tennis.” For mild physical activity, participants were asked, “How often each week (7 days) do you usually do mild exercise? For example, slow dancing, bowling, or golf.”

For each intensity level, frequency was measured by “Not counting walking outside of the home, how often each week (7 days) do you usually do the exercises below?” Responses were: never, 1 2, 3, 4, and 5 or more days a week. Duration was measured by the question, “How long do you usually exercise like this at one time?” Response options were: less than 20 min, 20–39 min, 40–59 min, and 1 h or more. Two different types of physical activity variables were used: a binary indicator of whether or not the participant exercises at least one day a week and a continuous variable equal to the number of minutes of exercise per week. The latter variable was calculated by multiplying a participant's self-reported frequency (number of days a week) by their reported duration (9.5, 29.5, 49.5, and 60 min were used as the numerical values for options listed above). Separate binary and continuous variables were calculated for mild and moderate-to-strenuous activity. The variables were also combined to determine if someone participated in any physical activity (mild or moderate-to-strenuous) and to calculate total number of minutes per week participating in any activity.

2.2. Symptom score

Participants were asked on Form 370 to indicate the occurrence and severity of 24 physical and psychological symptoms experienced over the past four weeks. Symptoms assessed were physical (e.g., difficulty breathing, feeling tired) and psychological (e.g., feeling anxious, feeling depressed) [46]. The presence of symptoms (yes/no) and their severity (mild, moderate, severe) were totaled to create a symptom score. Total scores ranged from 0 to 72, with higher scores indicating higher symptom burden.

2.3. Pain

Pain was assessed on Form 370 by the occurrence (yes/no) and severity (mild, moderate, severe) of general aches and pains over the past four weeks. Scores ranging from 0 (no pain) to 4 (severe pain), with higher scores indicating a higher level of pain.

2.4. Self-rated health, global quality of life, and physical functioning

Data on self-rated health, global quality of life, and physical functioning were only included if collected within one year of F370 completion. Participants were asked to rate their current health status using the following item: “In general, would you say your health is excellent, very good, good, fair, or poor?” Responses were assigned the following scores which measure the probability of being healthy in the future: 15 (poor), 30 (fair), 80 (good), 90 (very good), and 95 (excellent) [47].

Global quality of life was measured by the question: “Overall, how would you rate your quality of life?” [48] Responses ranged from 0 to 10, with higher scores indicating higher global quality of life. This single-item measure of quality of life has high internal reliability ($\alpha = 0.86–0.89$) and validity [49].

Participants' physical functioning was measured using the 10-item RAND-36 physical functioning subscale [50]. Item responses were: 1) no, not limited at all, 2) yes, limited a little, and 3) yes, limited a lot. Single items were summed together to create the subscale score, and then were transformed to a 0–100 scale. Higher scores indicated better physical functioning. The RAND-36 has high reliability ($\alpha > 0.90$) and validity [50,51].

2.5. Social support

Social support was measured by a single item, “How often do you have someone with whom you can have a good time?” derived from the MOS-Social Support Questionnaire [52]. Participant response was on a 5-point scale ranging from 1 (none of the time) to 5 (all of the time), with a higher score indicating a higher level of social support.

2.6. Demographic and clinical information

Participant's age at diagnosis, race, ethnicity, education, marital status, living situation (alone vs. with someone), and insurance status were collected. Due to its high missingness rate (16.5%) and the small number of uninsured participants, insurance status was not used in any multivariable models. Clinical information including cancer stage at diagnosis, time since diagnosis, self-reported receipt of chemotherapy (yes/no), self-reported receipt of radiation (yes/no), number of treatment-related comorbidities, and presence of lymphedema

(yes/no) were also collected. Body mass index (BMI) was calculated using a woman's self-reported weight on the LILAC baseline questionnaire (Form 340) and her most recent height measurement (WHI Form 180). BMI categories were created: BMI <25 (underweight/normal weight), 25–30 (overweight), and ≥30 (obese).

2.7. Data analyses

Descriptive statistics (means for continuous variables and percentages for categorical variables) were used to characterize the distribution of the demographic, clinical, and psychosocial characteristics by physical activity among older breast cancer survivors. Multiple linear regression models were used to identify the association of demographic (age group, race, ethnicity, marital status, living situation, education), clinical factors (cancer stage), treatment type (chemotherapy, radiation, surgery), BMI, health status (symptom presence, lymphedema presence, physical functioning, pain, self-rated health), and physical and psychosocial factors with physical activity levels (minutes/week) among older cancer survivors. Due to the skewed distribution of the outcome variable, Generalized Estimating Equations were used to avoid normality assumptions. Participation in any physical activity was modeled using relative risk regression and robust standard errors [53]. Interactions between age group and other factors were examined to determine if associations of risk factors with physical activity levels differed by age group (65–74, 75–84, ≥85). All variables significant at the 0.25 level in univariate analyses were included in a hierarchical backward selection procedure in which interactions were selected before their corresponding main effects. Variables significant at the 0.05 level were retained in the final model. Age group was forced into the model regardless of significance level. Separate models were built for mild, moderate/strenuous, and total physical activity. Due to the high percentage of participants (46%) with missing data on one or more study variables, the multiple regression models were fit using 50 imputed data sets created using a fully conditional specification procedure [54]. At each step of backward selection, coefficient values were averaged across imputed data sets and hypothesis tests were performed on these averages to determine which variables to remove from the model [55]. All analyses were performed using SAS Version 9.4 (SAS Inc., Cary, NC).

3. Results

3.1. Sample characteristics

Among the 3710 participants, the average age at the LILAC year-1 follow-up was 78.8 ± 5.9 (range 66–97) years. The majority were white non-Hispanic, married, and college educated. Nearly 80% of the women had in situ/localized breast cancer and 45% had their cancer diagnosis more than ten years prior. More than half of the participants were overweight or obese. Forty-four percent of the participants reported their health to be “excellent” or “very good.” The average physical function score was 69.2 ± 25.8 out of 100. Participants who were older, had less education, were widowed, lived alone, had both public and private insurance, did not receive radiation, had higher BMIs, higher symptom burden, lower self-rated health, lower physical functioning, higher pain and greater depressive symptoms, and lower social support were more likely to report lower levels of any physical activity (all $p < 0.05$) (Table 1).

3.2. Bivariate associations of physical activity duration

Table 2 shows the duration of mild and moderate/strenuous physical activity by participants' demographic, clinical, and psychosocial factors, respectively. Overall, women who were younger, had higher education, were married, had higher reported social support, received radiation, were underweight/normal weight, had lower symptom burden, no lymphedema, higher self-rated health, higher quality of life, higher physical functioning, no pain, and no depressive symptoms had significantly higher duration of physical activity (all $p < 0.05$).

3.3. Multivariate associations of physical activity engagement

Table 3 shows the multiple regression results for engaging in any mild physical activity, moderate/strenuous physical activity, and any physical activity based on 50 imputed data sets. All factors listed were significantly associated with physical activity engagement at the $p < 0.05$ level. Results indicated that women who had higher education, self-rated health, physical functioning, and social support were more likely to engage in mild physical activity, moderate/strenuous physical activity, and any physical activity. Older age (≥75 years) and being over-weight/obese were associated with being less likely to engage in mild physical activity, moderate/strenuous physical activity, and any physical activity. Race, marital status, living situation, cancer stage, time since diagnosis, chemotherapy, radiation, symptom burden, lymphedema, quality of life, pain, and depressive symptoms were not associated with physical activity engagement.

3.4. Multivariate associations of physical activity duration

Table 4 shows the multiple regression results for the duration of mild physical activity, moderate/strenuous physical activity, and total physical activity. All factors listed were significant at the $p < 0.05$ level. Women who were underweight/normal weight, had higher education, higher physical functioning, and higher social support had longer duration of mild, moderate/strenuous, and any physical activity. Women with higher self-rated health had longer duration of moderate/strenuous physical activity and total minutes of physical activity. Age, race, marital status, living situation, cancer stage, time since diagnosis, chemotherapy, symptom burden, lymphedema, quality of life, and depressive symptoms were not associated with physical activity duration.

There were also two significant interactions in our models. Among women aged <75, radiation therapy was associated with more minutes of total physical activity per week, but was not associated with duration among older women. The association between pain and duration of moderate/strenuous activity also differed with age: among women aged <75, those with moderate pain averaged fewer minutes of moderate/strenuous physical activity per week than those with no pain. However, among women aged ≥85, those with moderate pain averaged more minutes of moderate/strenuous physical activity per week than those with no pain.

4. Discussion

This study examined the demographic, lifestyle, physical, psychosocial, and clinical factors related to frequency and duration of physical activity among a sample of US older breast

cancer survivors. This study also examined age-specific correlates (65–74 years vs. 75–84 years vs. ≥85 years) of physical activity. Results indicated that physical activity among older breast cancer survivors was low, corresponding with the existing literature [13,17,39]. Krok-Schoen et al. [56] recently reported 75%, 54%, and 68% of older female cancer survivors reported no strenuous, moderate, and mild physical activity, respectively. Thus, it is important to understand the correlates of physical activity to improve engagement among this population.

The results indicated that higher self-rated health and higher physical functioning were associated with higher levels of physical activity. Given the cross-sectional nature of the study, the directionality of the associations of self-rated health and higher physical functioning with increased physical activity cannot be determined. These two significant factors may facilitate physical activity or be a positive outcome of physical activity. Social support was also found to be associated with physical activity among older breast cancer survivors, which is consistent with prior research [20,57-59]. Breast cancer survivors view adequate social support as a facilitator of physical activity maintenance and inadequate support as a barrier to physical activity engagement [60]. Whitehead and Lavelle [59] found that older breast cancer survivors reported that physical activity offered a chance to socialize with others and meet new people. Future physical activity promotion interventions for older breast cancer survivors should consider the importance of social support to foster encouragement and maintenance of physical activity.

Women with higher education were more likely to engage in any physical activity, corresponding with the literature [56,61,62]. Lee et al. [62] found that higher educational attainment was associated with higher engagement in light, moderate, and vigorous physical activity among older cancer survivors. Health professionals should prioritize assessment of health literacy among older breast cancer survivors, thereby facilitating the development of health-promoting behaviors in this population [63].

Results indicated that the association between radiation therapy and physical activity differed with age. Among women 66–74 years of age, those who received radiation therapy were more physically active. In contrast, radiation therapy was not associated with physical activity frequency or duration among women ≥75 years of age. Few studies have explored radiation therapy as an independent correlate (i.e., not combined with other therapies) of physical activity among breast cancer survivors. Vagenes and colleagues [64] found that receipt of radiation therapy was associated with higher body weight among posttreatment breast cancer survivors. Contrasting with the current study, Coletta et al. [13] found that breast cancer survivors who did not undergo radiation therapy were more likely to meet aerobic activity guidelines. Both studies included younger (<65 years) breast cancer survivors and neither explored potential age differences in this association. Radiation therapy alone or concurrently with chemotherapy can predispose a survivor to cardiovascular issues, including decreased cardiorespiratory fitness, myocardial fibrosis, and heart failure [65]. Understanding this population's motivation for physical activity (e.g., cardiovascular health vs. weight management) as well as exploring the variance of cancer treatment received, physical activity habits pre-diagnosis, and receipt of physical activity promotion

from healthcare providers would help illuminate the reasons behind the age differences in the association between radiation therapy and physical activity.

The present study also found age differences in the association between pain and physical activity. Again, this finding may be the result of being a cross-sectional study, where causation cannot be determined. A potential explanation is that higher durations of physical activity may cause more pain among women aged ≥85 compared to younger women. Previous studies [66,67] have found chronic pain was more common among women and among adults ≥80 years. Additional information is needed to investigate these age differences including sources of pain (e.g., cancer treatments vs. comorbidities) and impact of pain on physical activity through validated measures such as the Brief Pain Inventory [68]. Romero et al. [69] found that 75% of cancer survivors with pain did not meet physical activity guidelines; therefore, it is crucial to thoroughly measure and manage pain in older breast cancer survivors to facilitate their physical activity.

Physical activity interventions tailored to the older breast cancer survivor are needed to improve important health outcomes including muscular strength, balance, and physical functioning. This current study adds to this effort by examining the multiple factors that may impact frequency and duration of physical activity. Demographic factors, such as older age, are non-modifiable factors and highlight the subpopulations that are more likely to be physically inactive and thus may have a greater need for personalized interventions. To date, previous studies predominately focused on younger breast cancer survivors, and consequently, physical activity interventions in older breast cancer survivors remain understudied [70]. Based on this study's results, future physical activity interventions for this population should be focus on age-related (e.g., comorbidities, frailty) and treatment-related (e.g., receipt of radiation) factors in order to be effective.

Several study limitations must be noted. First, physical and psychological symptoms were self-reported and may be subject to recall and survivor biases. Additional potential correlates of physical activity that were not examined by this study include specific comorbidities, rural-urban residence, and use of hormonal therapy. Second, the majority of the participants were white, non-Hispanic, and educated, therefore lacking in adequate diversity by race, ethnicity, and education. Although the LILAC study has multiple data collection points, physical activity level was only reported on the year-1 follow-up survey. Thus, this study was unable to establish the temporality between physical activity and many of its correlates. Future studies with repeated measures would provide a more comprehensive understanding of how changes in physical activity, including aerobic and strength training, are associated with demographic, lifestyle, physical, psychosocial, and clinical factors.

5. Conclusion

This study sought to examine the multifaceted correlates of physical activity following cancer treatment of older breast cancer survivors from the WHI LILAC study. Results indicated multiple health and social factors associated with the frequency and duration of physical activity among older breast cancer survivors. Future research should consider analysis of specific population subgroups, for example, women with higher symptom

burden, and should consider specific aspects of physical activity recommendations such as resistance training and flexibility exercises. The results from this study can inform the design of interventions to promote healthy aging and survivorship among older breast cancer survivors.

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Table 1

Frequency of participants who engage in mild, moderate/strenuous, and any physical activity by demographic, clinical, and psychosocial factors (N = 3710).

Variable	Level	Mild Activity			Moderate/Strenuous Activity			Any Activity		
		None n (%)	Any n (%)	p	None n (%)	Any n (%)	p	None n (%)	Any n (%)	p
Age Group	<75	595 (61.5)	373 (38.5)	<0.001	413 (42.1)	568 (57.9)	<0.001	300 (31.2)	662 (68.8)	<0.001
	75–84	1368 (69.9)	589 (30.1)		1024 (51.6)	959 (48.4)		792 (41.3)	1126 (58.7)	
	85+	493 (72.9)	183 (27.1)		425 (62.9)	251 (37.1)		340 (52.2)	311 (47.8)	
Race	Asian/Pacific Islander	51 (68.9)	23 (31.1)	0.316	38 (50.7)	37 (49.3)	0.709	35 (47.3)	39 (52.7)	0.722
	Black	115 (74.7)	39 (25.3)		79 (48.5)	84 (51.5)		64 (41.8)	89 (58.2)	
	Hispanic/Latina	47 (73.4)	17 (26.6)		35 (54.7)	29 (45.3)		28 (45.2)	34 (54.8)	
	White	2214 (67.8)	1050 (32.2)		1684 (51.1)	1610 (48.9)		1288 (40.3)	1910 (59.7)	
	Other	25 (64.1)	14 (35.9)		23 (60.5)	15 (39.5)		15 (39.5)	23 (60.5)	
Education	Less than HS	44 (84.6)	8 (15.4)	<0.001	43 (75.4)	14 (24.6)	<0.001	35 (67.3)	17 (32.7)	<0.001
	HS Diploma/GED	359 (77.7)	103 (22.3)		301 (65.6)	158 (34.4)		262 (58.2)	188 (41.8)	
	College/Vocational School	1160 (68.9)	524 (31.1)		899 (52.9)	800 (47.1)		692 (41.9)	958 (58.1)	
	Grad/Prof School	877 (63.5)	505 (36.5)		610 (43.4)	794 (56.6)		435 (32.0)	923 (68.0)	
Marital Status	Married/living as married	1110 (66.8)	551 (33.2)	0.051	789 (46.8)	897 (53.2)	<0.001	605 (37.0)	1032 (63.0)	<0.001
	Widowed	815 (70.5)	341 (29.5)		670 (57.1)	504 (42.9)		511 (45.1)	622 (54.9)	
	Divorced/separated	302 (65.8)	157 (34.2)		227 (49.2)	234 (50.8)		180 (39.9)	271 (60.1)	
	Never married	124 (73.4)	45 (26.6)		89 (53.0)	79 (47.0)		69 (42.1)	95 (57.9)	
Lives Alone	No	1360 (68.0)	640 (32.0)	0.953	975 (48.1)	1052 (51.9)	<0.001	747 (37.9)	1222 (62.1)	0.004
	Yes	905 (68.1)	424 (31.9)		739 (54.9)	608 (45.1)		562 (43.1)	743 (56.9)	
Insurance	None	13 (50.0)	13 (50.0)	0.199	16 (61.5)	10 (38.5)	0.041	8 (30.8)	18 (69.2)	0.020
	Public	786 (67.2)	384 (32.8)		572 (48.3)	613 (51.7)		429 (37.2)	723 (62.8)	
	Private	205 (68.1)	96 (31.9)		152 (50.2)	151 (49.8)		122 (40.9)	176 (59.1)	
	Public + Private	1056 (69.4)	465 (30.6)		819 (53.4)	715 (46.6)		640 (42.9)	851 (57.1)	
Cancer Stage	In Situ/Localized	1920 (67.9)	906 (32.1)	0.716	1453 (50.9)	1400 (49.1)	0.647	1115 (40.2)	1658 (59.8)	0.638
	Regional	515 (69.2)	229 (30.8)		387 (51.2)	369 (48.8)		301 (41.4)	426 (58.6)	
	Distant	10 (62.5)	6 (37.5)		10 (62.5)	6 (37.5)		8 (50.0)	8 (50.0)	
Time Since Diagnosis	<5 years	632 (66.3)	321 (33.7)	0.338	493 (51.6)	463 (48.4)	0.602	375 (40.1)	560 (59.9)	0.770

Variable	Level	Mild Activity			Moderate/Strenuous Activity			Any Activity		
		None n (%)	Any n (%)	p	None n (%)	Any n (%)	p	None n (%)	Any n (%)	p
	5–10 years	693 (68.5)	318 (31.5)		538 (52.2)	493 (47.8)		413 (41.5)	582 (58.5)	
	>10 years	1131 (69.1)	506 (30.9)		831 (50.3)	822 (49.7)		644 (40.2)	957 (59.8)	
Chemotherapy	No/Don't know	1755 (68.4)	812 (31.6)	0.795	1331 (51.5)	1255 (48.5)	0.556	1027 (40.9)	1487 (59.1)	0.596
	Yes	688 (67.9)	325 (32.1)		521 (50.4)	513 (49.6)		398 (39.9)	600 (60.1)	
Radiation Therapy	No/Don't know	758 (70.6)	316 (29.4)	0.050	581 (53.9)	496 (46.1)	0.035	456 (43.3)	596 (56.7)	0.034
	Yes	1683 (67.3)	818 (32.7)		1271 (50.1)	1265 (49.9)		969 (39.5)	1485 (60.5)	
# Treatment-related Symptoms[a]	Mean ± SD	1.0 ± 1.7	1.0 ± 1.6	0.622	1.1 ± 1.7	1.0 ± 1.7	0.121	1.1 ± 1.8	1.0 ± 1.6	0.080
BMI Group	Underweight/Normal	928 (62.9)	547 (37.1)	<0.001	644 (43.3)	845 (56.7)	<0.001	467 (32.5)	971 (67.5)	<0.001
	Overweight	788 (69.1)	353 (30.9)		620 (52.9)	551 (47.1)		472 (41.9)	655 (58.1)	
	Obese	598 (76.5)	184 (23.5)		487 (62.0)	298 (38.0)		404 (52.1)	372 (47.9)	
Symptom Checklist Score[b]	Mean ± SD	11.9 ± 7.4	10.9 ± 6.6	<0.001	12.4 ± 7.6	10.6 ± 7.6	<0.001	12.7 ± 7.7	10.8 ± 6.5	<0.001
Lymphedema	Absent	2066 (67.8)	981 (32.2)	0.960	1540 (49.9)	1544 (50.1)	0.113	1176 (39.3)	1818 (60.7)	0.516
	Present	161 (67.6)	77 (32.4)		131 (55.3)	106 (44.7)		97 (41.5)	137 (58.5)	
Self-rated Health[c]	Mean ± SD	78.9 ± 19.4	84.0 ± 13.5	<0.001	77.2 ± 20.3	84.0 ± 20.3	<0.001	76.1 ± 21.2	83.5 ± 14.4	<0.001
Quality of Life Score[d]	Mean ± SD	7.8 ± 1.6	8.2 ± 1.4	<0.001	7.6 ± 1.6	8.2 ± 1.6	<0.001	7.5 ± 1.7	8.2 ± 1.4	<0.001
Physical Function Score[e]	Mean ± SD	65.8 ± 27.0	76.0 ± 21.8	<0.001	62.3 ± 26.8	76.5 ± 26.8	<0.001	60.1 ± 27.5	75.2 ± 22.6	<0.001
Aches/Pain Past Four Weeks	None	491 (63.7)	280 (36.3)	<0.001	366 (47.3)	407 (52.7)	<0.001	275 (36.6)	476 (63.4)	<0.001
	Mild	1248 (68.2)	582 (31.8)		889 (48.2)	955 (51.8)		686 (38.0)	1121 (62.0)	
	Moderate	565 (70.0)	242 (30.0)		472 (58.6)	333 (41.4)		372 (47.0)	419 (53.0)	
	Severe	120 (81.6)	27 (18.4)		95 (64.2)	53 (35.8)		82 (57.7)	60 (42.3)	
Depression Past Four Weeks	None	1559 (67.8)	740 (32.2)	0.496	1138 (49.1)	1181 (50.9)	<0.001	866 (38.2)	1400 (61.8)	<0.001
	Mild	666 (68.1)	312 (31.9)		520 (53.4)	454 (46.6)		417 (43.8)	534 (56.2)	
	Moderate	157 (71.0)	64 (29.0)		134 (60.6)	87 (39.4)		104 (47.7)	114 (52.3)	
	Severe	21 (77.8)	6 (22.2)		20 (74.1)	7 (25.9)		17 (63.0)	10 (37.0)	
How often do you have someone with whom you can have a good time?	None of the time	54 (81.8)	12 (18.2)	<0.001	50 (76.9)	15 (23.1)	<0.001	42 (65.6)	22 (34.4)	<0.001
	A little of the time	239 (79.7)	61 (20.3)		184 (60.7)	119 (39.3)		156 (53.6)	135 (46.4)	
	Some of the time	751 (71.5)	300 (28.5)		583 (55.3)	472 (44.7)		464 (44.9)	569 (55.1)	
	Most of the time	1003 (63.9)	567 (36.1)		751 (47.1)	845 (52.9)		541 (35.1)	1001 (64.9)	
	All of the time	345 (66.5)	174 (33.5)		244 (46.5)	281 (53.5)		190 (37.1)	322 (62.9)	

Other races include American Indian or Native Alaskan (N = 8); p-values reflect differences in the demographic, clinical, and psychosocial factors between the “none” and “any” groups of mild, moderate/strenuous, and any activity. BMI=Body Mass Index; HS = High School; GED = General Educational Development; SD=Standard Deviation.

[a] N = 2366 No, 1102 Any Mild Activity; N = 1789 No, 1722 Any Moderate/Strenuous Activity; N = 1375 No Activity, 2032 Any Activity.

[b] N = 2045 No, 953 Any Mild Activity, N = 1527 No, 1489 Any Moderate/Strenuous Activity; N = 1181 No Activity, 1777 Any Activity.

[c] N = 2303 No, 1088 Any Mild Activity, N = 1744 No, 1684 Any Moderate/Strenuous Activity; N = 1339 No Activity, 1989 Any Activity.

[d] N = 2336 No, 1109 Any Mild Activity, N = 1765 No, 1716 Any Moderate/Strenuous Activity; N = 1350 No Activity, 2029 Any Activity.

[e] N = 2117 No, 1022 Any Mild Activity, N = 1601 No, 1574 Any Moderate/Strenuous Activity; N = 1217 No Activity, 1869 Any Activity.

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Table 2

Duration of physical activity (minutes/week) by demographic, clinical, and psychosocial factors (*N* = 3707).

Variable	Level	Mild Activity				Moderate/Strenuous Activity				Total Activity			
		N	Mean	SD	p	N	Mean	SD	p	N	Mean	SD	p
Age Group	<75	955	31.6	57.1	0.001	978	64.6	79.4	<0.001	948	95.6	105.7	<0.001
	75–84	1930	25.3	53.5		1966	50.5	71.9		1875	74.8	99.7	
	85+	670	21.5	49.5		673	36.5	62.2		642	56.7	89.1	
Race	Asian/Pacific Islander	74	32.5	68.2	0.077	75	62.0	83.6	0.626	74	93.3	138.3	0.486
	Black	154	17.4	46.3		162	49.7	70.9		152	64.7	99.3	
	Hispanic/Latino	63	19.3	45.4		64	60.0	86.7		61	80.2	98.9	
	White	3220	26.6	53.9		3272	51.5	72.6		3135	77.3	99.3	
	Other	38	34.9	62.2		38	42.3	67.1		37	79.3	110.6	
Education	Less than HS	52	11.4	30.1	<0.001	57	25.1	62.3	<0.001	52	39.0	75.8	<0.001
	HS Diploma/GED	455	17.5	44.8		458	34.9	65.9		442	52.2	94.3	
	College/Vocational	1664	26.3	54.2		1683	48.4	70.9		1616	73.7	99.7	
	Grad/Prof School	1363	30.0	56.8		1398	62.0	76.3		1334	91.0	102.0	
Marital Status	Married/Cohabiting	1638	27.7	54.3	0.171	1676	56.9	74.4	0.001	1605	84.0	100.7	0.002
	Widowed	1142	24.7	52.6		1167	45.5	70.5		1112	69.8	99.7	
	Divorced/separated	455	27.5	55.6		457	54.3	76.5		443	81.5	107.4	
	Never married	169	19.7	51.1		167	52.9	73.2		163	70.0	91.1	
Lives Alone	No	1973	26.8	54.2	0.929	2016	54.9	73.8	0.007	1931	81.1	100.8	0.054
	Yes	1315	26.6	55.4		1337	48.0	71.8		1281	74.0	102.1	
Insurance	None	25	26.8	34.3	0.860	26	33.8	55.0	0.011	25	61.9	66.9	0.112
	Public	1157	25.1	50.4		1175	56.5	74.5		1130	81.1	97.9	
	Private	299	28.3	60.4		302	53.9	74.2		295	82.1	108.8	
	Public+Private	1505	25.6	53.0		1526	48.3	71.4		1467	73.2	97.9	
Cancer Stage	In Situ/Localized	2789	26.3	53.6	0.708	2835	51.9	72.8	0.991	2721	77.5	100.2	0.788
	Regional	736	26.1	54.2		752	51.6	74.0		715	76.3	101.1	
	Distant	16	45.2	93.0		16	50.8	71.2		16	96.0	122.0	
Time Since Diagnosis	<5 years	943	27.7	54.2	0.623	950	49.9	71.1	0.639	920	76.8	100.6	0.892
	5–10 years	1002	25.5	52.1		1025	51.8	73.5		980	76.2	97.2	

Variable	Level	Mild Activity				Moderate/Strenuous Activity				Total Activity			
		N	Mean	SD	p	N	Mean	SD	p	N	Mean	SD	p
	>10 years	1610	25.9	54.8		1642	52.7	73.6		1565	78.0	102.2	
Chemotherapy	No/Don't know	2532	25.4	52.2	0.191	2570	51.3	72.5	0.546	2464	75.7	98.6	0.200
	Yes	1002	28.2	57.3		1027	52.9	73.9		982	80.7	104.8	
Radiation Therapy	No/Don't know	1062	24.4	52.9	0.212	1068	47.5	71.5	0.028	1031	71.3	97.1	0.028
	Yes	2467	26.8	53.9		2522	53.3	73.4		2409	79.3	101.3	
Treatment-Related Symptoms	0	1812	26.1	54.7	0.969	1838	54.2	75.6	0.228	1768	79.6	103.2	0.629
	1	628	27.3	52.2		644	54.4	71.1		617	80.7	96.0	
	2–3	543	26.2	51.6		555	51.8	72.6		529	77.4	97.6	
	>3	308	26.2	57.2		312	45.6	69.9		302	72.0	104.5	
BMI Group	Underweight/Normal	1453	32.9	60.9	<0.001	1478	63.2	78.9	<0.001	1405	96.3	110.5	<0.001
	Overweight	1128	24.4	50.9		1164	50.8	71.9		1108	74.3	98.3	
	Obese	776	17.2	41.6		781	34.0	58.8		766	50.6	76.8	
Symptom Checklist Score	<6	576	32.5	63.7	0.002	591	63.6	81.5	<0.001	568	95.2	116.4	<0.001
	6–10	946	27.8	52.3		954	55.9	72.7		928	83.1	96.8	
	11–20	1109	24.1	51.3		1117	50.0	71.7		1087	73.1	96.2	
	>20	334	19.7	44.9		335	32.2	57.5		325	50.7	79.6	
Lymphedema	No	3012	26.9	54.9	0.358	3063	53.5	73.8	0.021	2940	79.5	101.9	0.046
	Yes	234	24.0	46.5		237	43.0	66.7		230	67.1	89.4	
Self-rated Health	Excellent	329	39.0	70.8	<0.001	338	92.3	91.9	<0.001	324	130.8	126.5	<0.001
	Very good	1356	32.6	59.3		1382	59.2	74.0		1323	90.6	103.2	
	Good	1334	21.3	45.9		1355	43.4	67.7		1301	64.3	91.4	
	Fair	312	12.6	38.6		310	20.0	44.1		301	31.3	60.9	
	Poor	21	4.2	19.3		21	16.9	35.9		21	21.1	38.9	
Quality of Life Score	1–4	99	12.8	43.0	<0.001	99	22.9	52.4	<0.001	97	35.6	77.5	<0.001
	5–7	887	18.3	43.4		903	35.1	62.9		861	52.3	83.8	
	8–10	2417	30.4	57.8		2456	60.2	76.4		2359	89.9	105.5	
Physical Functioning Score	0–25	273	9.0	31.4	<0.001	270	18.6	42.4	<0.001	264	27.1	55.1	<0.001
	30–50	549	17.8	43.9		554	30.9	58.4		532	47.9	80.1	
	55–75	775	23.3	47.2		791	41.7	61.9		758	64.4	82.2	
	80–100	1502	36.1	62.9		1540	73.3	82.6		1474	109.2	114.0	

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Variable	Level	Mild Activity				Moderate/Strenuous Activity				Total Activity			
		N	Mean	SD	p	N	Mean	SD	p	N	Mean	SD	p
Aches/Pain Past Four Weeks	None	756	33.1	62.2	<0.001	771	62.4	81.3	<0.001	734	93.7	113.1	<0.001
	Mild	1812	26.0	52.4		1831	54.1	73.3		1777	79.8	99.1	
	Moderate	797	22.2	47.8		800	39.5	62.1		778	60.1	87.2	
	Severe	145	17.5	48.3		146	34.0	65.6		138	52.3	89.8	
Depression Past Four Weeks	None	2273	27.5	55.1	0.004	2304	55.4	74.9	<0.001	2227	82.0	102.7	<0.001
	Mild	967	26.0	53.3		968	47.3	71.0		934	71.5	97.9	
	Moderate	218	18.3	41.4		220	34.0	55.5		215	53.0	79.2	
	Severe	26	11.7	32.1		27	26.7	60.7		26	39.4	78.4	
How often do you have someone with whom you can have a good time?	None of the time	66	9.9	28.7	<0.001	65	21.0	52.7	<0.001	64	30.8	59.5	<0.001
	A little of the time	300	15.3	39.8		301	33.5	59.3		289	47.5	76.1	
	Some of the time	1037	22.1	48.5		1051	44.2	67.1		1016	64.7	91.3	
	Most of the time	1550	30.3	57.3		1586	58.4	75.6		1513	88.0	104.5	
	All of the time	510	31.8	60.9		520	62.3	81.5		499	93.9	112.4	

BMI=Body Mass Index; HS = High School; GED = General Educational Development; SD=Standard Deviation.

Table 3

Multiple regression models for engaging in mild physical activity, moderate/strenuous physical activity, and any physical activity.

Predictor	Level	Mild Physical Activity		Moderate/Strenuous Physical Activity		Any Physical Activity	
		RR	95% CI	RR	95% CI	RR	95% CI
Age Group	<75	Referent					
	75–84	0.87	0.78–0.96	0.93	0.87–1.00	0.94	0.89–0.99
	≥85	0.91	0.77–1.06	0.83	0.74–0.93	0.87	0.80–0.96
Education	High School or Less	Referent					
	College/Vocational School	1.32	1.11–1.57	1.30	1.14–1.47	1.33	1.20–1.48
	Graduate/Professional School	1.44	1.21–1.72	1.46	1.29–1.66	1.47	1.32–1.63
BMI Group	Underweight/Normal	Referent					
	Overweight	0.89	0.80–1.00	0.89	0.83–0.96	0.93	0.87–0.98
	Obese	0.77	0.66–0.89	0.81	0.73–0.90	0.84	0.77–0.91
Self-rated Health	10-point increase	1.05	1.01–1.10	1.05	1.02–1.09	1.04	1.02–1.07
Physical Functioning Score	5-point increase	1.04	1.02–1.05	1.04	1.03–1.05	1.03	1.02–1.04
How often do you have someone with whom you can have a good time?	None of the time	Referent					
	A little of the time	1.02	0.58–1.77	1.45	0.93–2.27	1.22	0.87–1.72
	Some of the time	1.35	0.80–2.28	1.56	1.01–2.41	1.38	0.99–1.91
	Most of the time	1.58	0.94–2.65	1.70	1.10–2.62	1.50	1.08–2.08
	All of the time	1.42	0.84–2.41	1.65	1.06–2.54	1.41	1.01–1.96

Predictors selected are all significant at $p < 0.05$ level. No mild, moderate/strenuous, or no physical activity were the reference groups.
Results were averaged across 50 imputed data sets.

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Table 4

Multiple regression models for duration of mild physical activity, moderate/strenuous physical activity, and any physical activity.

Predictor[2]	Level	Minutes of Mild Physical Activity		Minutes of Moderate/Strenuous Physical Activity		Total Minutes of Physical Activity	
		Coefficient[1]	95% CI	Coefficient[1]	95% CI	Coefficient[1]	95% CI
Education	High School or Less	Referent					
	College/Vocational School	6.8	2.4–11.2	9.0	2.6–15.4	14.6	5.5–23.6
	Graduate/Professional School	8.3	3.5–13.1	18.1	11.4–24.9	24.7	15.3–34.2
BMI Group	Underweight/Normal	Referent					
	Overweight	−6.2	−10.4, −2.0	−7.6	−13.1, −2.1	−14.7	−22.5, −7.0
	Obese	−9.0	−13.5, −4.5	−15.5	−21.5, −9.6	−25.8	−33.9, −17.7
Self-rated Health	10-point increase	–	–	1.9	0.7–3.1	2.6	1.1–4.2
Physical Function Score	5-point increase	1.5	1.1–1.8	2.7	2.2–3.3	4.1	3.3–4.8
Aches/Pain Past Four Weeks[2]	<75: None	–	–	Referent		–	–
	<75: Mild			−3.6	−16.5-9.4		
	<75: Moderate			−14.4	−28.6, −0.1		
	<75: Severe			−4.4	−32.7-23.9		
	75–84: None	–	–	Referent		–	–
	75–84: Mild			−4.7	−13.7-4.3		
	75–84: Moderate			−8.6	−18.3-1.1		
	75–84: Severe			5.6	−11.3-22.4		
	≥85: None	–	–	Referent		–	–
	≥85: Mild			6.6	−4.9-18.2		
	≥85: Moderate			16.6	2.9–30.3		
	≥85: Severe			7.1	−9.9-24.2		
Radiation Therapy[3]	<75 years old	–	–	–	–	19.7	6.1–33.3
	75–84 years old					−3.2	−12.9, −6.4
	≥85 years					0.1	−13.3-13.4
How often do you have someone with whom you can have a good time?	None of the time	Referent					
	A little of the time	3.4	−5.2-12.0	5.6	−10.1–21.3	8.3	−10.7-27.4

Predictor[2]	Level	Minutes of Mild Physical Activity		Minutes of Moderate/Strenuous Physical Activity		Total Minutes of Physical Activity	
		Coefficient[1]	95% CI	Coefficient[1]	95% CI	Coefficient[1]	95% CI
	Some of the time	8.4	0.5–16.3	12.7	−2.0-27.4	19.7	1.9–37.5
	Most of the time	14.3	6.4–22.2	21.1	6.5–35.6	35.0	17.2–52.8
	All of the time	14.7	5.8–23.6	21.5	6.0–37.0	36.9	17.6–56.2

[1]Difference in average minutes per week from reference

[2, 3]Significant interaction with age ($p = 0.03$; $p = 0.02$, respectively). Predictors selected are all significant at $p < 0.05$ level. Results were averaged across 50 imputed data sets.