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Postdiagnosis Physical Activity:

Association with long-term fatigue and sleep disturbance in older adult breast cancer survivors

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Abstract

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BACKGROUND: Physical activity is frequently proposed as an intervention to reduce fatigue and sleep disturbance in cancer survivors; however, the long-term effects of physical activity are often not reported, and older adults are typically excluded from these intervention studies.

OBJECTIVES: This article aimed to examine if postdiagnosis physical activity is associated with lower long-term fatigue and sleep disturbance in older adult breast cancer survivors.

METHODS: Data were analyzed of a prospective cohort of 440 breast cancer survivors aged 65 years or older from the Women's Health Initiative study. Multiple linear and logistic regression models were used to examine associations of physical activity with fatigue and sleep disturbance.

FINDINGS: Higher postdiagnosis physical activity was associated with lower long-term fatigue but was not associated with lower sleep disturbance after adjusting for demographics, cancer characteristics, and baseline measures.

Keywords

physical activity; cancer survivor; fatigue; sleep disturbance; breast neoplasm; exercise

ALTHOUGH CANCER SURVIVAL RATES ARE IMPROVING, cancer treatments are not without substantial symptom burden. Fatigue and sleep disturbance are two commonly reported long-term symptoms, persisting in about 33% of adult cancer survivors as many as 10 years after treatment has ended (Jones et al., 2016; Slade et al., 2019). Fatigue is thought to be closely associated with sleep disturbance, and these symptoms tend to occur together in symptom clusters (Fox et al., 2020; Lee et al., 2020). Long-term fatigue and sleep disturbance, often defined as lasting longer than six months after treatment, are associated with reduced quality of life in breast cancer survivors (Jones et al., 2016; Oh & Cho, 2020). Most literature on these symptoms has focused on middle-aged adults, despite older adults making up the largest proportion of cancer survivors (Bluethmann et al., 2016). Consequently, relatively little is known about long-term fatigue and sleep disturbance or strategies for managing these symptoms in older adult cancer survivors.

Prior research, including large meta-analyses, has demonstrated that physical activity interventions are associated with reduced fatigue levels in the short term and are often proposed as interventions to reduce long-term fatigue and symptom burden in cancer survivors (Brown et al., 2012; Speck et al., 2010; Tomlinson et al., 2014). Limited research has also shown that physical activity interventions may benefit perceived sleep disturbance in cancer survivors; however, the results of randomized controlled trials on sleep disturbance have been mixed (Medysky et al., 2017; Rogers et al., 2017; Zhu et al., 2016).

Evidence exists to support the benefits of physical activity to reduce fatigue and sleep disturbance during and shortly after treatment. However, few studies have evaluated the effects of physical activity on long-term fatigue or sleep disturbance in cancer survivors. In studies that have examined these symptoms, there is strong support showing that elevated physical activity levels prior to and after a cancer diagnosis are associated with reduced long-term fatigue in adult cancer survivors as many as five years after diagnosis (Matias et al., 2019; Nilsson et al., 2020; Penttinen et al., 2019; Witlox et al., 2018).

There has been a paucity of research focused on older adult survivors (Penttinen et al., 2019; Witlox et al., 2018). Although evidence exists to show that physical activity interventions improve symptoms during and shortly after the end of the intervention, the lasting effects of physical activity on fatigue and sleep disturbance are still unknown, particularly in the older adult population (Segal et al., 2017). This is important because older adults present with unique challenges, such as the presence of comorbidities, age-related deficits in physical function, changes in body composition, and decreased bone density (Waldman & Morrison, 2014). Additional research examining the impact of physical activity on long-term fatigue and sleep disturbance in older adults could provide support for a more rigorous intervention among older adult cancer survivors. Consequently, the aims of this study were to examine the associations of postdiagnosis physical activity and long-term fatigue and sleep disturbance in older adult breast cancer survivors and to explore if physical function, presence of comorbidities, or treatment type modified the relationship between physical activity and long-term fatigue and sleep disturbance.

Women’s Health Initiative Study

The Women’s Health Initiative (WHI) is a longitudinal, prospective cohort study focused on preventing the development of disease outcomes and ascertaining data to investigate relationships among lifestyle, health, and risk factors in postmenopausal women. A total of 161,808 women were enrolled in either the clinical trial (CT) or observational study (OS) at 40 clinical centers in the United States from 1993 to 1998. The OS followed 93,676 women aged 50–79 years, with data collection of the OS ending in 2005. Women were eligible for the OS if they were postmenopausal, unlikely to relocate or die within three years, and not enrolled in a WHI CT. At the end of the OS, women were asked to participate in follow-up extension studies for an additional five years in 2005 and again in 2010. Of the 63,229 women who enrolled in the first WHI extension study, 52,051 participated in the second WHI extension study. Details on study design, recruitment, data collection measures and methods, and baseline characteristics have been published (Anderson et al., 2003; Langer et al., 2003; WHI Study Group, 1998). All women provided informed consent prior to data collection.

The Life and Longevity After Cancer (LILAC) study is a cancer survivorship subcohort study within the WHI. A primary goal of LILAC was to collect information on cancer treatment and outcomes in women diagnosed with cancer. Women with no prior cancer diagnosis at WHI enrollment were eligible for LILAC if they had a confirmed cancer diagnosis during WHI follow-up in the CT or OS. Recruitment for LILAC began in 2013, and 4,211 women with breast cancer were enrolled. LILAC-specific data were collected retrospectively (Paskett et al., 2018).

Methods

This was a prospective, secondary analysis using data from participants in the WHI LILAC study who were in the OS and actively participating in the second extension study between 2011 and 2012. To be included in this analysis, women had to be diagnosed with breast cancer, be aged 65 years or older at cancer diagnosis, be diagnosed with breast cancer prior to the collection of physical activity measures, and have completed the necessary questionnaires for fatigue and sleep disturbance. Only participants in the OS were eligible because of the availability of the necessary questionnaires. Because a cancer diagnosis could have occurred at any time before the collection of physical activity measures, this time frame in relation to cancer diagnosis varied.

Measures

Physical activity was self-reported and measured as total metabolic equivalent (MET) minutes per week calculated from self-report questionnaires (McTiernan et al., 2003). Women were asked to complete the WHI Physical Activity Questionnaire based on their usual activity as part of the OS in the eighth year of follow-up (between 2002 and 2006) (Meyer et al., 2009). Women were asked to self-report the frequency, duration, and speed of walking, as well as the frequency and duration of physical activities classified as mild, moderate, or strenuous. METs, an estimate of metabolic cost, were assigned to different intensities of physical activity based on the Compendium of Physical Activities (Ainsworth et al., 2000).

MET minutes per week were calculated by multiplying the METs per type of exercise by the total number of minutes of physical activity per week for each classification of physical activity. Total MET minutes per week were the sum of MET minutes per week for each classification of physical activity. Physical activity was measured continuously and in categories based on current physical activity recommendations. The American Cancer Society's physical activity recommendation for cancer survivors is at least 150 minutes of moderate-intensity activity or at least 75 minutes of vigorous-intensity aerobic activity each week, equating to 500–1,000 MET minutes per week (Rock et al., 2012). Categories for this analysis were defined as less than 500 MET minutes per week (below recommendation), 500–1,000 MET minutes per week (meets recommendation), and greater than 1,000 MET minutes per week (exceeds recommendation).

The physical activity questionnaire used has demonstrated strong test-retest reliability in a diverse sample of postmenopausal women in the WHI, with intraclass correlation coefficients of 0.77 (0.73–0.8) for moderate to strenuous physical activity and 0.76 (0.71–0.79) for total recreational physical activity (Meyer et al., 2009).

Primary Outcomes

FATIGUE: Fatigue was measured in the WHI between 2011 and 2012 using the SF-36® vitality subscale. Participants were asked during the last four weeks how often they (a) felt full of pep, (b) had a lot of energy, (c) felt worn out, and (d) felt tired. Each question was scored from 1 (experiencing the feeling all the time) to 6 (experiencing the feeling none of the time). The numeric values were recoded so that the final index score ranges from 0 to 100, with 100 indicating a more favorable health state. Fatigue was analyzed continuously and as a binary variable using a cutoff of 50, with scores less than 50 indicating fatigue and scores of 50 or greater indicating nonfatigue, which has been validated in previous studies (Alfano et al., 2012; Bower et al., 2002, 2005; Collado-Hidalgo et al., 2008).

Although the SF-36 was created as a general measure of fatigue, it has been used as a measure of fatigue in many contexts and among several populations, including cancer survivors (Brown et al., 2011; Ware, 2000). In addition, the SF-36 has been widely used as the standard comparison for measures designed to evaluate fatigue among individuals with cancer, such as the Fatigue Symptoms Inventory, the Multidimensional Fatigue Symptom Inventory, and the Piper Fatigue Score. Convergent validity of the SF-36 with these measures shows strong correlations (Meeske et al., 2007). Although the SF-36 is unidimensional, internal consistency of the SF-36 is strong, with alpha coefficients ranging from 0.89 to 0.91 in populations of individuals with cancer (Brown et al., 2011; Stein et al., 2004).

SLEEP DISTURBANCE: Sleep disturbance was measured in the WHI between 2011 and 2012 using the WHI Insomnia Rating Scale (IRS), which consists of five questions. These questions assessed frequency of insomnia symptoms during the past four weeks, including sleep latency, sleep maintenance, early morning awakening, and average sleep quality. Total IRS scores range from 0 to 20, with a score of 9 used as the threshold for sleep disturbance and higher scores indicating greater sleep disturbance (Levine et al., 2003). The IRS shows acceptable internal consistency in a large sample of WHI participants, with an alpha coefficient of 0.79 (95% confidence interval [CI] [0.7, 0.85]).

Baseline Measures

Demographic information on education, income, and ethnicity was collected from WHI baseline questionnaires. Additional information on potential confounders, such as baseline fatigue, sleep disturbance, depression, pain, physical function, and alcohol use, was collected from self-report questionnaires. Fatigue, depression, pain, and physical function were measured using the SF-36 energy/fatigue, emotional well-being, pain, and physical functioning subscales, respectively. Baseline sleep disturbance was measured using the WHI IRS.

Comorbidities were assessed using a modified Charlson Comorbidity Index (CCI) score as characterized previously in the WHI (Gold et al., 2006). The CCI was originally developed as a measure to predict mortality among patients with multiple comorbidities. Scores were calculated based on the presence of specific comorbid conditions, such as cardiovascular diseases, cerebrovascular disease, chronic obstructive pulmonary disease, diabetes, liver disease, and kidney disease, using WHI baseline data and self-reported medical history. For diseases that were evaluated at multiple time points, data from the most recent medical history questionnaire prior to the collection of the physical activity measurement were used. Modifications from the original CCI were necessary because certain disease categories were not evaluated in the WHI medical history questionnaires (Gold et al., 2006). Possible scores range from 0 to 15, with higher scores indicating greater morbidity. A diagnosed cancer is scored as 2 points; as a result, all participants had a minimum score of 2 because an inclusion criterion was a breast cancer diagnosis.

Cancer-Related Variables

Cancer characteristics, such as age at diagnosis and stage at diagnosis, were collected from medical records and adjudicated outcomes. Treatment data were collected as part of LILAC either as self-report from the baseline LILAC questionnaire or abstracted from medical records. Treatment was classified in this analysis as neither radiation therapy nor chemotherapy, radiation therapy only, chemotherapy only, or both. The main analysis was conducted in the total eligible group (N = 440), and a secondary analysis was conducted in the subset with treatment data available (n = 245).

Statistical Analysis

Descriptive statistics were summarized as proportions for the baseline and cancer characteristic variables. Rates of fatigue and sleep disturbance in this sample were reported based on clinically relevant cut points. A score of 50 was used as the cut point for fatigue and a score of 9 was used as the cut point for sleep disturbance, based on previous research (Alfano et al., 2012; Bower et al., 2002, 2005; Collado-Hidalgo et al., 2008; Levine et al., 2003). Bivariate statistics using chi-square tests compared individuals with clinically significant fatigue to those without clinically significant fatigue based on proportions of baseline characteristics. This was repeated for clinically significant sleep disturbance.

To determine if postdiagnosis physical activity was associated with fatigue and sleep disturbance, multiple linear and logistic regression models were used. All regression models were adjusted for education, household income, ethnicity, age at diagnosis, stage at diagnosis, baseline CCI score, physical function, pain, and depression. Models analyzing fatigue as an outcome included baseline fatigue, whereas models analyzing sleep disturbance as an outcome included baseline sleep disturbance. These variables were chosen based on evidence of confounding presented in the literature and whether they were associated with both the exposure and outcome in this analysis (Bower, 2014).

Linear regression models were used to test the association between physical activity and fatigue and sleep disturbance scores, modeled continuously with beta coefficients (b) and 95% CIs. Logistic regression was used to determine the association of physical activity with fatigue and sleep outcomes based on clinically relevant cut points by producing an odds ratio (OR) and 95% CI. Participants with an SF-36 vitality subscale score of less than 50 were considered to be fatigued, and those with an IRS score of 9 or greater were considered to have sleep disturbance. Logistic regression was included because cut points are often useful for clinical practice.

Physical activity was modeled as a continuous variable (MET minutes per week) and in categories based on physical activity recommendations. The group not meeting the physical activity recommendation was the reference group for the linear and logistic regression models. The likelihood ratio test was used to determine the overall association of physical activity categories and fatigue and sleep outcomes. The Wald test was used to determine the relationship between physical activity (continuous variable and categorical variable) and fatigue and sleep outcomes. The trend test was used to determine if the risk of fatigue and sleep disturbance was reduced with increasing levels of physical activity in logistic regression models.

In addition, an interaction term was included to test for the presence of effect modification by physical function and comorbidities in the linear and logistic regression models previously described. A subgroup analysis was used to test whether treatment type modified the effect of physical activity on fatigue and sleep within a subcohort of 245 women with treatment data available. All analyses were conducted using RStudio, version 3.6.1. An alpha level of 0.05 was used to determine statistical significance.

Results

Baseline Characteristics

A total of 440 women were eligible for this analysis. The sample (see Table 1) was composed of primarily White participants (94%). Mean age at cancer diagnosis was 71.1 years (SD = 4.81); most women were aged 65–75 years (82%), and 18% were aged older than 75 years.

On average, physical activity exposures were assessed three and a half years after breast cancer diagnosis; fatigue and sleep disturbance outcomes were assessed eight years after physical activity. Clinically significant fatigue (29%) and sleep disturbance (39%) were common. A large proportion (44%) of women did not meet the physical activity recommendation of 500–1,000 MET minutes per week.

Those with clinically significant fatigue (SF-36 vitality subscale score of greater than 50) were more likely to be older ($p < 0.001$) and to report worse physical function scores ($p < 0.001$), pain ($p < 0.001$), fatigue ($p < 0.001$), and sleep disturbance ($p < 0.001$), as well as greater depression ($p < 0.001$), at baseline (see Table 2). Those with sleep disturbance were more likely to report greater depression ($p = 0.006$), pain ($p = 0.003$), and sleep disturbance ($p < 0.001$) at baseline. Among the nonfatigued participants (N = 311), the mean number of years between diagnosis and physical activity was 3.42 (SD = 2.18), compared to 3.81 years (SD = 2.12) among fatigued participants (N = 129) ($p = 0.083$). For nonfatigued participants, the mean number of years from physical activity to fatigue was 8.11 (SD = 0.7), compared to 7.97 years (SD = 0.74) for fatigued participants ($p = 0.054$).

Associations of Postdiagnosis Physical Activity With Fatigue and Sleep

Using multiple linear regression, mean fatigue scores were significantly higher (indicating less fatigue) in older adult breast cancer survivors who exercised more ($p < 0.001$) (see Table 3). For each additional 60 MET minutes of physical activity per week, the mean fatigue score was higher by 0.22 points (95% CI [0.08, 0.36]). When physical activity was modeled using recommendation categories, there was an overall significant association between physical activity categories and mean fatigue scores ($p < 0.001$). The mean fatigue score in breast cancer survivors who met the physical activity recommendation was 6.02 points higher than in the reference group (95% CI [1.91, 10.12]), and the mean fatigue score in those who exceeded the physical activity recommendation was 7.31 points higher than in the reference group (95% CI [3.05, 11.58]).

Results from multivariable logistic regression are shown in Table 4. Using logistic regression, the odds associated with fatigue were estimated to be 4% lower (OR = 0.96, 95% CI [0.94, 0.99]) for each additional 60 MET minutes per week of physical activity. A significant association between physical activity recommendation categories and long-term fatigue was observed ($p = 0.002$). The odds of being fatigued among those who exceeded the recommended MET hours per week were 72% lower compared to those who did not meet the recommended MET minutes per week (OR = 0.28, 95% CI [0.13, 0.59]). There was no evidence that meeting the recommendation was associated with lower odds of being fatigued (OR = 0.6, 95% CI [0.32, 1.1]). Findings from the trend test revealed that the odds of long-term fatigue were lower with higher levels of physical activity after adjustment ($p < 0.001$).

There was no evidence of an association between physical activity and sleep disturbance using linear regression or logistic regression, although effect estimates were in the expected direction of greater physical activity being associated with lower sleep disturbance.

There was no statistical evidence that the association between physical activity and fatigue was modified by physical function or modified CCI score. In addition, similar baseline characteristics and regression results were found between women with treatment data available and those without treatment data available, showing no effect modification by cancer treatment on the association between physical activity and sleep.

Discussion

This study examined whether postdiagnosis physical activity influenced long-term fatigue and sleep disturbance in older adult breast cancer survivors. Findings demonstrated that physical activity after cancer diagnosis was strongly associated with lower fatigue in the long term; however, a significant association was not observed between postdiagnosis physical activity and sleep disturbance. Findings were not modified by factors such as physical function, comorbidities, or treatment type.

In this sample, a significant dose-response relationship was noted between MET minutes per week and lower fatigue in older adult breast cancer survivors when physical activity was modeled continuously and categorically. However, this association was only statistically significant among women who exceeded the recommended physical activity guidelines, not among those who met the recommended physical activity guidelines. Recommendations for older adult cancer survivors are similar to those for the general older adult population: at least 150 minutes of moderate-intensity activity or at least 75 minutes of vigorous-intensity aerobic activity each week, equating to 500–1,000 MET minutes per week (Rock et al., 2012; Runowicz et al., 2016). Given this, many studies developing physical activity interventions in older adults aim to achieve 500–1,000 MET minutes of aerobic activity per week (Kessels et al., 2018). Based on results of the current study, aerobic recommendations for older adult cancer survivors may need to be increased to greater than 1,000 MET minutes per week to have a greater clinical impact on fatigue; however, interventions have not been designed or tested with this level of aerobic activity to determine if greater physical activity leads to greater improvement in fatigue.

Despite the complex underlying biological mechanisms of fatigue, there is strong evidence that fatigue is associated with inflammatory processes and cardiorespiratory fitness (O'Higgins et al., 2018). Physical activity is proposed to reduce fatigue by altering inflammatory processes and reducing circulating inflammatory markers (Mills, 2017). There is evidence that aerobic physical activity reduces the proinflammatory biomarkers C-reactive protein, interleukin-6, and tumor necrosis factor alpha in older adults (Kohut et al., 2006; Nilsson et al., 2020). In addition, there is limited evidence that high-intensity physical activity is associated with improved cardiorespiratory fitness, measured by peak VO_2 max (Kampshoff et al., 2015). Taken together, a dose-response relationship may emerge between physical activity and fatigue through the improvement of inflammatory functions and cardiorespiratory fitness. Future interventions should test this dose-response relationship between physical activity and long-term fatigue to determine the optimal amount of physical activity to produce the greatest reduction in long-term fatigue.

The current authors hypothesized that postdiagnosis physical activity would be associated with reduced sleep disturbance; however, the results of the study did not find a significant association between postdiagnosis physical activity and sleep disturbance, although this association was trending toward significance. Although there is support in the literature for an association between physical activity and reduced sleep disturbance (Fiorentino & Ancoli-Israel, 2007; Rogers et al., 2017; Roveda et al., 2017), the current study did not detect such an association.

A large meta-analysis examining the effect of physical activity on sleep disturbance in patients with cancer found moderate effects of physical activity on improving sleep disturbance (Tomlinson et al., 2014). However, this analysis did not focus solely on older adults and included participants within the entire cancer spectrum, including those in active treatment and after treatment. Sleep disturbance and physical activity rates are often different in those currently undergoing cancer treatment versus long-term survivors, which could explain the differences in study findings. Another potential explanation for this lack of association could be the length of time between the physical activity questionnaire and the IRS, with an average of eight years in between. A physical activity intervention study targeted toward breast cancer survivors by Rogers et al. (2017) found that self-reported sleep improved immediately after a three-month intervention but that the results were not sustained three months postintervention. In addition, it may be that the IRS may not be adequate to describe sleep disturbance in cancer survivors because it has not been validated for this population. However, research shows that insomnia is common in cancer survivors, with variables such as delayed sleep onset, sleep maintenance, and sleep quality often affected; these were captured by the tool used in this study (Ferioli et al., 2018).

The current authors did not find evidence that treatment type or presence of comorbidities were effect modifiers on the relationship between physical activity and fatigue; however, this may have been affected by the timing of data collection. Measuring physical function and comorbidities at the time of diagnosis may yield different results.

Limitations

There is evidence to suggest that pretreatment fatigue is a predictor of post-treatment fatigue in cancer survivors (Bower, 2014). Given the constraints of the data set and the timing of variable collection, the current authors were likely unable to adequately assess the effects of pretreatment fatigue in the study's models. As such, there may be residual confounding for which the authors cannot control.

In addition, although baseline fatigue was included in the regression models, the average time from baseline measures to cancer diagnosis in this sample was 4.4 years; consequently, it is possible that fatigue scores could have changed during that time (Bower, 2014). Based on previous studies (Lucas et al., 2017; Romero et al., 2018), fatigue prior to and during treatment is highly correlated with the degree of postdiagnosis physical activity because individuals with higher rates of fatigue are less likely to have the energy to engage in physical activity. As such, the relationships presented must be interpreted with caution, and reverse causality is a limitation acknowledged by the current authors. However, in data from the current study, the percentage of women who reported 500–1,000 or more MET minutes per week was 56%, which is higher than in other studies and is significant considering that the current sample is aged 65 years or older. Given that the rates of physical activity in this sample are higher than the rates typically reported in cancer survivors, a cautious assumption can be made that the rates of fatigue in this population prior and during treatment were low.

Physical activity recommendations for older adults include balance training and muscle-strengthening activities in addition to aerobic activity. Although the physical activity measure used in this study asked detailed questions regarding a variety of physical activities, it primarily assesses aerobic activity. It is difficult to objectively determine the degree of balance and muscle-strengthening activities in this study. However, research strongly supports resistance training, in addition to aerobic physical activity, to improve fatigue in cancer survivors. Additional studies are needed to examine the most effective combination of physical activity to improve fatigue in older adults.

All variables were measured in this study using self-report questionnaire data, which could result in measurement error. However, the scales have been well validated and widely used with adequate psychometric properties.

The timing of variables may pose a limitation, given the constraints of the data set and the lack of repeated measures for physical activity and fatigue. Although the length of time between diagnosis and fatigue and sleep disturbance measurements was, on average, 11.5 years, there were no significant differences in time from diagnosis to physical activity assessment or in time from physical activity to outcome measurements among fatigued and nonfatigued women. In addition, a significant effect was still observed among variables, even though the duration between measurement collection was long. The authors were able to capture physical activity at only one time point. Studies are needed to examine changes in physical activity over time in relation to fatigue and sleep disturbance in older adult cancer survivors.

Implications for Nursing

The results of this study support the benefits of physical activity in older adult cancer survivors. Although physical activity is beneficial for most older adults, many cancer survivors experience long-term symptoms that may be mitigated by physical activity, particularly fatigue. Nurses play an important role in monitoring symptoms, and it is important for nurses to assess for fatigue and sleep disturbance incidence and severity in cancer survivors even after treatment has ended because long-term symptoms can occur as many as 10 or more years later. Nurses should educate patients on the importance of exercise for reducing symptoms and encourage older adult cancer survivors to engage in increased physical activity, as tolerated, in coordination with their oncologists. In addition to providing patient education, nurses should also assess the safety of physical activity for older adults by considering factors such as polypharmacy, comorbidities, physical function, and cognitive function.

Conclusion

The findings of this study support the need for healthcare providers, including nurses, to promote physical activity in older adult cancer survivors to improve fatigue. Older adults who engage in levels of physical activity greater than the recommended 500–1,000 MET minutes per week may have the largest benefit in relation to fatigue. Long-term outcomes, such as fatigue and sleep disturbance, should be measured in future trials to determine the effects of physical activity on these outcomes. In addition, longitudinal observational and randomized controlled trials that focus on older adults are needed to determine the most effective type and duration of physical activity, as well as safety considerations to improve deleterious symptoms in older adult cancer survivors. Additional research is needed in this population to determine if physical activity is an efficacious intervention to improve fatigue and sleep disturbance through further examination of the biological mechanisms of symptom clusters and the impact that physical activity may have on these mechanisms or symptom clusters.

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IMPLICATIONS FOR PRACTICE

- Encourage physical activity for older adult breast cancer survivors to reduce fatigue and sleep disturbance.
- Include older adults in physical activity interventions.
- Measure long-term symptom outcomes in physical activity intervention trials.

TABLE 1.

SAMPLE CHARACTERISTICS AT BASELINE (N = 440)

CHARACTERISTIC	n	%
Age at diagnosis (years)		
65–74	361	82
75–85	76	17
Older than 85	3	1
Alcohol consumption		
Fewer than 7 drinks per week	264	60
7 or more drinks per week	61	14
Past drinker	63	14
Nondrinker	30	7
Missing data	22	5
Depression[a]		
0–25	1	< 1
26–50	18	4
51–75	80	18
76–100	336	76
Missing data	5	1
Education level		
High school or less/GED	75	17
More than high school, less than bachelor’s degree	142	32
Bachelor’s degree	50	11
More than bachelor’s degree	173	39
Ethnicity		
White	415	94
African American	12	3
Hispanic/Latino	4	1
Other	9	2
Fatigue[a]		
0–25	8	2
26–50	68	15
51–75	208	47
75–100	154	35
Missing data	2	< 1
Income ($)		
0–34,999	143	33
35,000–74,999	207	47
75,000 or more	81	18

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CHARACTERISTIC	**n**	**%**
Do not know	9	2
Modified CCI score		
2	332	75
3	89	20
4 or greater	19	4
Pain[a]		
0–25	13	3
26–50	44	10
51–75	134	30
76–100	245	56
Missing data	4	1
Physical activity		
Less than 500 MET minutes per week	163	37
500–1,000 MET minutes per week	91	21
More than 1,000 MET minutes per week	149	34
Missing data	37	8
Physical function[a]		
0–25	7	2
26–50	11	3
51–75	70	16
76–100	345	78
Missing data	7	2
Sleep disturbance[b]		
0–5	189	43
6–10	152	35
11–15	59	13
16–20	12	3
Missing data	28	6
Stage at diagnosis		
Local	350	80
Regional	80	18
Distant	2	< 1
Missing data	8	2

[a]Measured using the SF-36®; possible scores range from 0 to 100, with higher scores indicating a more favorable health state. For fatigue, scores less than 50 indicate fatigue, whereas scores of 50 or greater indicate nonfatigue.

[b]Measured using the Women's Health Initiative Insomnia Rating Scale; total possible scores range from 0 to 20, with 9 used as the threshold for sleep disturbance and higher scores indicating greater sleep disturbance.

CCI—Charlson Comorbidity Index; MET—metabolic equivalent

Note. Possible CCI scores range from 0 to 15, with higher scores indicating greater morbidity. A diagnosed cancer is scored as 2 points; as a result, all participants in the current study had a minimum score of 2 because an inclusion criterion was a breast cancer diagnosis.

Note. Because of rounding, percentages may not total 100.

TABLE 2.

COMPARISON OF NONFATIGUED AND FATIGUED BREAST CANCER SURVIVORS

	NONFATIGUED (N = 311)		FATIGUED (N = 129)		
CHARACTERISTIC	**n**	**%**	**n**	**%**	**p**
Age at diagnosis (years)					< 0.001
65–74	269	86	92	71	
75–85	39	13	37	29	
Older than 85	3	1	–	–	
BL fatigue[a]					< 0.001
0–25	2	1	6	5	
26–50	28	9	40	31	
51–75	143	46	65	50	
75–100	137	44	17	13	
Missing data	1	< 1	1	1	
BL physical activity					0.682
Less than 500 MET minutes per week	100	32	53	41	
500–1,000 MET minutes per week	66	21	25	19	
More than 1,000 MET minutes per week	105	34	44	34	
Missing data	40	13	7	5	
BL sleep dist[b]					< 0.001
0–5	123	40	26	20	
6–10	110	35	51	40	
11–15	52	17	36	28	
16–20	12	4	15	12	
Missing data	14	5	1	1	
Depression[a]					0.001
0–25	–	–	1	1	
26–50	7	2	11	9	
51–75	50	16	30	23	
76–100	249	80	87	67	
Missing data	5	2	–	–	
Education level					0.226
High school or less/GED	46	15	29	22	
More than high school, less than bachelor’s degree	100	32	42	33	
Bachelor’s degree	37	12	13	10	
More than bachelor’s degree	128	41	45	35	
Ethnicity					0.47
White	290	93	125	97	
African American	10	3	2	2	

CHARACTERISTIC	NONFATIGUED (N = 311) n	NONFATIGUED (N = 311) %	FATIGUED (N = 129) n	FATIGUED (N = 129) %	p
Hispanic/Latino	3	1	1	1	
Other	8	3	1	1	
Income ($)					0.137
0–34,999	95	31	48	37	
35,000–74,999	144	46	63	49	
More than 75,000	64	21	17	13	
Do not know	8	3	1	1	
Modified CCI score					0.426
2	238	77	94	73	
3	62	20	27	21	
4 or greater	11	4	8	6	
Pain[a]					0.001
0–25	5	2	8	6	
26–50	27	9	17	13	
51–75	87	28	47	36	
76–100	190	61	55	43	
Missing data	2	1	2	2	
Physical function[a]					< 0.001
0–25	1	< 1	6	5	
26–50	7	2	4	3	
51–75	41	13	29	22	
76–100	258	83	87	67	
Missing data	4	1	3	2	
Stage at diagnosis					0.074
Local	245	79	105	81	
Regional	59	19	21	16	
Distant	–	–	2	2	
Missing data	7	2	1	1	

[a]Measured using the SF-36®; possible scores range from 0 to 100, with higher scores indicating a more favorable health state. For fatigue, scores less than 50 indicate fatigue, whereas scores of 50 or greater indicate nonfatigue.

[b]Measured using the Women's Health Initiative Insomnia Rating Scale; total possible scores range from 0 to 20, with 9 used as the threshold for sleep disturbance and higher scores indicating greater sleep disturbance.

BL—baseline; CCI—Charlson Comorbidity Index; MET—metabolic equivalent; sleep dist—sleep disturbance

Note. Possible CCI scores range from 0 to 15, with higher scores indicating greater morbidity. A diagnosed cancer is scored as 2 points; as a result, all participants in the current study had a minimum score of 2 because an inclusion criterion was a breast cancer diagnosis.

Note. Because of rounding, percentages may not total 100.

TABLE 3.

ASSOCIATIONS OF PHYSICAL ACTIVITY EXPOSURE WITH CONTINUOUS FATIGUE AND SLEEP DISTURBANCE OUTCOMES IN SAMPLE (N = 440)

VARIABLE	β	95% CI	p
Fatigue[a]			
60 MET minutes per week	0.22	[0.15, 0.3]	0.002
Not meeting rec[b]	–	–	–
Meeting rec	6.02	[0.58, 7.98]	0.0004
Exceeding rec	7.31	[3.29, 10.77]	< 0.001
Sleep disturbance[c]			
60 MET minutes per week	−0.003	–	0.85
Not meeting rec[b]	–	–	–
Meeting rec	−0.04	–	0.945
Exceeding rec	0.22	–	0.69

[a] Likelihood ratio test $p < 0.001$; trend test $p < 0.001$; adjusted for education, household income, ethnicity, baseline fatigue, physical function, age at diagnosis, stage at diagnosis, modified Charlson Comorbidity Index score, pain, and depression

[b] Reference

[c] Likelihood ratio test $p = 0.895$; trend test $p = 0.714$; adjusted for education, household income, ethnicity, baseline sleep disturbance, physical function, age at diagnosis, stage at diagnosis, modified Charlson Comorbidity Index score, pain, and depression

CI—confidence interval; MET—metabolic equivalent; rec—recommendation

Note. Not meeting rec is categorized as less than 500 MET minutes per week, meeting rec is 500–1,000 MET minutes per week, and exceeding rec is greater than 1,000 MET minutes per week.

TABLE 4.

ASSOCIATIONS OF PHYSICAL ACTIVITY EXPOSURE WITH CLINICALLY RELEVANT FATIGUE AND SLEEP DISTURBANCE OUTCOMES IN SAMPLE (N = 440)

VARIABLE	OR	95% CI	p
Fatigue[a]			
60 MET minutes per week	0.96	[0.94, 0.99]	0.009
Not meeting rec[b]	1	–	–
Meeting rec	0.6	[0.32, 1.1]	0.1
Exceeding rec	0.28	[0.13, 0.59]	< 0.001
Sleep disturbance[c]			
60 MET minutes per week	1	[0.99, 1.03]	0.498
Not meeting rec[b]	1	–	–
Meeting rec	1.09	[0.61, 1.95]	0.766
Exceeding rec	1.28	[0.71, 2.31]	0.406

[a]Likelihood ratio test p = 0.002; trend test p < 0.001; adjusted for education, household income, ethnicity, baseline fatigue, physical function, age at diagnosis, stage at diagnosis, modified Charlson Comorbidity Index score, pain, and depression

[b]Reference

[c]Likelihood ratio test p = 0.708; trend test p = 0.4121; adjusted for education, household income, ethnicity, baseline sleep disturbance, physical function, age at diagnosis, stage at diagnosis, modified Charlson Comorbidity Index score, pain, and depression

CI—confidence interval; MET—metabolic equivalent; OR—odds ratio; rec—recommendation

Note. Not meeting rec is categorized as less than 500 MET minutes per week, meeting rec is 500–1,000 MET minutes per week, and exceeding rec is greater than 1,000 MET minutes per week.