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Physical Activity and Sleep Quality in Breast Cancer Survivors: A Randomized Trial

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Abstract

Purpose—Data from large randomized controlled trials confirming sleep quality improvements with aerobic physical activity have heretofore been lacking for post-primary treatment breast cancer survivors. Our primary purpose for this report was to determine the effects of a physical activity behavior change intervention, previously reported to significantly increase physical activity behavior, on sleep quality in post-primary treatment breast cancer survivors.

Methods—Post-primary treatment breast cancer survivors (n=222) were randomized to a 3-month physical activity behavior change intervention (BEAT Cancer) or usual care. Self-report (Pittsburgh Sleep Quality Index [PSQI]) and actigraphy (latency and efficiency) sleep outcomes were measured at baseline, 3 months (M3), and 6 months (M6).

Results—After adjusting for covariates, BEAT Cancer significantly improved PSQI global sleep quality when compared with usual care at M3 (mean between group difference [*M*] = −1.4; 95% CI = −2.1 to −0.7; $p < .001$) and M6 (*M* = −1.0; 95% CI = −1.7 to −0.2; *P* = .01). BEAT Cancer improved several PSQI subscales at M3 (sleep quality *M* = −0.3; 95% CI = −0.4 to −0.1; *P* = .002; sleep disturbances *M* = −0.2; 95% CI = −0.3 to −0.03; *P* = .016; daytime dysfunction *M* = −0.2; 95% CI = −0.4 to −0.02; *P* = .027) but not M6. A non-significant increase in percent of

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Conflict of Interest and Adherence to Ethical Standards

Laura Rogers and all contributing authors declare they have no personal or professional relationships that may represent a potential conflict of interest. All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. The results of the present study do not constitute endorsement by the American College of Sports Medicine (ACSM). Study results are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

participants classified as good sleepers occurred. No significant between group difference was noted for accelerometer latency or efficiency.

Conclusion—A physical activity intervention significantly reduced perceived global sleep dysfunction at 3 and 6 months, primarily due to improvements in sleep quality aspects not detected with accelerometer.

Keywords

oncology; survivorship; psychosocial; exercise; symptom

INTRODUCTION

The cancer survivorship journey begins for an individual at the time of diagnosis and continues until the end of life. This journey may involve detrimental effects on normal activities including but not limited to sleep. The term “sleep quality” encompasses perceived and/or objective measures of sleep aspects (e.g., onset) and effects (e.g., tiredness during the day) (17). Persistent poor sleep quality plagues nearly a third of breast cancer survivors with such symptoms being of substantial clinical significance (8). Specifically, poor sleep is associated with greater breast cancer mortality (18,19) and being able to sleep is among the top 5 highest ranked patient-reported outcomes of importance (i.e., ranked as “important or very important” by 96% of breast cancer survivors) (13). Physical activity is one potential non-pharmacologic intervention for poor sleep quality (20,24) yet a recent meta-analysis reported no benefits of exercise interventions on sleep quality in breast cancer survivors (39).

The inability of this meta-analysis to detect sleep quality benefits is not unexpected given that currently published randomized controlled trials (RCTs) of aerobic exercise (e.g., home-based walking, supervised aerobic exercise) in breast cancer survivors specifically have not consistently reported beneficial intervention effects on sleep (10,22,27,30–32,34,37). In the seven trials measuring self-report, significant intervention effects were reported for overall sleep quality in four studies (two occurred during chemotherapy/radiation) (10,22,27,37), efficiency in one study (during chemotherapy) (10), latency in two studies (one during chemotherapy) (10,31), and sleep duration in one (post-chemotherapy/radiation) (30). Another post chemotherapy/radiation trial reported beneficial effects on accelerometer measured efficiency, latency, and awake time (34). The three trials using both accelerometer and self-report measures did not occur during chemotherapy or radiation and reported no effect on accelerometer efficiency and latency even when global self-report sleep quality benefits were found (27,30,31). Importantly, 5 of the 8 trials available in breast cancer survivors, to date, were post-primary treatment (i.e., participants had completed surgery, chemotherapy, and/or radiation) yet enrolled ≤ 46 participants per trial reducing their study power (27,30–32,34). The only large trial (301 participants) was carried out during chemotherapy (limiting generalizability to post-primary treatment survivors) and did not include an accelerometer or objective measure of sleep quality (10). Published scientific reviews including trials enrolling mixed or cancer types other than breast and testing a variety of exercise modes (e.g., resistance, yoga) also support inconsistencies in exercise

effects on sleep among cancer survivors and the infrequent use of objective sleep measures (20,21,39).

Given the importance of sleep quality after breast cancer diagnosis, the lack of agreement between accelerometer and self-report outcomes, and the generally accepted use of physical activity for treatment of poor sleep without consistent scientific data to support its use, further testing in larger trials is needed to better describe physical activity effects on sleep quality. As previously reported, our 3-month physical activity behavior change intervention significantly increased the odds of meeting physical activity recommendations (primary outcome for this trial) (28). Measurement of sleep outcomes as a secondary study outcome provides the opportunity to further address the current knowledge gap by testing sleep outcomes in a larger trial (33). Therefore, the primary purpose of this report was to compare the effects of a physical activity behavior change intervention with usual care (written materials) on self-report and accelerometer-measured sleep quality outcomes. Our primary outcome for this report was perceived sleep quality (Pittsburgh Sleep Quality Index global score; lower scores indicate better sleep quality). We hypothesized that, when compared with usual care, the physical activity intervention would result in significant improvement in self-report and accelerometer-measured sleep quality outcomes immediately post-intervention (month 3; M3) and 3 months post-intervention (month 6; M6).

METHODS

Study design, setting, participants, and randomization

A multicenter, randomized controlled trial enrolling 222 breast cancer survivors was carried out at three U.S. academic institutions with study design and sample size justification previously described (ClinicalTrials.gov identifier NCT00929617) (33). Inclusion criteria included women, age 18 to 70 years, history of ductal carcinoma in situ (DCIS) or stage I-IIIA breast cancer, post-primary treatment (i.e., no longer on radiation or chemotherapy but could be on longer term treatments such as anti-estrogen therapy), ≥ 8 weeks post-surgery, English speaking, physician clearance received, and reporting ≤ 30 minutes of vigorous physical activity or ≤ 60 minutes of moderate activity per week, on average, during the past six months. Exclusion criteria included dementia, inability to ambulate, unable to fully participate in study activities, anticipated surgery during the intervention, anticipated out of town travel in the first 4 weeks and travel ≥ 1 week in the last 8 weeks of the intervention, physical activity contraindication, metastatic or recurrent breast cancer, and current participation in another exercise trial. The trial received institutional review board approval and all participants provided written informed consent before initiating study activities. Computer generated numbers in blocks of 4 and stratified by study site were used for randomization (33). Randomization occurred in the order of participant completion of baseline testing with study staff kept blinded to group allocation until the baseline assessment was complete.

Study group allocations

All participants received written materials regarding physical activity for cancer survivors publically available from the American Cancer Society. Half were randomized to also

receive the 3-month, social cognitive theory-based Better Exercise Adherence after Treatment for Cancer (BEAT Cancer) physical activity behavior change intervention (i.e., intervention group) while the remaining half comprised the usual care group (33). BEAT Cancer included 12 supervised exercise sessions with exercise specialists during the first six weeks that were tapered to entirely unsupervised exercise off-site (e.g., home-based) supported by update counseling sessions with exercise specialists every two weeks. BEAT Cancer participants also completed six discussion group sessions that included topics such as exercise barriers (e.g., time management, stress management, etc.), exercise benefits, goal setting with self-monitoring, behavioral modification strategies, safety, relapse prevention, and exercise role models (33). Achieving ≥150 weekly minutes of moderate-to-vigorous intensity physical activity was the goal of the intervention with exercise progression previously described (33).

Measures

Demographic and medical factors (e.g., age, race, income, marital status, comorbidities scale (12), cancer stage, cancer treatment, and months since diagnosis) were self-reported at baseline. Remaining measures were collected at baseline, immediately post-intervention (month 3; M3) and 3 months post-intervention (month 6; M6). Perceived sleep quality was measured with the Pittsburgh Sleep Quality Index (PSQI) and scored according to published protocol (5). A higher score indicates poorer sleep quality and the PSQI yields 7 ordinal subscales (0, 1, 2, or 3; subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, daytime dysfunction) that are summed for a continuous global PSQI score (5). Global PSQI score was analyzed as a continuous variable and also dichotomized as ≤ 5 (“good” sleepers) vs. > 5 (“poor” sleepers) (5). If ≤ 2 items were missing from the sleep disturbances subscale, imputation was done by calculating the mean of the provided responses. Only four surveys required imputation (one at baseline, two at month 3, and one at month 6). No other imputations were required for the remaining PSQI components or global score.

A wrist-worn accelerometer was worn for 7 nights (MTI/Actigraph accelerometer; models GT1M and GT3X) (6,38). The participant recorded the time in and out of bed on a record sheet. Three valid nights were required; ActiLife software was used along with default algorithm (i.e., Sadeh (35)). Accelerometer validity has been previously reported (6,38). The objective, accelerometer outcomes of sleep latency and efficiency are described in this report.

Statistical analyses

Intervention effects on continuous sleep outcomes were analyzed using adjusted linear mixed models incorporating a first-order autoregressive covariance matrix (i.e., PROC MIXED). Ordinal (PSQI subscales) and dichotomous (“poor” vs. “good” sleepers) variables were analyzed using generalized linear mixed models (i.e., PROC GLIMMIX). All of these models used restricted maximum likelihood as the estimation technique. Statistical analyses were performed using SAS, version 9.4 (Cary, NC). All statistical tests were two-tailed, with a *P*-value < 0.05 denoting statistical significance. Because there were no substantial differences between the unadjusted and adjusted analyses, we only report our primary

analysis (i.e., adjusted). Covariates included baseline value of the outcome, study site (stratification variable for randomization), hormonal therapy (baseline difference between study groups (28); none vs. on hormonal therapy for ≤ 1 year vs. on hormonal therapy for > 1 year), breast cancer stage (based on literature review (3)), and baseline factors associated with sleep quality at month 6 (income, race [Caucasian vs. other], marital group [married/significant other vs. other], and number of comorbidities [self-report scale by Groll *et al.* (12)]). PSQI global and subscale factors were normally distributed, as determined by an examination of normal probability plots, box plots, and the Kolmogorov-Smirnov test, and no outliers were noted. The accelerometer outcomes were analyzed with and without five possible outliers (from participants whose data remained in the analyses) without change in the results, hence, we report the analyses with all available data. Accelerometer latency was analyzed with and without $\log_{10}$ transformation due to concerns about a skewed distribution. No difference in results was observed hence, we report the analyses without log transformation. Of the 222 participants randomized, 214 were available for the PSQI analyses and 209 for the accelerometer outcome analyses. This is due to incomplete assessments at both month 3 and month 6 or the exclusion of accelerometer data from five participants due to a high likelihood of invalid data (e.g., activity intensity too vigorous to indicate sleep; erratic, erroneous, or uncertain time in and out of bed).

RESULTS

Of the 222 participants randomized, 110 were assigned to BEAT Cancer and 112 to usual care (28). Retention was 97% at M3 and 96% at M6 (similar for both study groups) (28). Study groups differed at baseline with regard to percent on hormonal therapy for ≤ 1 year (i.e., 17% for BEAT Cancer vs. 30% for usual care; $P = .02$) but were otherwise balanced as previously published in table format (28). Hence, baseline demographic and medical characteristics for both groups combined are summarized as follows: mean (SD) age of 54.4 (8.5) years, mean (SD) education was 15.5 (2.6) years, 98% non-Hispanic, 84% White, 11% African-American, 11% DCIS, 42% stage I, 35% stage II, 12% stage III, mean (SD) months since diagnosis was 54 (54.5), 58% history of chemotherapy, 68% history of radiation therapy, and 49% currently on hormonal therapy (28).

After adjusting for covariates, BEAT Cancer significantly improved PSQI global sleep quality when compared with usual care at M3 (model study group effect $P < .001$; mean between group difference = −1.4; 95% CI = −2.1 to −0.7; $P < .001$) and remained statistically significant at M6 (mean between group difference = −1.0; 95% CI = −1.7 to −0.2; $P = .01$) (Table 1). A statistically significant between group difference favoring the BEAT Cancer intervention was noted at M3 for the following PSQI subscales: sleep quality (model study group effect $P = .02$; mean between group difference = −0.3; 95% CI = −0.4 to −0.1; $P = .002$), sleep disturbances (model study group effect $P = .014$; mean between group difference = −0.2; 95% CI = −0.3 to −0.03; $P = .016$), and daytime dysfunction (model study group effect $P = .019$; mean between group difference = −0.2; 95% CI = −0.4 to −0.02; $P = .027$) (Table 1). Although the M3 between group comparison was significant for PSQI efficiency subscale (Table 1), the model study group effect P value was not ($P = .13$). Although the percent of participants classified as good sleepers increased, the odds of being a good sleeper for BEAT Cancer vs. usual care was not statistically significant (Table 2). No

significant between group difference was noted for accelerometer latency or efficiency (Table 1).

DISCUSSION

When compared with usual care, the BEAT Cancer physical activity behavior change intervention significantly improved perceived global sleep quality at 3 and 6 months. This improvement was primarily due to improvements in the perceived sleep quality, sleep disturbances, and daytime dysfunction subscales. Although a significant between group difference was noted for the efficiency subscale, the overall group effect *P* value was not significant suggesting minimal contribution to the intervention effects on global sleep quality. No significant intervention effects were noted for accelerometer efficiency or latency.

Our findings of improvements in self-reported sleep quality but not accelerometer efficiency or latency is consistent with prior smaller randomized trials (27,30,31). Several explanations for intervention effects on self-report and not accelerometer measured sleep outcomes exist. Given the lack of statistically significant associations between PSQI and actigraph sleep measures in other studies (11), the statistically significant baseline correlations between PSQI subscale and accelerometer outcome in our data set for efficiency ($r = -0.32$, $P < .0001$) and latency ($r = .19$, $P = .005$) suggest that lack of relationship between the two measures may have contributed to but does not fully explain the inconsistency in our study reported here. Importantly, the PSQI global improvement was due to subscales other than efficiency and latency suggesting that the accelerometer does not measure the aspects of sleep quality responsible for perceived sleep improvements. Also, participants may have inconsistently provided accurate information regarding time in and out of bed to sleep, information key to delineating the monitor interval for analysis. For example, some participants had difficulty differentiating getting in the bed to read or watch television rather than getting in the bed to sleep. Also, the possibility of social desirability bias exists since it was impossible to blind participants to their study group allocation and placebo effects may have occurred given the lack of attention equivalent control group. Polysomnography would provide more objective measures of latency, efficiency, and sleep architecture possibly responsible for perceived improvements with no prior exercise training study including such a measure. We also acknowledge that inclusion of more current sleep measurement options such as bed sensors or home sleep recorders could also overcome some of the accelerometer limitations (36). Although integrating these procedures into future studies will increase study cost and participant burden, doing so should be considered to better elucidate physical activity effects on sleep quality.

Our beneficial intervention effect on self-reported sleep disturbances is consistent with the meta-analysis by Mishra et al. (20) which reported a standardized mean difference of −0.46 (95% CI −0.72 to −0.20) for exercise effects on sleep disturbances (all cancer types combined; only significant at the 12-week follow-up time point). Nevertheless, comparison with the meta-analysis is limited by the heterogeneity of the exercise interventions (e.g., aerobic, yoga, etc.) and cancer types (e.g., mixed, colon, etc.) included. Moreover, the meta-analytic results are not consistent with the lack of effect on sleep outcomes in a more recent

meta-analysis examining exercise effects on sleep in breast cancer survivors specifically due, in part, to few studies all enrolling small sample sizes (39). Of note, the data reported here are the first sleep outcomes data from a large randomized controlled physical activity (walking or traditional supervised aerobic exercise) and cancer trial specifically focused on post-primary treatment breast cancer survivors. Hence, our report describing a small to medium intervention effect size of 0.35 and significant between group difference with regard to PSQI global score for an aerobic physical activity intervention vs. usual care group is noteworthy.

Our statistically significant intervention effects on PSQI global score, sleep quality subscale, and daytime dysfunction subscale at month 3 exceeded the threshold for clinically important benefits (1) with the month 6 intervention effect on PSQI global approaching a clinically important benefit. Interventions that improve sleep quality are of value in the clinical care of cancer survivors. Diminished sleep quality is associated with fatigue, depression, and poorer quality of life in breast cancer survivors (15,16). Similarly, being able to sleep is among the top 5 patient-reported outcomes of importance relevant to breast cancer survivors with 96% indicating being able to sleep was important or very important (13). Reducing sleep disturbances may also be important for improved health. Although the association between sleep quality and breast cancer mortality has not been well-studied, poor sleep quality has been associated with all-cause mortality (not cancer-specific) (7,14). Furthermore, sleep disturbances have been associated with detrimental metabolic states linked to breast cancer biomarkers and medical comorbidities (e.g., impaired glucose tolerance, insulin resistance) (4). Similarly, abnormal sleep has been associated with an increase in cardiovascular risk (2), an outcome of particular importance given that cardiovascular disease competes with breast cancer as the leading cause of death in breast cancer survivors (25,26). Clearly, the ability of our physical activity behavior change intervention to improve global sleep quality during the intervention with persistent improvements months after completing the intervention has noteworthy potential for improving the health and well-being of breast cancer survivors.

Sleep quality was a secondary health outcome in this randomized trial (33) and as such, a “floor effect” with regard to sleep quality might be expected because study inclusion was not limited to only breast cancer survivors who were “poor sleepers”. Hence, it is noteworthy that most of our participants answered > 5 on the PSQI scale (i.e., “poor sleepers”) reinforcing the importance of this symptom in the breast cancer survivor experience. Although our between group difference was significant for the continuous PSQI global score, our lack of statistical significance related to odds of being a “good sleeper” suggests that physical activity can improve perceived sleep quality yet moving participants out of the “poor sleeper” category may require combining physical activity with other strategies (e.g., good sleep hygiene counseling, screening/treatment for undiagnosed obstructive sleep apnea, etc.). Randomization evenly distributed baseline anxiety and depressive symptoms between intervention and control groups (i.e., mean Hospital Anxiety and Depression Scale scores were 4.8 vs. 4.7 for depression, $p = .80$ and 7.0 vs. 7.0 for anxiety, $p = .90$) yet we did not measure personality disorders that might influence sleep outcomes. Also, several factors associated with sleep in cross-sectional studies (i.e., fatigue, depression, and anxiety) improved with the intervention (29). Longitudinal, multilevel path analyses were beyond the

scope of this report yet future studies should consider including such an approach to elucidate the relationships among these variables over time.

Our study strengths include its randomized controlled design, multicenter enrollment, and high retention rates. Circadian rhythm was not measured in our study and should be considered in future trials aiming to improve our understanding of how physical activity improves sleep outcomes. Also, generalizing our study results to underrepresented ethnic and racial groups is limited. As with any physical activity intervention that includes group and individual interactions providing behavioral support for improving adherence (9), discriminating between the effects of physical activity independent of the behavioral and staff support is not possible. Yet, continued improvements months after intervention completion (and without the ongoing support) add credence to the presumed role of physical activity in intervention outcomes on sleep quality.

Although trials have reported the effects of yoga on sleep outcomes (23), this study is the first large randomized controlled physical activity (walking or traditional supervised aerobic exercise) trial in post-primary treatment breast cancer survivors reporting sleep outcomes. Our rigorous study design, high retention rate, and use of both actigraphy and PSQI suggest future directions in the field. Poor sleep is a frequent problem of importance for post-primary treatment breast cancer survivors and warrants attention in future randomized trials. The field could be advanced by considering polysomnography or ambulatory measures other than accelerometry (when feasible and appropriate), testing physical activity interventions in combination with other strategies for possible synergistic effects, integrating measures of circadian rhythm, and exploring exercise effects on sleep in relation to breast cancer mortality. In so doing, the exercise oncology scientific field can optimize the use of physical activity in improving the health and well-being of cancer survivors through improved sleep.

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Table 1

Effects of a physical activity behavior change intervention (BEAT Cancer) on self-report sleep outcomes post-intervention (month 3) and 3 months after intervention completion (month 6) in breast cancer survivors

	Unadjusted means			Adjusted[a] between-group differences Estimated least square mean with (95% CI); *P* value	
PSQI outcome	**Baseline mean (SD)**	**Month 3 mean (SD)**	**Month 6 mean (SD)**	**BEAT Cancer vs. usual care at month 3 (post-intervention)**	**BEAT Cancer vs. usual care at month 6 (3 months post-intervention)**
PSQI global score[b]				−1.4 (−2.1 to −0.7); <.001	−1.0 (−1.7 to −0.2); .010
BEAT Cancer	8.5 (3.7)	7.0 (3.7)	7.3 (3.8)		
Usual care	7.3 (4.1)	7.5 (4.0)	7.6 (4.2)		
PSQI subscales					
Sleep quality				−0.3 (−0.4 to −0.1); .002	−0.1 (−0.2 to 0.1); .41
BEAT Cancer	1.3 (0.7)	1.0 (0.6)	1.1 (0.7)		
Usual care	1.1 (0.8)	1.1 (0.8)	1.0 (0.8)		
Sleep latency[b]				−0.2 (−0.4 to 0.1); .18	−0.1 (−0.3 to 0.2); .64
BEAT Cancer	1.6 (1.0)	1.3 (1.0)	1.3 (1.1)		
Usual care	1.1 (1.0)	1.1 (0.9)	1.1 (0.9)		
Sleep duration				−0.2 (−0.4 to 0.01); .06	−0.2 (−0.4 to 0.03); .09
BEAT Cancer	1.1 (1.0)	0.9 (0.9)	1.0 (0.9)		
Usual care	0.9 (0.9)	0.9 (0.9)	1.0 (1.0)		
Sleep efficiency				−0.2 (−0.5 to −0.01); .044	−0.1 (−0.3 to 0.2); .60
BEAT Cancer	0.8 (1.0)	0.6 (0.9)	0.7 (1.0)		
Usual care	0.7 (1.0)	0.8 (1.1)	0.8 (1.0)		
Sleep disturbances				−0.2 (−0.3 to −0.03); .016	−0.1 (−0.3 to 0.03); .11
BEAT Cancer	1.6 (0.6)	1.5 (0.6)	1.5 (0.6)		
Usual care	1.6 (0.7)	1.7 (0.6)	1.6 (0.6)		
Sleep medication use				−0.04 (−0.3 to 0.2); .72	−0.2 (−0.5 to 0.03); 0.08
BEAT Cancer	1.0 (1.2)	0.9 (1.2)	0.8 (1.2)		
Usual care	0.8 (1.2)	0.7 (1.1)	0.9 (1.2)		

	Unadjusted means			Adjusted[a] between-group differences Estimated least square mean with (95% CI); *P* value	
PSQI outcome	**Baseline mean (SD)**	**Month 3 mean (SD)**	**Month 6 mean (SD)**	**BEAT Cancer vs. usual care at month 3 (post-intervention)**	**BEAT Cancer vs. usual care at month 6 (3 months post-intervention)**
Daytime dysfunction				−0.2 (−0.4 to −0.02); .027	−0.1 (−0.3 to 0.03); .10
BEAT Cancer	1.1 (0.7)	0.9 (0.8)	0.9 (0.7)		
Usual care	1.1 (0.8)	1.1 (0.8)	1.1 (0.8)		
Accelerometer efficiency				0.05 (−1.5 to 1.6); .95	−1.1 (−2.7 to 0.5); .17
BEAT Cancer	83.2 (5.8)	82.8 (6.4)	82.6 (7.2)		
Usual care	81.6 (7.0)	81.4 (8.2)	81.9 (6.9)		
Accelerometer latency				0.7 (−2.1 to 3.4); .64	−0.4 (−3.1 to 2.4); .80
BEAT Cancer	8.9 (7.5)	9.5 (10.2)	8.6 (7.3)		
Usual care	9.9 (8.2)	9.9 (13.6)	10.2 (10.3)		

CI, confidence interval; SD, standard deviation; PSQI, Pittsburgh Sleep Quality Index (higher scores indicate greater sleep dysfunction; lower scores indicate better sleep quality)

[a]Adjusted for baseline value, study site, breast cancer stage, current hormonal therapy, number of comorbidities, income, race, and marital status

[b]Indicates significant between group difference at baseline ($p < .05$); mixed model repeated measures analysis accounted for difference by adjusting for baseline value of the outcome.

Table 2

Odds of being a good sleeper (PSQI score of ≤ 5) post-intervention (month 3) and 3 months after BEAT Cancer intervention completion (month 6) in breast cancer survivors[a]

	Unadjusted % "good sleepers"			Adjusted[a] Odds Ratio with (95% CI[b]); P value	
Outcome	**Baseline**	**Month 3**	**Month 6**	**BEAT Cancer vs. usual care; month 3**	**Beat Cancer vs. usual care; month 6**
PSQI score ≤ 5 ("good sleeper")				2.0 (0.8 to 4.6); .12	1.7 (0.7 to 4.3); .22
BEAT Cancer	25.7	40.4	35.3		
Usual care	35.8	37.6	32.3		

CI, confidence interval; PSQI, Pittsburgh Sleep Quality Index

[a]Adjusted for baseline value, study site, breast cancer stage, current hormonal therapy, number of comorbidities, income, race, and marital status