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Randomized trial of Tibetan Yoga in Breast Cancer Patients Undergoing Chemotherapy

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Abstract

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BACKGROUND—This randomized trial examined the effects of a Tibetan yoga program (TYP) versus a stretching program (STP) and usual care (UC) on sleep and fatigue in women with breast cancer undergoing chemotherapy.

METHODS—Women with stage I–III breast cancer undergoing chemotherapy were randomized to TYP (n=74), STP (n=68), or UC (n=85) groups. Participants in the TYP and STP groups participated in 4 sessions during chemotherapy, followed by three booster sessions over the subsequent 6 months, and encouraged to practice at home. Self-report measures of sleep disturbances (Pittsburgh Sleep Quality Index) fatigue (Brief Fatigue Inventory), and actigraphy were collected at baseline, 1-week post-treatment, and 3, 6 and 12 months.

RESULTS—There were no group differences in total sleep disturbances or fatigue levels over time. However, patients in TYP reported fewer daily disturbances 1-week post-treatment than STP (difference=−0.43, 95% CI: −0.82, −0.04, P=0.03) and UC (difference=−0.41, 95.5% CI: −0.77, −0.05, P=0.02). Group differences at the other time points were maintained for TYP versus STP. Actigraphy data revealed greater minutes awake after sleep onset for STP 1-week post treatment versus TYP (difference=15.36, 95% CI: 7.25,23.48, P=0.0003) and UC (difference=14.48, 95% CI: 7.09,21.87, P=0.0002). Patients in TYP who practiced at least two times a week during follow-up reported better PSQI and actigraphy outcomes at 3 and 6 months post-treatment than those who did not and better than those in UC.

CONCLUSIONS—Participating in TYP during chemotherapy resulted in modest short-term benefits in sleep quality, with long-term benefits emerging over time for those who practiced TYP at least two times a week.

Keywords

Tibetan; Yoga; Breast; Cancer; Patients; Chemotherapy; sleep quality

INTRODUCTION

Although chemotherapy for breast cancer improves disease-free and overall survival, toxicities remain high and impact quality of life (QOL)^{1,2}. Sleep disturbances and fatigue, often ranked as the most problematic side effects of treatment^{3,4}, are especially debilitating. Specific rates of fatigue are hard to estimate from previous studies due to different measures used and lack of clinical specificity. Nevertheless, one cohort study of 218 women reported that at the end of treatment 26% of the sample experienced case-rates of fatigue and 16% of the sample reported case-rates of fatigue plus mood disturbances⁵. Some studies have also shown only modest increases in fatigue⁶. Additionally, fatigue levels do not appear to be linear in nature. For instance, two longitudinal studies revealed that women showed a marked increase in fatigue during cycle I, which then decreased, yet peaked during cycle 4.^{7,8} The prevalence of sleep disturbance seems to be higher, with estimates ranging between 30 and 75 percent^{9,10}, yet with some studies showing stable levels⁷.

Yoga is an effective modality to reduce symptoms pertaining to sleep disturbances and fatigue for cancer *survivors* who had completed cancer treatment. A large multi-center randomized controlled trial involving 410 survivors (75% breast cancer) with sleep disturbances found that an 8-session yoga intervention improved both objective and

subjective sleep quality compared to a usual care group¹¹. Two smaller trials conducted in breast cancer survivors after completing treatment, one single-arm¹² and the other comparing yoga to a health-education control group¹³, found that yoga was effective at reducing persistent fatigue that was maintained at 3-months post-intervention.

Although research has examined the effects of yoga delivered during chemotherapy for women with breast cancer^{14–24}, only one was designed to specifically target fatigue and none targeting sleep outcomes. Taso et al.¹⁶ conducted a small RCT comparing yoga to usual care for women with breast cancer undergoing chemotherapy and found reduced fatigue relative to usual care that showed increased fatigue. Other studies have examined sleep and fatigue as secondary outcomes. Improvement in fatigue was noted in two small single arm studies^{21,25} and only for within group analyses in RCTs²² and for those attending more yoga classes²⁶. Similarly, a small RCT by Dhruva et al.¹⁴ found that the amount of yoga practice during chemotherapy was associated with decreased sleep disturbance. Our prior work of a Tibetan Yoga Program (TYP) for patients with lymphoma undergoing treatment, or within 12 months of completing treatment, found that the program resulted in fewer sleep disturbances compared to a wait-list control group²⁷. A subsequent trial for women with breast cancer found that TYP led to reduced sleep disturbances and fatigue²⁸ for women who were undergoing chemotherapy at the time of intervention delivery.

Previous yoga research has not typically included active control groups or long-term follow-up, limiting the interpretation of the findings. The current trial was designed to address limitations of previous studies and to further our knowledge regarding effective management of sleep disturbances and fatigue in women with breast cancer actively receiving chemotherapy. We hypothesized that the TYP group would have lower sleep disturbances and fatigue than an active stretching program (STP) and usual care wait-list control group (UC), as the TYP integrates physical movements with specific breathing exercises and meditative stress reduction techniques.

PATIENTS AND METHODS

Study Population

Women with stage I–III breast cancer undergoing chemotherapy who were 18 years old; ability to read, write, and speak English; and scheduled to undergo neoadjuvant or adjuvant chemotherapy (weekly or every 21 days) at MD Anderson Cancer Center (MDACC). Patients with lymphedema; deep vein thrombosis; documented diagnosis of a formal thought disorder (e.g., schizophrenia); a score of 23 or below on the Mini-Mental State Examination; extreme mobility problems limiting ability to engage in the practices (self-defined); or who had regularly (self-defined) practiced yoga in the year before diagnosis were excluded. The protocol was approved by MDACC's Institutional Review Board, and patients were recruited between 2007–2012.

Procedures

Women were approached either before starting or within the first two cycles of chemotherapy. Chemotherapy consisted of neoadjuvant or adjuvant paclitaxel given weekly

for 12 cycles or every 3 weeks for 4 cycles or docetaxel neoadjuvant every 3 weeks for four cycles followed by FAC/FEC every 3 weeks for four cycles. The majority of patients, therefore, completed the TYP or STP intervention sessions within the first 12 weeks of chemotherapy and before starting FAC/FEC. After providing written informed consent, participants completed a 60-minute baseline assessment and wore an actigraphy watch 24 hours a day for 7 days to assess sleep quality. Participants were then randomized to one of three groups: 1) TYP; 2) STP; or 3) UC waitlist control, using a form of adaptive randomization, minimization,²⁹ with age, stage of disease, time since diagnosis, baseline fatigue scores, menopausal status, type of surgical procedure, and chemotherapy treatment and regimen as randomization factors. Follow-up assessments were conducted one week after the end of the intervention and 3, 6 and 12 months later. Participants were given a gift certificate (\$25 value) after completing each assessment. Participants in the UC group completed all assessments on the same timeline as the active groups. STP and UC group participants were offered yoga classes at the end of their study participation. All participants were asked to refrain from participating in any other yoga classes while on study or to report it if they did practice.

Intervention Programs

Participants in the TYP and STP groups attended four, 75–90 minute classes during their chemotherapy treatment. Most classes were delivered in a one-on-one format to meet each patient's unique schedule. Patients were also encouraged to practice daily outside of the classes at the hospital. Patients in both interventions were given printed materials, audio recordings, and a video of all the techniques. Both groups also had three booster sessions during follow-up. The manualized interventions are available upon request.

TYP—Each TYP class was taught by one of four trained instructors from the Ligmincha Texas Institute, with continuity of instructor for each patient. TYP instructors had at least three years of practice experience and received relevant oncology training as well as specific training for teaching the TYP protocol to breast cancer patients.

TYP consisted of four main components: 1) mindfulness and focused attention through guided meditation with breathing and visualization; 2) an alternate nostril breathing practice (9 breathings of purification) and a breath retention exercise (e.g., 4-Part Breath); 3) *Tsa Lung* movements; and 4) closing with a brief compassion-based meditation. *Tsa Lung*²⁷ is an ancient Tibetan contemplative practice that includes a series of five gentle movements involving rotations and stretches of different parts of the body coordinated with specific breathing patterns.

STP—A physical therapist and an exercise physiologist taught the majority of the STP classes, with less than 10% of the sessions taught by a mind-body instructor, with continuity of instructor for each patient. They had over 10 years of experience. STP included exercises recommended specifically for women undergoing or recovering from breast cancer treatment.^{30,31} The exercises included standing, lying down, and sitting positions and approximated the gross movements of the TYP (e.g., horizontal arm stretch, breast stroke, neck stretch, quarterback throwing a football).

Outcome Measures

Demographic and medical data were collected and extracted from medical records.

Primary Intervention Outcomes: Self-report—*Sleep disturbances* were assessed using the Pittsburgh Sleep Quality Index (PSQI)³². The PSQI is an 18-item self-rated questionnaire that assesses quality of sleep and sleep disturbances over a 1-month period. The scale includes three component subscales of sleep efficiency, perceived sleep quality, and daily disturbances, and a total score, with scores of 5 or greater indicating clinically significant sleep disturbances³².

Fatigue was assessed using the Brief Fatigue Inventory (BFI)³³. The BFI is a 9-item questionnaire designed to be used in the clinical setting to rapidly assess fatigue severity. The items are ranked from 0 to 10, and patients rate their fatigue at its “worst” and “usual” and as it is “now,” with 0 = “no fatigue” and 10 = “fatigue as bad as you can imagine” and how much their fatigue has interfered with their life.

Secondary Intervention Outcomes: Objective measures—*Objective sleep patterns* were measured with actigraphy. Participants were instructed to wear actigraphs on the wrist of their non-dominant arm for 24 hours for 7 days at each study time point. Data was collected in 15-second epochs for the entire 7 days. Weekly aggregate scores for daily data are presented for measures of sleep *efficiency* (SE; the percentage of time asleep during the sleep episode), *onset latency* (OL; the number of minutes it takes to fall asleep), *total sleep time* (TST), and *wake after sleep onset* (WASO) (number of minutes awake during the night after initial sleep onset).

Out of Class Practice—Out of class practice was encouraged for TYP and STP participants, and patients reported their out-of-class practice each week during the intervention phase and then at each follow-up assessment, asking about practice during previous week.

Data Analyses

The primary outcomes were self-reported sleep disturbances and fatigue. When the sample size in each of the three groups is 100, a one-way analysis of variance (ANOVA) will have 81% power to detect at the 0.05 level a difference in means of each outcome characterized by a variance of means of 0.034, assuming that the common standard deviation (SD) is 1.0. As an example, the variance of means of 0.034 may be characterized by means of 0, 0.39, and 0.39 across the UC, STP, and TYP groups, respectively. While we recognized that the power calculation was based on one outcome at one time point, specifically, one week after the intervention, with a 0.05 significance level, we considered it to be appropriate to make a Bonferroni adjustment for the analyses of the PSQI and BFI total scores to reduce inflated type I errors, yielding an alpha level of 0.025 for each outcome. Main analyses were based on observed data from women who were randomized and met the study eligibility criteria, and were performed with multilevel modeling (MLM) using PROC MIXED (SAS, 9.2.2 version). These analyses allowed between-group comparisons of the outcomes of interest not only across time points, but also at specific time points as post hoc analyses, when desirable.

We assumed a random intercept in the model, and randomization factors were entered as a priori covariates in all main analyses (stage of disease, type of surgery, chemotherapy regimen, timing of chemotherapy, menopausal status, age, and time since diagnosis). Time point was treated as a categorical variable. We examined the group main effect while controlling for baseline scores of the outcome. For the secondary outcomes of PSQI subscales and actigraphy, we used a conventional alpha level at 0.05. We used CONTRAST statements within the mixed procedure to test for group differences. If there was no significant group main effect or contrast comparison effect, we then examined the group $\times$ time interaction using CONTRAST statements to determine if there were significant group differences at a given time point and reported on the effect size estimates. Model assumptions were examined by plotting histograms and quantile-quantile (Q-Q) plots of the studentized residuals from the mixed models. In case model assumptions were not met, a log or square root transformation was applied, as appropriate, with the corresponding results briefly summarized, yet with the untransformed data being presented for the results to be comparable with those in the literature.

RESULTS

Baseline Characteristics of Sample

We approached 933 potentially eligible patients (Figure 1) of which 132 patients were ineligible, 349 refused participation, and 452 consented. Of those, 352 completed baseline measures and were randomized. Of those randomized, 54 had completed chemotherapy at baseline, and 71 did not provide any follow-up data, resulting in an evaluable sample of 227 participants. The dropout rate was similar in each group. Chi-square and t-tests comparing baseline demographic and medical characteristics and outcome measures of study completers versus non-completers revealed no significant differences except for PSQI total score (F-value =4.26, P=0.04); completers had lower PSQI scores (less sleep disturbance) compared to non-completers. Actiwatch data was missing on 31% (n=71) of participants who returned questionnaires. No significant group differences were found in regard to demographic and medical factors (Table 1) or any of the baseline study variables. There were no group differences based on when patients had surgery relative to their participation in the study (11.5% before, 52.0% during, 36.6% after).

Completion of Interventions

Fifty-four participants (73% of baseline sample) completed all four TYP sessions, 6 completed three sessions, 5 completed two sessions, and 8 completed only one session. Fifty STP participants (74% of baseline sample) completed all four sessions, 7 completed three sessions, 5 completed two sessions, and 5 completed only one session. Sixty-three percent of the participants in TYP said they practiced 2 or more times a week one week after the end of the program, as did 38.3% at 3 months, 41.3% at 6 months, and 20.5% at 12 months. STP participants reported high levels of practice at each follow-up time point: 69.4% at 1 week; 45.4% at 3 months, 61.5% at 6 months, and 50.0% at 12 months. Adherence to the booster sessions was lower for both groups (TYP (N=74): 51% did not have any booster sessions; 24% had one booster class; 16% had two booster classes; and 8% had all three booster classes; STP (N=68): 43% did not have any booster sessions; 31% had one booster class;

12% had two booster classes; and 15% had all three booster classes). There were no significant group differences in class attendance or frequency of practice during the follow-up time period. There were no adverse events associated with either intervention.

Intervention Efficacy

Sleep disturbances—Although there was a significant time main effect ($F=11.52$, $P<.0001$) with a decrease in sleep disturbances over time, the group main effect ($F=1.86$, $P=0.16$) and the group $\times$ time interaction ($F=0.25$, $P=0.96$) for the PSQI total score were not significant (see Table 2). There was a significant group main effect for daily disturbances ($F=4.89$, $P=0.008$), with the TYP group reporting lower scores than the STP ($F=9.55$, Least Square Mean (LSM) TYP: 2.26 vs STP: 2.75, $P=0.002$), but neither group different than UC (LSM: 2.45). Contrast comparisons revealed that women in the TYP group reported significantly fewer daily disturbances than women in the STP and UC groups at 1-week ($F=4.67$, $P=0.03$, Cohen's $D=-0.41$; $F=5.05$, $p=0.025$, Cohen's $D=-0.39$, respectively; LSM TYP: 2.47, STP: 2.90, UC: 2.88). Contrast comparisons for the other time points are presented in Figure 2, revealing group differences between TYP and STP remained over time. The main effects, time $\times$ group interactions, and contrast comparisons were not significant for sleep efficiency, perceived sleep quality, or use of sleep medications. Effect size estimates for the 1-week follow-up time point are presented in Table 3.

Fatigue—There was a significant main effect of time ($F=19.19$, $P<0.0001$), with significant increases in fatigue at the 1 week and 3 month time points and returning to baseline at 6 and 12 months (see Table 2). However, the group main effect ($F=0.12$, $p=0.89$), contrast comparisons, and the group $\times$ time interaction ($F=0.49$, $p=0.82$), were not significant.

Actigraphy—Although the group main effect was not significant, there was a significant group $\times$ time interaction for WASO ($F=2.50$, $P=0.03$). At 1-week, women in the TYP and UC groups reported significantly shorter WASO times than those in the STP group ($F=14.09$, $P=0.0003$, Cohen's $D=-0.96$ and $F=15.09$, $P=0.0002$, Cohen's $D=-0.91$, respectively; LSM: TYP: 44.72; STP: 60.09; UC: 45.61), with no differences noted at any of the other time points. For sleep efficiency, there was no group main effect, but there was a significant group $\times$ time interaction ($F=2.56$, $P=0.02$) (Table 2). Contrast comparisons revealed that the TYP group had significantly higher sleep efficiency than STP 1 week ($F=5.45$, $P=0.02$; LSM: TYP: 82.69 vs STP: 80.02, Cohen's $D=0.53$), with no differences between either group and UC (LSM=81.92) (Table 2). The histograms of studentized residuals from the mixed models for WASO and sleep efficiency looked slightly right- and left-skewed, respectively. A log and a square root transformation was thus applied to each of the outcomes, respectively, resulting in approximate normality of the residuals. After the log transformation for WASO, the group $\times$ time interaction became non-significant, with the 1-week outcomes remaining the same. The outcomes remained the same for sleep efficiency after a square root transformation was applied. There was no group main effect or group $\times$ time interaction for sleep latency and total sleep time, and no contrast comparisons were significant. Effect size estimates for the 1-week follow-up time point are presented in Table 3.

Class Attendance and Out of Class Practice—Exploratory analyses examined the association between class attendance and out of class practice and outcomes, covarying for baseline. Number of classes attended was not associated with any of the outcomes; however, there was little variance, as most participants attended all 4 classes (TYP: 72.97%; STP: 73.53%). TYP participants who indicated they practiced at least 2 times per week compared to those who practiced less often reported less daily disturbances at 3 months (LSM: 2.01 vs 2.66, $F=5.49$, $P=0.024$, Cohen's $D=-0.74$) and better overall sleep quality (LSM: 5.01 vs. 7.47, $F=6.09$, $P=0.018$, Cohen's $D=-0.78$), better sleep efficiency (LSM: 0.53 vs. 1.50, $p=0.01$, $F=6.86$, $P=0.01$, Cohen's $D=-0.82$), and better perceived sleep quality (LSM: 2.10 vs 3.51, $F=4.54$, $P=0.04$, Cohen's $D=-0.67$) 6 months post treatment. A practice effect was not found for those in the STP group for any outcome. When we compared the TYP participants who practiced at least 2 times per week to the UC group, we found TYP participants reported fewer daily disturbances at 3 months (LSM: TYP=1.97, UC=1.56, $F=5.95$, $P=0.017$, Cohen's $D=-0.67$) and better sleep efficiency at 6 months (PSQI sleep efficiency subscale LSM: TYP=0.45, UC= 1.37; $F=5.14$, $P=0.026$, Cohen's $D=-0.61$). Frequency of practice was not associated with BFI scores or actigraphy data.

Although there were no group differences between participants with and without missing data on demographic, medical, or the outcome variables at baseline (except for PSQI total score), we imputed 20 values for the missing data using multiple imputations (SAS V9.2 MI procedure) with Markov Chain Monte Carlo method and then used the MIANALYZE procedure to generate statistical inferences. All the analyses remained the same or resulted in similar p values.

DISCUSSION

We examined a TYP program targeting sleep disturbance and fatigue in women undergoing chemotherapy for breast cancer. Group differences mainly emerged when comparing TYP to STP, suggesting that the STP had worse daily sleep disturbances than TYP and more minutes being awake after sleep onset (WASO) than both TYP and UC, which did not differ from each other except for daily sleep disturbances at the end of program with the differences disappearing over time. However, there were no statistically significant group differences for the primary outcomes of total sleep disturbance and fatigue, limiting the clinical significance of the findings. Sleep disturbance scores remained in the clinically significant range over time and fatigue levels did increase significantly during treatment, but then returned to baseline levels by the 6 and 12 month time points. It was found, however, that patients who reported practicing TYP two or more times a week did have better sleep outcomes than those who did not and better than those in the UC group 3 and 6 months after the program, with medium to large effect sizes.

A reason for the modest effects of TYP in the current study compared to our past studies and those of others examining the effects of yoga may be due to frequency of instruction and time of instruction. In our prior studies of a similar TYP²⁷, our work with Tibetan Yoga for lung cancer patients and their caregivers³⁴, and our Indian-based yoga research, the patient-instructor contact varied from a low of seven, weekly, 60-minute sessions²⁷ up to 18 60-minute sessions (three times a week for 6 weeks)³⁵. In the current trial, patients had a

maximum of four, 90-minute, sessions. The original trial design was to deliver seven, weekly 60-minute sessions over 7 weeks. However, due to the fact that many patients started to receive paclitaxel every 3 weeks instead of weekly, it became impractical to conduct weekly sessions due to patients not wanting to come to the hospital for their sessions. Future research should ideally have a minimum of six weekly sessions so there is some continuity of practice. If shorter exposure is necessary, then it is critical to ensure patients are willing to engage in the practices outside of class to enhance the benefits and provide them with home-based support.

In fact, we did find that those patients who engaged in the TYP two or more times a week did have better sleep outcomes. This finding is consistent to other yoga studies that found frequency of practice being associated with better outcomes^{14,24,25}. The minimum frequency of yoga practice to achieve positive benefits has yet to be determined, however, it is generally believed that daily practice is ideal. Future studies should examine methods to increase practice frequency outside of class including reminders for practice, engaging local practitioners for convenient booster sessions, and exploring the delivery of yoga classes via mobile technologies.

Although we hypothesized that the TYP would result in better outcomes than STP and UC, it turned out TYP was mainly better than STP, with only one outcome different than UC. The differences between STP and TYP/UC were mainly due to the fact that the STP group did not get better over time as was seen with the other two groups. It remains unclear why simple stretching exercises would slow down improvement in sleep outcomes after chemotherapy relative to usual care. Chart reviews did not reveal any clues.

There are a number of limitations with this study. Recruiting patients undergoing chemotherapy was challenging resulting in a 56% participation rate. Moreover, 22% dropped out of study prior to randomization and another 20% did not provide any follow-up data and, therefore, were not included in the analyses. However, we noted that there were no systematic differences on any factors between those who provided follow-up data or were lost to follow-up diminishing concerns of a biased sample. The high rate attrition may have resulted in the trial being underpowered. However, it is unlikely that a larger sample size would have changed the findings. This was also a single-center study with a relatively homogeneous patient population. The patient-instructor encounter time was also limited and this may have been the main reason for a lack of benefit when comparing TYP to UC. In addition, the classes were delivered in one-on-one format, removing the possible benefits derived from teaching yoga in a group format where participants receive social support. The study was not *a priori* powered to detect clinically significant group differences, however, most group differences were classified as medium to large effects. In addition, due to the exclusion of the 54 patients who were not on treatment during the trial, our analyses were not entirely consistent with the intent-to-treat principle. Instead it is deemed a per-protocol analysis based on women who were randomized and met the study eligibility criteria. The trial was also not conducted in a blinded manner as to the group assignment. As there were two active intervention groups, participants could have been informed that we are testing two different behavioral interventions to improve aspects of QOL. In this way, participants would not have known the details of each intervention group and patients in both groups

would have thought they were getting the active intervention. This is the model our laboratory and others are now using for mind-body research. However, when the current study was launched this innovative approach was not being used. We also did not inquire about expectations of the benefits of the interventions programs, which could have influenced outcomes.

Even with the limitations, it is notable that there were some modest short-term benefits associated with TYP, even though patients had only up to 4 in-person sessions spread over 4–12 weeks. It is also encouraging to see that the frequency of practice outside of class was associated with improved sleep outcomes over time. The findings suggest that it is ideal to have more than four in-person sessions to improve patient outcomes and the minimum dose necessary to improve outcomes was previously unknown. Future research using shorter in-class instruction exposure should focus on increasing patient engagement in the practices after leaving the formative instructional portion of the intervention.

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Fig. 1.
CONSORT diagram.
Abbreviations: TYP, Tibetan Yoga Program; STP, Stretch Program; UC, Usual Care.

Fig 2.

Contrast comparisons for daily disturbances subscale of the (a) Pittsburg Sleep Quality Index – Total, (b) Pittsburgh Sleep Quality Index – Daily Disturbances, and (c) Brief Fatigue Inventory. CONTRAST statements within the mixed procedure were used to test for group differences adjusting for stage of disease, type of surgery, chemotherapy regimen (weekly versus every 3 weeks), timing of chemotherapy (adjuvant versus neoadjuvant), menopausal status, age, and time since diagnosis.

Abbreviations: TYP, Tibetan Yoga Program; STP, Stretch Program; UC, Usual Care.

* TY<ST ($p=0.031$), TY<UC ($p=0.025$)

† TY<ST ($p=0.002$)

‡ ST>UC ($p=0.026$)

TY<ST ($p=0.013$)

Table 1

Participant Demographic and Clinical Characteristics at Baseline

	TYP (n=74)	STP (n=68)	UC (n=85)	p-value
Age (years: mean, SD)	49.5 (9.8)	50.4(10.3)	49(10 1)	0.715
Race (n=222)				0.572
White	43 (58.1)	46 (68.7)	53 (65.4)	
Hispanic	12(16.2)	6 (9.0)	12(14.8)	
Black	9(12.2)	10(14.9)	12(14.8)	
Asian	6(8.1)	4 (6.0)	2 (2.5)	
Other/unknown	4 (5.4)	1 (15)	2 (2.5)	
Employment status (n=220)				0.622
Employed full-time	38 (52.8)	31 (47.0)	41 (50.0)	
Employed part-time	8(11.1)	14(21.2)	14(17 1)	
Not employed	26 (36.1)	21 (31.8)	27 (32.9)	
Education (n=221)				0.687
High school or technical school	13(18.1)	12(18.2)	17(20.5)	
Some college	11 (15.3)	16 (24.2)	18(21.7)	
Higher education	48 (66.7)	38 (57.6)	48 (57.8)	
Income (n=204)				0.769
>75,000	36 (52.9)	31 (51.7)	33 (44.4)	
<75,000	32 (47.1)	29 (48.3)	43 (56.6)	
Time since diagnosis (days: mean, SD)	19.3(30.1)	15.2(11.1)	15(8.8)	0.290
Stage				0.538
I	18 (24.3)	16 (23.5)	16(18 8)	
II	39 (52.7)	42 (61.8)	48 (56.5)	
III	17(23.0)	10(14.7)	21 (24.7)	
Chemotherapy regimen (n=226)				0.156
Weekly	55 (74.3)	49(73.1)	72 (84.7)	
Every 3 weeks	19(25.7)	18 (26.9)	(18(15.3)	
Timing of chemotherapy				0.473
Neo-adjuvant	33 (44.6)	35 (51.5)	46 (54.1)	
Adjuvant	41 (55.4)	33 (48.5)	39 (45.9)	
Surgery				0.394
Segmental	26 (35.1)	31 (45.6)	26 (30 6)	
Mastectomy	22 (29.8)	16 (23.5)	29 (34.1)	
Mastectomy with reconstruction	26 (35.1)	21 (30.9)	30 (35.3)	
Menopausal				0.926
Pre-menopausal	35 (47.3)	34 (50.0)	40 (47.1)	
Menopausal	39 (52.7)	34 (50.0)	45 (52.9)	

Table 2

Raw Means (Standard Deviations) for BFI, PSQI, and Actigraphy Over Time

	Baseline			1-week post treatment			3-months			6-months			12-months		
	TYP	STP	UC	TYP	STP	UC	TYP	STP	UC	TYP	STP	UC	TYP	STP	UC
BFI	2.6 (2.1)	2.8 (2.2)	2.6 (2.1)	3.2 (2.4)	3.7 (2.3)	3.5 (2.5)	3.0 (2.4)	2.9 (2.2)	2.9 (2.4)	2.7 (2.1)	2.3 (2.1)	2.2 (2.0)	2.5 (2.4)	2.2 (1.9)	2.1 (2.1)
PSQI															
Total	7.8 (3.7)	8.5 (3.9)	8.1 (4.2)	7.3 (3.6)	8.2 (4.4)	8.1 (4.4)	7.0 (3.9)	8.3 (4.2)	7.1 (4.4)	6.4 (3.6)	7.1 (3.9)	6.4 (3.9)	6.3 (4.1)	6.5 (3.4)	6.1 (3.9)
SE	1.5 (1.6)	1.8 (1.9)	1.8 (2.0)	1.5 (1.8)	1.6 (1.9)	2.6 (1.2)	1.5 (1.8)	1.7 (1.8)	1.7 (2.0)	1.0 (1.2)	1.4 (1.7)	1.4 (1.8)	1.4 (1.8)	1.3 (1.5)	1.2 (1.5)
PSQ	3.7 (2.3)	3.7 (2.1)	3.6 (2.0)	3.2 (1.8)	3.6 (2.3)	3.5 (2.3)	3.1 (2.2)	3.8 (2.4)	2.8 (2.0)	2.9 (2.2)	3.0 (2.1)	2.8 (1.9)	2.8 (2.2)	2.7 (2.0)	2.6 (2.0)
DD	2.7 (1.0)	2.9 (1.1)	2.6 (1.1)	2.6 (1.2)	3.0 (1.2)	3.0 (1.1)	2.4 (1.1)	2.9 (1.3)	2.6 (1.1)	2.5 (1.1)	2.7 (1.3)	2.3 (1.0)	2.1 (1.2)	2.5 (1.2)	2.3 (1.1)
Actigraphy															
SE (%)	81.2 (6.7)	80.7 (6.6)	81.4 (6.1)	81.9 (4.8)	79.6 (6.2)	81.4 (6.6)	79.7 (5.9)	81.9 (4.4)	81.3 (5.7)	81.8 (5.1)	79.7 (12.3)	80.8 (6.4)	81.6 (5.5)	82.0 (4.9)	83.3 (3.8)
OL (min)	34.4 (22.2)	29.5 (17.9)	32.9 (19.2)	34.7 (16.4)	32.6 (22.6)	29.9 (16.5)	35.2 (24.9)	27.6 (13.0)	32.1 (21.0)	32.9 (23.2)	43.2 (33.2)	30.6 (15.9)	40.0 (26.4)	31.8 (20.2)	34.1 (18.0)
TST (hr)	7.2 (0.8)	7.1 (1.1)	7.1 (1.1)	7.3 (0.9)	7.2 (1.1)	7.3 (0.9)	7.0 (1.0)	7.4 (1.1)	7.4 (1.0)	7.1 (0.8)	7.3 (1.4)	6.9 (1.0)	7.3 (0.8)	7.3 (1.1)	7.2 (0.9)
WASO (min)	44.0 (25.4)	48.4 (17.1)	48.8 (21.2)	45.0 (17.9)	60.7 (20.2)	49.6 (17.7)	50.8 (20.8)	52.3 (20.7)	49.7 (20.5)	41.2 (16.7)	42.4 (9.6)	50.1 (22.6)	39.9 (8.9)	45.5 (15.7)	44.6 (16.3)

Abbreviations: BFI, Brief Fatigue Inventory; PSQI, Pittsburgh Sleep Quality Index; PSQI-SE, Pittsburgh Sleep Quality Index-Sleep Efficiency; PSQI-PSQ, Pittsburgh Sleep Quality Index-Perceived Sleep Quality; PSQI-DD, Pittsburgh Sleep Quality Index-Daily Disturbance; Actigraphy SE (%), Sleep Efficiency in percent; Actigraphy OL (min), Onset Latency in minutes; Actigraphy TST (hr), Total Sleep Time in hours; Actigraphy WASO (min), Wake After Sleep Onset in minutes.

Table 3

Effect Sizes (ES) and P Values for BFI and PSQI at 1-Week Post Treatment

	1-week post treatment					
	TYP vs. UC		STP vs. UC		TYP vs. STP	
	ES	p-value	ES	p-value	ES	p-value
BFI	-0.11	0.53	0.05	0.76	-0.16	0.39
PSQI-Total	-0.18	0.32	0.06	0.75	-0.24	0.22
PSQI-SE	-0.01	0.95	-0.001	0.99	-0.009	0.96
PSQI-PSQ	-0.07	0.69	-0.06	0.72	-0.005	0.98
PSQI-DD	-0.39	0.025	0.02	0.92	-0.41	0.031