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Effects of reallocating sedentary time with physical activity on quality of life indicators in breast cancer survivors

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Abstract

Objectives: Physical activity is associated with better quality of life (QOL) among breast cancer survivors. However, it is unknown the extent to which time spent sedentary or replacing this time with active behaviors may affect QOL. Our aim was to determine the effect of substituting time between sedentary and active behaviors on QOL indicators in breast cancer survivors.

Methods: An isotemporal substitution approach was used to examine the associations of reallocating time to sedentary and active behaviors measured by accelerometry with Functional Assessment of Cancer Treatment-Breast (FACT-B; total, physical, social, emotional, functional well-being, and breast cancer specific concerns) and the Hospital Anxiety and Depression Scale (HADS) scores in a pooled analysis of breast cancer survivors (n= 753; M_{age}=56.9±9.5 yrs) from two observational studies.

Results: Reallocating 30 minutes of sedentary time to 30 minutes of MVPA was associated with **improved** FACT-B total (B=3.0, 95% CI: 0.6, 4.5), physical well-being (B=0.8, 95% CI: 0.33, 1.2), and functional well-being (B=0.6, 95% CI: 0.03, 1.2) scores. Reallocating 30 minutes of light activity to 30 minutes of MVPA was associated with **improved** FACT-B total (B=2.4, 95% CI: 0.3, 6.0) and physical well-being (B=0.72, 95% CI: 0.27, 1.2) scores. There were no significant substitution of time effects on HADS scores.

Conclusions: Substituting sedentary time with MVPA showed the greatest range of effects across QOL indicators. These results can inform intervention development interventions and more comprehensive activity recommendations for breast cancer survivors.

Keywords

breast cancer survivors; cancer; oncology; physical activity; sedentary behavior

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CONFLICT OF INTEREST STATEMENTS

All authors report no conflicts of interest.

BACKGROUND

Breast cancer survivors experience a range of physical, social, psychological, and functional side effects of cancer and its treatment, which greatly impact quality of life (QOL).[1–3] Increasing light (LPA) or moderate-to-vigorous intensity physical activity (MVPA) can alleviate these negative side effects.[4,5] Conversely, high levels of sedentary behavior are associated with deleterious effects on survivors' QOL, even when controlling for time spent in LPA or MVPA.[6]

Accelerometer-measured prevalence data indicate breast cancer survivors spend about 9.3 hours per day, or over half (66.4%) of their waking day, in sedentary pursuits, which is an hour greater than in the general US population.[7] Only 11% of cancer survivors meet the PA guidelines for adults (150 min per week of MVPA) and, in particular, breast cancer survivors accumulate 95 minutes per week of MVPA.[8] These data indicate physical activity promotion and sedentary behavior reduction interventions need to be developed for breast cancer survivors to positively change these behaviors. In doing so, it is important to consider all activity intensities, as the accumulation of LPA and MVPA have both shown independent health enhancing effects.[9] Therefore, developing a better understanding of the relationship of all activity intensities (i.e. sedentary, LPA, MVPA) to QOL and other health outcomes in breast cancer survivors is an important next step for understanding the health benefits of different doses (i.e. intensity and duration) of activity and refining activity prescriptions for this population.

While previous research has illustrated increased MVPA is associated with more favorable scores on measures of QOL and QOL indicators (i.e. fatigue, depression, anxiety) and improved overall health outcomes,[4] the interdependence among all physical activity intensities (sedentary behavior, LPA, MVPA) due to a fixed number of hours in a day has been largely ignored. For example, spending time in one of these behaviors results in less time in another behavior. Therefore, results from these studies may misrepresent the true relationship between variables.

Isotemporal substitution approaches allow us to statistically model how QOL indicators would be altered by reallocating time spent in one behavior with time spent in LPA or MVPA, independently, while keeping total time and time in other activities constant.[10] Two previous studies have used this approach to examine physical activity and sedentary behavior in relation to QOL in other cancer survivor groups.[11,12] Findings indicate substitution of sitting behaviors with more active behaviors (standing, LPA, etc.) was significantly associated with improved QOL[12] and reduced fatigue[11] in colorectal and non-hodgkins lymphoma cancer survivors, respectively. While isotemporal substitution has been used in breast cancer survivors to illustrate the benefit of replacing time spent sedentary with time spent in MVPA on body mass index, waist circumference [13], and cognitive impairment, [14] to our knowledge, no study has used isotemporal substitution to examine QOL in breast cancer survivors; the largest group of cancer survivors in the US.[15] The purpose of this study was to determine the effect of substituting time between sedentary and active behaviors on QOL indicators in breast cancer survivors. Findings from this study will provide us with information on how QOL indicators may change in response to increasing light intensity

physical activity or MVPA or reducing sedentary time and have the potential to inform future understandings of how these different behaviors influence QOL indicators and can be targeted in interventions to improve QOL among breast cancer survivors.

METHODS

Participants

We conducted a pooled analysis of 753 breast cancer survivors from two observational studies, study 1: n=440 and study 2: n=313, for a total sample size of **753** in the present analysis. Full details on study 1 [16] and study 2 [17] can be found in previously published manuscripts of the studies main aims. For the current analysis, participants from both studies were included if they had accelerometer data with at least 4 valid days, defined as at least 10 hours of accelerometer wear time for each day, and complete data on demographic and QOL outcome assessment [18]. All participants consented to the study procedures approved by the University of Illinois at Urbana-Champaign Institutional Review Board (Study 1: reference number 10085; Study 2: reference number 15666).

Breast cancer survivors from both studies were recruited nationally through the Army of Women. Study 2 also recruited through BreastCancerTrials.org, social media, emailed flyers, and word of mouth. For Study 1, women were eligible if they were at least 18 years of age, had a prior diagnosis of breast cancer, were English speaking, and had access to the internet. For Study 2, women were eligible if they were at least 21 years of age, had a prior diagnosis of breast cancer, and had access to an iPad with iOS 6.0 or later in order to answer questionnaires.

Procedures

In both studies, participants were mailed an accelerometer, activity log and self-addressed stamped envelope to return materials to study investigators. In Study 1, participants were emailed a secure link to complete an online battery of questionnaires. Participants in Study 2 were instructed to download a free iPad application (app; Digital Artefacts, Iowa City, IA), designed for the study, which included a series of questionnaires to complete.

Measures

Demographics and Health History. Participants completed a demographic questionnaire self-reporting age, education, height, and weight. Participants also self-reported their health history, including breast cancer disease stage, time since diagnosis, treatment received, and recurrence. In addition, they were asked about history of other chronic disease.

Accelerometer. Participants wore the Actigraph Accelerometer (GT1M and GT3X in Study 1 and GT3X in Study 2; Actigraph Corp., Fort Walton Beach, FL) for seven consecutive days. In Study 1, the monitor was worn during all waking hours, except when bathing or swimming, on the non-dominant hip. In Study 2, the monitor was worn at all times, except when bathing or swimming, on participants' non-dominant hip during waking hours and on the non-dominant wrist during sleep. The current analysis only includes the hip-worn, waking time data from Study 2. Accelerometer data were analyzed in 60-second epochs. A

valid day of accelerometer wear time was defined as ≥600 minutes with no more than 60 minutes of consecutive zero-values, with allowance of ≤2 minutes of observations <100 counts.[18] Data were then categorized into intensity categories using the following cutpoints: <100 counts per minute (cpm) sedentary, 100–1951 cpm LPA, and ≥1952 cpm MVPA [19].

Functional Assessment of Cancer Treatment-Breast (FACT-B). The 27-item FACT-B assesses health-related quality of life including, physical, social, emotional and functional well-being, and additional concerns specific to breast cancer survivors. Participants were asked to indicate how true each of the items had been for them over the last 7 days on a five-point Likert scale ranging from **0** (not at all true) to 4 (very much true). Total FACT-B score was calculated as the sum of all subscales. Higher scores on the FACT-B and subscales indicate better QOL. The FACT-B has been shown to have high reliability (r=0.85) and construct validity (r=0.86–0.87).[20] Internal consistency for the FACT-B was α=0.79 in study 1 and α=0.80 in study 2.

Hospital Anxiety and Depression Scale. The Hospital Anxiety and Depression Scale (HADS) is a 14-question survey, intended to detect anxiety and depression [21]. The scale assesses the frequency of depressive states (7 items) and anxiety (7 items) over the past week from 0 (not at all) to 3 (most of the time). Positively worded items were reverse scored. Individual items were summed to obtain total subscale scores from 0 to 21. Higher scores indicate greater symptomology on this measure. HADS has been shown to provide a reliable indication of anxiety and depression in medical patient populations [21]. Internal consistency for the HADS was α=0.72 in study 1 and α=0.80 in study 2.

Statistical Methods

All statistical analyses were completed in SPSS version 25 (IBM, Chicago, IL). Three models, a single activity model, partition model, and isotemporal substitution model, were run to evaluate the association between time spent in sedentary behavior, LPA, and MVPA and QOL indicators including the FACT-B total score and subscales (i.e. physical, social, emotional, and functional well-being and breast cancer specific concerns), and the HADS anxiety and depression subscales. The single activity model examines the association of each activity intensity separately on the outcomes but does not take into account any of the other activity intensities.[10] The partition model partitions out total physical activity into each intensity category but does not account for total activity time. The output from the partition models represent the adjustment for engagement in other activity intensities. The isotemporal substitution models examine the mean effect of the outcome of reallocating: a) 30 minutes of time spent sedentary to 30 minutes of LPA or MVPA, and b) 30 minutes spent in LPA to 30 minutes of MVPA.[10] In order to prevent confounding of variables with a known relationship between physical activity and QOL, analyses controlled for age, body mass index, education, disease stage, time since diagnosis, treatment, number of comorbidities, activity monitor waking day wear time, and study.

RESULTS

Participants

A total of 753 breast cancer survivors had valid accelerometer, complete questionnaire data, and therefore were included in the current analysis. Participant demographic and disease-specific characteristics are reported in Table 1. Participant's average age was 56.9±9.5 years and they had an average body mass index of 26.4±5.5 kg/m^2. The majority were white (96.7%), and over half had a college/university degree or greater (69.5%). About two-thirds (61.4%) received chemotherapy, 68.1% received radiation therapy, and 40.7% received both chemotherapy and radiation. One-third were diagnosed with Stage 1 breast cancer and approximately one-third were diagnosed with Stage 2 breast cancer. Participants engaged in an estimated average of 583.0±74.4 minutes/day of sedentary time, 266.9±67.9 minutes/day of LPA, 25.2±20.8 minutes/day of MVPA.

FACT-B

In the single activity model, there was a significant positive association between MVPA and FACT-B total score, physical well-being, and functional well-being (see Table 2). In the partition model, there was a significant positive association between MVPA and FACT-B total score and physical well-being (see Table 2).

Results for the isotemporal substitution models are presented in Table 3. In these models, reallocating 30 minutes of sedentary time to 30 minutes of MVPA was associated with higher FACT-B total (B=3.0, 95% CI: 0.6, 4.5), physical well-being (B=0.8, 95% CI: 0.33, 1.2), and functional well-being (B=0.6, 95% CI: 0.03, 1.2) scores. Reallocating 30 minutes of LPA to 30 minutes of MVPA was associated with higher FACT-B total (B=2.4, 95% CI: 0.3, 6.0) and physical well-being (B=0.72, 95% CI: 0.27, 1.2) scores. Although statistically significant, when we examine in context of minimally important differences, 7–8 points in total FACT-B score and 2 points for physical and functional well-being score represent a clinically significant change. Therefore, the change observed in the current study does not exceed these criteria.[22,23]

Anxiety and Depression (Hospital Anxiety and Depression Scale)

Single activity, partition and isotemporal models showed no significant association between any physical activity category for anxiety and depression (see Table 2 and Table 3).

DISCUSSION

In this study we determined the effect of reallocating time between sedentary and active behaviors on QOL indicators in breast cancer survivors using isotemporal substitution. Results indicated reallocating 30 minutes of sedentary behavior to MVPA was associated with higher physical and functional well-being scores and total FACT-B scores. Additionally, reallocating 30 minutes of LPA to MVPA resulted in a significant increase in the physical well-being scores and total FACT-B scores. There were no other significant effects of reallocation of time on the remaining QOL indicators examined.

Only two previously published studies have examined the isotemporal substitution effect of replacing time spent sitting with time spent in active behaviors on QOL indicators in cancer survivors. van Roekel and colleagues found substituting one hour of sedentary time with physical activity (defined as >1.5 METS) resulted in a significant 5.6 point (95% CI: 0.7, 10.6) increase in physical functioning in colorectal cancer survivors using the European Organization for the Research and Treatment of Cancer Quality of Life Questionnaire-Core 30.[12] In contrast, Vallance and colleagues found no significant effect on health-related QOL when substituting 30 minutes of bouted (i.e. occurs for at least 10 minutes at one time) or non-bouted sedentary time with 30 minutes of bouted or non-bouted physical activity, respectively, in non-Hodgkin lymphoma survivors.[11] Our results support those of van Roekel and colleagues suggesting a significant effect of substituting time spent sitting with time spent in MVPA resulting in higher reported physical functioning scores. In addition, we also saw significant positive changes in survivors' functional well-being scores. While these two studies allow comparisons between cancer survivor groups, differences in results may be due to differences in cancer survivor populations and represents the importance of understanding how different activity intensities specifically impact QOL in breast cancer survivors in the present study.

Two other studies have used isotemporal substitution in breast cancer survivors [13,14]. Boyle and colleagues found a significantly lower body mass index and waist circumference when reallocating sleep, sedentary time, or LPA to MVPA [13]. Ehlers et al. examined the effect of reallocation of sedentary time on cognitive function, finding reallocation of time to MVPA was significantly associated with better cognitive performance.[14] Collectively, our results and results from previous research demonstrate there are multiple health-related benefits for breast cancer survivors of replacing sitting time with MVPA and provide evidence for the importance of future research investigating additional objective measures of health outcomes (i.e. physical functioning, fitness, biomarkers) using isotemporal substitution models. This information could, in turn, help optimize interventions and recommendations for specific behaviors and outcomes in breast cancer survivors.

This is the first study to examine the isotemporal effect of reallocating time spent in sedentary time for physical activity on QOL indicators in breast cancer survivors. Our results are in agreement with results from intervention trials examining the association between physical activity and QOL in breast cancer survivors. Courneya and colleagues found FACT-B scores increased 8.8 points (95% CI: 3.6, 14.0) more in the exercise-trained group compared to a control group [24] following a 15-week supervised moderated intensity exercise intervention in breast cancer survivors. Likewise, Turner and colleagues completed a 6-week multi-modal, moderate intensity exercise intervention in breast cancer survivors and found a significant improvement in FACT-B scores.[25] However, there was no change in anxiety or depression following the 6-week training period.[25] Similarly, we saw a significant effect of reallocating sitting time to MVPA on FACT-B score but no effect of reallocation on anxiety or depression. Results from the interventions are much greater in magnitude when compared to our isotemporal substitution modeling, however, our results indicate anxiety and depression was not increased but ratings were maintained with substitution of MVPA for sedentary time. Additionally, comparison shows long term interventions to increase MVPA may elicit a greater increase in QOL when compared to our cross-sectional analysis. This

may be due to the analyses from interventions capturing more structured MVPA as a result of completion of exercise sessions, whereas our analysis included more incidental MVPA, including every minute of MVPA (non-bouted) accumulated throughout the day. However, both studies provide evidence that increasing time spent in MVPA can positively impact FACT-B QOL indicator scores.

Reallocating sedentary time or light intensity to MVPA demonstrated the only effect across the QOL indicators examined, including higher scores for physical well-being, functional well-being, and total FACT-B score. However, it is important to note that none of the reallocation change scores reached clinical significance as indicated by published minimally important differences. [22,23] In order to reach the minimally important difference[23] for FACT-B scores (7-point change) with reallocation, we would have to substitute about 70 minutes of sedentary time for MVPA. The same is true to reach the minimally important difference for the physical and functional well-being subscale scores[22,23]; we would have to substitute about 70 minutes of sedentary time for MVPA. The lack of clinical significance in the current study could be a result of our sample being relatively high functioning and further from diagnosis. Additionally, this sample may have also contributed to the lack of significant association observed for anxiety, depression, social, and emotional well-being. Future work is warranted to determine the dose necessary to elicit not only statistically meaningful, but clinically meaningful changes in QOL indicators, among survivors closer to treatment and those with poorer QOL or compromised functioning. Additionally, our results reveal reallocating 30 minutes of sedentary time to LPA may not confer the necessary stimulus to elicit changes in QOL indicator scores when compared to higher intensities. These differences may be due to the incongruency among energy expended (total kcals) among intensity classes (light, MVPA) with a fixed time period (30 minutes) that is necessary for the isotemporal substitution analysis. However, previous research examining the relationship between sedentary time and LPA and QOL, revealed significant associations with physical well-being score and breast cancer specific concerns, respectively. No other significant relationship were found between sedentary time or LPA and total FACT-B score and its components, anxiety, or depression.[6,26] Future research should either employ a more sensitive measure for QOL or test among a larger sample size in order to determine whether there is a potential impact substituting sedentary behavior with LPA or MVPA may have on QOL in breast cancer survivors.

CONCLUSIONS

Study Limitations

There are several limitations in the present study. First, we did not examine the individual effects of physical activity and sleep since we did not have sleep assessments in both studies. As sleep quality and quantity may have additional effects on QOL, future work should examine the effect reallocation of sleep with physical activity (and vice versa) may have on QOL outcomes in breast cancer survivors. Second, we estimated sedentary time using the Actigraph activity monitor worn at the waist, which may misclassify total sedentary time. Finally, this study was cross-sectional and among a largely white, educated population,

limiting our ability to infer causality and generalizability among substitution of time in physical activities and QOL.

Study Strengths

A major strength of the current study was the utilization of isotemporal substitution modeling which allowed us to understand how reallocating one activity intensity for another (sedentary, light, MVPA) changed outcome measures while accounting for all activity intensities. In addition, we measured physical activity objectively using activity monitors in a national sample of breast cancer survivors who were diverse in terms of times since treatment, treatment received and disease stage. Finally, our study sample was large (N=753) comprising over three times the number of breast cancer survivors when compared to other studies using isotemporal substitution.

Clinical Implications

Reallocating sedentary time with MVPA showed the greatest range of effects across QOL indicators (physical and functional well-being and FACT-B total score) among breast cancer survivors suggesting developing MVPA interventions may be the most beneficial for influencing QOL in breast cancer survivors. Results from this study provide an important first step in understanding the relationship between QOL indicators, sedentary time, LPA, and MVPA. Future work should examine other QOL indicators (i.e. fatigue, pain, physical function) and other outcomes (i.e. fitness, functional performance, biomarkers of disease prognosis) and the effect of sleep quality and quantity in order to better refine activity and sedentary prescriptions and develop more effective interventions for a range of outcomes that may be important to breast cancer survivors.

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Table 1.

Participant Characteristics (mean(Standard Deviation) or percent)

	Total Sample (N=753)	Study 1 (n=440)	Study 2 (n=313)
Age (years)	56.4(9.5)	56.6(9.2)	57.3(9.8)
Body Mass Index (kg/m2)	26.5(5.7)	26.2(5.4)	26.5(5.7)
Education			
High School Graduate	6.6	7.7	3.8
1–3 Years College	23.8	25.5	16.2
College/University Graduate	35.7	37.3	35.0
Masters Degree	26.2	22.0	33.8
PhD or Equivalent	7.6	5.5	10.5
Race			
White	96.7	93.6	94.6
Black	1.2	0.9	0.0
Asian	0.8	0.9	1.0
American Indian	0.5	0.9	0.0
Pacific Islander	0.4	0.9	1.6
Other	0.4	0.0	0.6
Received Chemotherapy	61.4	57.2	71.3
Received Radiation	68.1	68.2	71.7
Time Since Diagnosis (years)	7.0(5.9)	6.8(5.6)	7.7(6.0)
Disease Stage			
Stage 0	17.2	18.9	7.0
Stage 1	33.4	30.0	39.8
Stage 2	32.7	31.6	34.4
Stage 3	11.3	10.0	16.2
Stage 4	2.1	2.5	1.9
Unknown	3.4	5.0	0.0
Average Number of Comorbidities	1.6(1.6)	1.7(1.6)	1.1(1.1)
Physical Activity			
Sedentary Time (min/d)	583.0(74.4)	571.0(73.8)	599.8(71.9)
Light Intensity (min/d)	266.9(67.9)	255.7(64.8)	282.8(69.1)
Moderate-to-Vigorous Intensity (min/d)	25.2(20.8)	21.9(19.1)	29.9(22.3)
Questionnaire Scores			
HADS Anxiety (scale: 0–21)	5.1(3.5)	5.0(3.2)	4.6(3.5)
HADS Depression (scale: 0–21)	4.3(3.8)	4.1(3.6)	4.0(3.8)
FACT-B Physical Well-Being (scale: 0–28)	23.7(4.3)	24.1(4.3)	23.3(4.1)
FACT-B Social Well-Being (scale: 0–28)	21.3(5.5)	21.8(5.5)	20.4(5.0)
FACT-B Emotional Well-Being (scale: 0–24)	19.7(3.8)	20.0(3.8)	19.5(3.6)
FACT-B Functional Well-Being (scale: 0–28)	21.7(5.2)	22.3(5.0)	21.5(4.7)
FACT-B Breast Cancer (scale: 0–40)	25.4(5.8)	26.3(5.6)	25.1(5.5)

	Total Sample (N=753)	Study 1 (n=440)	Study 2 (n=313)
FACT-B Total Score (0–148)	111.8(18.8)	114.4(18.5)	109.8(18.0)

HADS Hospital Anxiety and Depression Scale, FACT-B Functional Assessment of Cancer Treatment-Breast

Table 2.

Single activity and partition model associations between physical activity intensity (change per 30 minutes/day) and quality of life

	Sedentary		Light		MVPA	
	B	**95% CI**	**B**	**95% CI**	**B**	**95% CI**
Total FACT-B Score						
Single Activity	−0.36	(−0.9, 0.15)	0.39	(−0.3, 0.9)	**2.7**	**(0.9, 6.0)**
Partition	0.03	(−0.6, 0.6)	0.3	(−0.3, 0.9)	**2.7**	**(0.6, 4.5)**
Physical Well-Being						
Single Activity	−0.03	(−0.3, 0.09)	0.12	(−0.03, 0.24)	**0.81**	**(0.3, 1.2)**
Partition	0.12	(−0.03, 0.3)	0.15	(−0.03, 0.3)	**0.87**	**(0.3, 1.5)**
Functional Well-Being						
Single Activity	−0.09	(−0.3, 0.06)	0.12	(−0.03, 0.3)	**0.6**	**(0.06, 1.2)**
Partition	0.03	(−0.3, 0.3)	0.12	(−0.09, 0.3)	0.6	(−0.03, 1.2)
Emotional Well-Being						
Single Activity	−0.09	(−0.18, 0.03)	0.09	(−0.03, 0.21)	0.21	(−0.3, 0.6)
Partition	−0.09	(−0.3, 0.09)	0.06	(−0.09, 0.3)	0.12	(−0.3, 0.6)
Social Well-Being						
Single Activity	−0.09	(−0.24, 0.09)	0.03	(−0.15, 0.18)	0.6	(−0.12, 1.2)
Partition	−0.06	(−0.3, 0.3)	−0.03	(−0.3, 0.3)	0.42	(−0.3, 1.2)
Breast Cancer Specific						
Single Activity	−0.09	(−0.3, 0.06)	0.06	(−0.12, 0.21)	0.6	(−0.03, 1.2)
Partition	−0.03	(−0.3, 0.3)	−0.03	(−0.3, 1.2)	0.6	(−0.12, 1.2)
HADS – Anxiety						
Single Activity	0.03	(−0.09, 0.12)	−0.06	(−0.12, 0.12)	−0.030	(−0.3, 0.3)
Partition	0.03	(−0.09, 0.3)	0.03	(−0.12, 0.3)	−0.03	(−0.3, 0.3)
HADS-Depression						
Single Activity	0.03	(−0.06, 0.15)	−0.06	(−0.18, 0.06)	−0.39	(−0.9, 0.03)
Partition	−0.03	(−0.3, 0.12)	−0.03	(−0.3, 0.12)	−0.3	(−0.9, 0.03)

single activity model controlled for age, education, stage of breast cancer, received chemotherapy, received radiation, body mass index, number of comorbidities, time since diagnosis, study, and wear time. Partition model controlled for all covariates in single activity model and all other intensity categories. FACT-B Functional Assessment of Cancer Treatment-Breast, HADS Hospital Anxiety and Depression Scale, CI confidence Interval

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Table 3.

Isotemporal substitution model showing reallocation of 30 minutes of one activity for 30 minutes of another activity and change in quality of life scores in breast cancer survivors

	Reallocation of:	Sedentary		Light Intensity
	to:	Light	MVPA	MVPA
Total Fact-B Score	B 95% CI	0.3 (−0.3, 0.9)	**3.0 (0.6, 4.5)**	**2.4 (0.3, 6.0)**
Physical Well-Being	B 95% CI	0.03 (−0.12, 0.33)	**0.8 (0.33, 1.2)**	**0.72 (0.27, 1.2)**
Functional Well-Being	B 95% CI	0.09 (−0.6, 0.6)	**0.6 (0.03, 1.2)**	0.06 (−0.12, 1.2)
Emotional Well-Being	B 95% CI	0.09 (−0.03, 0.3)	0.3 (−0.3, 0.6)	0.06 (−0.3, 0.6)
Social Well-Being	B 95% CI	0.03 (−0.3, 0.3)	0.6 (−0.12, 1.2)	0.6 (−0.3, 1.2)
Breast Cancer Specific	B 95% CI	0.06 (−0.6, 0.6)	0.6 (−0.3, 0.3)	0.6 (−0.3, 1.2)
HADS-Anxiety	B 95% CI	0.03 (−0.12, 0.12)	−0.06 (−0.3, 0.3)	−0.03 (−0.6, 0.3)
HADS-Depression	B 95% CI	−0.03 (−0.3, 0.09)	0.3 (−0.9, 0.03)	−0.3 (−0.09, 0.09)

models controlled for age, education, stage of breast cancer, received chemotherapy, received radiation, body mass index, number of comorbidities, time since diagnosis, study, and wear time. FACT-B Functional Assessment of Cancer Treatment-Breast, HADS Hospital Anxiety and Depression Scale, CI confidence Interval