Published in final edited form as:
Psychooncology. 2012 July ; 21(7): 695–705. doi:10.1002/pon.1969.

Initial evaluation of an Internet intervention to improve the sleep of cancer survivors with insomnia

Lee M. Ritterband, Ph.D.*, **Elaine T. Bailey, Ph.D.**, **Frances P. Thorndike, Ph.D.**, **Holly R. Lord, Ph.D.**, **Leah V. Farrell, Ph.D.**, and **Lora D. Baum, Ph.D.**
Department of Psychiatry and Neurobehavioral Sciences, University of Virginia Health System, Charlottesville, VA, USA

Abstract

Objective—Insomnia is a common complaint among cancer survivors. Fortunately, cognitive-behavioral therapy for insomnia (CBT-I) has been shown to be an effective treatment in this population. However, it is rarely implemented given its limited availability. To address this barrier, we examined the ability of an easily-accessible online CBT-I program to improve insomnia symptoms in cancer survivors.

Methods—Twenty-eight cancer survivors with insomnia were randomly assigned to either an Internet insomnia intervention (n=14) or to a waitlist control group (n=14). The online program, Sleep Healthy Using the Internet, delivers the primary components of CBT-I (sleep restriction, stimulus control, cognitive restructuring, sleep hygiene, and relapse prevention). Pre- and post-assessment data were collected via online questionnaires and daily sleep diaries.

Results—Participants in the Internet group showed significant improvements at post-assessment compared to those in the control group in overall insomnia severity ($F_{1,26}$=22.8; P<.001), sleep efficiency ($F_{1,24}$=11.45; P=.002), sleep onset latency ($F_{1,24}$=5.18; P=.03), soundness of sleep ($F_{1,24}$=9.34; P=.005), restored feeling upon awakening ($F_{1,24}$=11.95; P=.002), and general fatigue ($F_{1,26}$=13.88; P=.001). Although other group x time interactions were not significant, overall adjusted effect sizes for all sleep variables as well as for fatigue, depression, anxiety, and quality of life ranged from small to large.

Conclusions—CBT-I delivered through an interactive, individually-tailored Internet intervention may be a viable treatment option for cancer survivors experiencing insomnia.

Keywords

cancer; oncology; sleep; insomnia; CBT-I; Internet

INTRODUCTION

As many as 63% of cancer patients and survivors experience disturbed sleep [1–5] and more than 30% meet criteria for insomnia [1, 4, 6, 7]. This insomnia rate is 2–3 times higher than that of the general population [8] where insomnia is associated with decreased quality of life, greater work absenteeism, depressive symptoms, and increased healthcare usage [9–11]. Insomnia reportedly impacts cancer patients' ability to cope with stress, carry out activities, and concentrate [1]. Insomnia in this population is also associated with mood disturbances, decreased quality of life, fatigue, and immunosuppression [1, 12–14].

*All correspondence should be sent to Lee M. Ritterband, Department of Psychiatry and Neurobehavioral Sciences, Behavioral Health & Technology, University of Virginia Health System, P.O. Box 801075, Charlottesville, Virginia 22908. LEER@virginia.edu.

Sleep disturbances are commonly addressed with pharmacotherapy, an effective short-term treatment for those with primary insomnia [15–17]. Although many cancer patients and survivors are prescribed sleeping medications [1, 4], pharmacotherapy presents several drawbacks for this population. First, little research has been conducted on the use of hypnotics in the context of cancer treatment and recovery [3]. Furthermore, hypnotic medications treat the symptoms of insomnia rather than the underlying cause, increase the risk for tolerance/dependence, frequently cause residual next-day effects, and have the potential for negative interactions with other medications that cancer survivors may take [3, 12, 18]. For these reasons, non-pharmacological treatments such as cognitive-behavioral therapy for insomnia (CBT-I) can present an attractive alternative for cancer survivors experiencing poor sleep.

Although the most common precipitating factors for sleep disturbance are psychological stress and/or major life changes (e.g., a cancer diagnosis), different maladaptive behaviors and dysfunctional thoughts typically perpetuate the problem. In fact, sleep difficulties often become independent of precipitating factors. At its core, CBT-I works to examine and change the thoughts and behaviors that frequently perpetuate insomnia [19–21]. It accomplishes this through five treatment components: sleep restriction, stimulus control, cognitive restructuring, sleep hygiene, and relapse prevention [19, 20, 22]. The validity of CBT-I has been well-established [17, 23, 24]; in 2005 the NIH State-of-the-Science Conference Statement acknowledged CBT-I as the first-line approach to insomnia treatment, one that may be even more effective in improving sleep in the long term than medications [17]. Recent evidence suggests CBT-based treatments may also be effective for treating cancer survivors with insomnia [25–31]. Despite its advantages, CBT-I is significantly underutilized for a number of reasons, including a limited number of providers trained in its delivery, poor geographical distribution of those providers who have adequate training, and limited insurance reimbursement [32, 33].

One approach to increase access to CBT-I is the use of the Internet as a means for intervention delivery. The Internet is increasingly being used as a resource for delivering a wide variety of behavioral and mental health programs with excellent success [34–36]. Disseminating interventions in this way significantly increases access to care, allowing greater numbers of people to receive treatment than would otherwise be possible. In Espie's model of stepped care for insomnia [37], the use of the Internet is advocated as a first step in providing treatment for insomnia.

There is already research documenting the feasibility and efficacy of Internet interventions for insomnia [38–41]. Specifically, Sleep Healthy Using the Internet (SHUTi, pronounced "Shut-Eye"), an individually-tailored, interactive intervention based on CBT-I, has been shown to significantly improve sleep in adults with primary insomnia [39]. The current article reports on the use of SHUTi to treat insomnia in a cancer survivor population. We hypothesized that those who have access to and utilize SHUTi would experience sleep improvements, particularly reduced insomnia severity and increased sleep efficiency, compared to the control group. We also explored whether fatigue, mood, and quality of life improved following the intervention.

METHODS

Participants were recruited between July 2008 and July 2009 using flyers placed in the University of Virginia's Cancer Center and the surrounding community, notices in Cancer Center newsletters and local newspapers, letters sent directly to patients of Cancer Center physicians, and online postings (Figure 1). The study was open to adults (age 21 or older) with regular Internet access and in remission from any stage and any type of cancer as long

as at least one month had passed since the completion of active treatment (radiation, chemotherapy, or surgery). In addition to meeting the DSM-IV-TR [42] definition of insomnia, participants had to report poor sleep for at least 6 months, difficulty sleeping at least 3 nights per week, daytime consequences of sleep disturbance (e.g. fatigue, performance deficits, mood disturbance), and no more than 6.5 hours of sleep per night on average over the past month. To be eligible, participants' cancer diagnosis or cancer treatment had to either cause the insomnia or worsen existing sleep problems based on self-report.

Exclusion criteria included having a diagnosis of a sleep disorder other than insomnia (e.g., sleep apnea, restless legs syndrome, narcolepsy) or a major psychiatric or medical condition other than cancer suspected to contribute to their sleep disturbance. Participants undergoing psychotherapy could enroll as long as they had not started psychotherapy within the past 3 months and were not receiving treatment specifically for insomnia. Other exclusion criteria included an unstable medication regimen, shift work schedule or other irregular sleep pattern, and pregnancy. All participants completed the informed consent process and were paid $100 upon study completion. This study was approved by the Institutional Review Board at the University of Virginia Health System.

Procedure

Potential participants contacted the research center via phone or email. A member of the research staff conducted a brief phone screen before inviting potentially eligible participants to attend an in-person screening session. During this visit, participants completed the informed consent process and participated in a semi-structured interview to ensure eligibility. At the conclusion of the visit, eligible participants were provided unique usernames and passwords to access the Internet program. Staff spent approximately 15 minutes instructing each participant on how to log in and navigate the initial elements of the program that all participants would view, such as how to complete online sleep diaries. Participants then entered the pre-assessment period in which they completed an online battery of questionnaires at home as well as daily online sleep diaries. Automatic daily email reminders prompted participants to enter their sleep diary data. After completing 10 days of sleep diaries within a 2-week period, participants received an email with notification of their assignment to either the experimental (Internet) or waitlist control group. Random group assignment was based on a computer-generated randomization schedule managed by the project coordinator (E.T.B.).

Although the core content of SHUTi can be reviewed in as few as 6 weeks, Internet participants were provided access to SHUTi for 9 weeks. At the conclusion of the intervention period, all participants entered the post-assessment period where they were again instructed to complete an online battery of questionnaires and 10 days of daily online sleep diaries (with daily email reminders). Following study completion, control participants were provided access to the SHUTi program, but no follow-up data was collected.

Internet Intervention for Insomnia

The SHUTi program, based on well-validated face-to-face CBT-I [17], includes six interactive cores. The first core, "Overview," provides an introduction to SHUTi and builds rationale for the intervention. The next two cores, "Behavior 1" and "Behavior 2," introduce sleep restriction (e.g., following an algorithmically-determined sleep window) and stimulus control (e.g., limiting time spent awake in bed in order to re-associate the bed and bedroom with sleep). The "Education" core focuses on sleep hygiene, and the "Sleep Thoughts" core helps users to identify and restructure unhelpful beliefs about sleep. The final core, "Problem Prevention," covers relapse prevention. Users are initially granted access to both

the Overview and Behavior 1 core and are subsequently provided access to a new core one week after completion of the previous core, thus allowing users time to consolidate what has been learned in each core. Each core takes between 45 and 60 minutes to complete, and users are able to revisit them at any time.

The SHUTi program provides a high degree of individual tailoring and feedback. This is accomplished, in part, by prompting SHUTi users to enter daily sleep diary data during the intervention. At the beginning of each core, users receive tailored sleep recommendations based on their diary data. Each core contains numerous interactive elements and includes a combination of text, graphics, vignettes, and animation. Automated emails are sent throughout the program to inform the users as to next steps (e.g., time to begin new cores or fill in diaries) as well as to encourage adherence (e.g., notifications that new cores will be available in a specified number of days; encouragement to log back in after periods of time without logins). The program was developed and evaluated based on the behavior change model for Internet interventions [43]. This model was developed to guide Internet intervention development and help predict and explain behavior changes and symptom improvement targeted by Internet interventions. It suggests that effective Internet interventions produce and maintain behavior change and symptom improvement based on a number of components including those focused on the user, environmental factors, website use and adherence, and support and website characteristics. No modifications were made to SHUTi for this trial. For a complete description of the SHUTi program, see Thorndike et al., 2008 [44].

Dependent Measures

Insomnia Severity Index—Participants completed the ISI [19, 45], a 7-item index of subjective sleep difficulty, as part of the online battery administered at pre- and post-assessment. The ISI uses a 5-point Likert scale to rate difficulty with sleep onset, sleep maintenance, and early morning awakenings, as well as interference with daytime functioning, how noticeable sleep problems are to others, distress caused by problematic sleep, and overall sleep satisfaction. Total scores range from 0–28 with higher scores indicating greater insomnia severity. ISI is a reliable, valid measure that can be delivered online [46] and is sensitive to changes in treatment studies [45].

Sleep Diary—Sleep diaries are widely used as a reliable and valid method to collect prospective sleep data [24]. In this study, participants completed online daily sleep diaries during pre- and post-assessment. In order to complete a given assessment period, participants were instructed to fill out 10 days of diary data within a 2-week period. While this was required at baseline, meaning the participant would not be able to continue if 10 diaries were not completed, at post-assessment, participants' diaries were included in data analysis as long as at least seven were completed. Although participants were encouraged to fill out diaries on a daily basis, the program accepted information that was up to 3 days old. The online sleep diaries contained ten standard questions including information about bedtime, sleep onset latency, number of awakenings, total length of awakenings, wake time, arising time, daytime naps, rating of soundness of previous night's sleep, rating of refreshed feeling upon morning awakening, and information about sleep aids (medication and/or alcohol use details).

Fatigue, Mood, and Quality of Life—All other measures were also delivered online. The Multidimensional Fatigue Symptom Inventory-Short Form (MFSI-SF) is a 30-item validated instrument that assesses fatigue in the past week and includes subscales of general fatigue, physical fatigue, emotional fatigue, mental fatigue, and vigor [47, 48]. The Hospital Anxiety and Depression Scale (HADS) [49] is a 14-item validated measure that is widely

used to assess mood in medical settings [50]. Quality of life was assessed using the SF-12, a 12-item scale that has been found to be a reliable and valid patient-based assessment of physical and mental health[51].

Internet Evaluation—To assess their experience using SHUTi, participants completed the Internet Intervention Utility Questionnaire (UQ) [44]. The UQ contains general questions relevant to all Internet interventions, as well as a few questions tailored to the particular Internet intervention being evaluated. The 16-item measure uses a 5-point Likert scale (0–4, with 4 indicating most positive response) to assess usability, likeability, usefulness, understandability, and convenience of the Internet intervention. A previous version of this scale was administered to users of a different Internet intervention and showed acceptable internal reliability (α=.69) [52]. The UQ also includes two additional open-ended questions that inquire about the most and least helpful aspects of the program to assist with future modifications to the system.

Statistical Analysis

Descriptive statistics were computed for age, sex, race, marital status, education, type and stage of cancer at diagnosis, time since completion of active treatment, and duration and frequency of sleep difficulties. Baseline comparisons were made using t-tests for continuous variables (e.g. age, education) and χ^2 tests for categorical variables (e.g. sex, race). A 2 (Internet and control group) × 2 (pre- and post-assessment) repeated-measures analysis of variance was conducted to compare changes across time. Primary outcome variables are ISI, SE, and TST. For those variables with a significant overall interaction, paired-sample t-tests were used to examine time effects within treatment group. Effect sizes were calculated and presented for all measures because of the limitations small sample sizes pose to significance testing [53]. Pre to Post effect sizes by group were computed as standardized mean differences (SMDs) using pooled baseline SDs, and Hedge's correction for small sample size. These SMDs by group were used to compute an adjusted treatment effect size to account for changes in both groups with one statistic. The adjusted effect size was computed by subtracting the control group Pre-Post SMD from the experimental group Pre-Post SMD. All effect sizes are presented so that a positive ES indicates an improvement in symptoms and a negative ES indicates worsening of symptoms. Results are reported using completers analyses. However, intent-to-treat analyses using the last observation carried forward were also conducted for variables with missing data, and results did not significantly differ. All analyses were conducted using the statistical software, SPSS for Windows version 17.0 (SPSS Inc, Chicago, Illinois).

RESULTS

Of the 29 participants who enrolled, 14 were randomized to immediately receive the Internet insomnia intervention (SHUTi) and 14 were randomized to the waitlist control condition; one participant became ineligible due to a return to active treatment for his cancer (thus his data is not included in analyses). On average, participants were 56.7 years of age and had completed 17.0 years of education. The majority were married (79%) and white (93%). Most participants' self-reported cancer diagnosis was either Stage I (46%) or Stage II (21%), and nearly 4 years had passed since the completion of their active treatment. On average, participants reported experiencing sleep difficulties for over 6 years and were currently experiencing disrupted sleep on more than 5 nights per week at the onset of the study.

There were no significant differences between the Internet and control groups on the baseline characteristics of age, ethnicity/race, marital status, years of education, cancer stage, time since completion of active treatment, duration of sleep difficulties, or frequency

of sleep difficulties (Table 1). There were, however, significant baseline differences for sex and cancer type. Females accounted for 86% of the sample, and, with no a priori plans to stratify on sex, the four male participants were randomly assigned to the control condition (χ^2=4.67, p=.03). Cancer type was also not evenly distributed between groups with 93% of the Internet participants carrying a breast cancer diagnosis compared to 36% of the control group (χ^2=10.0, p<.01). Importantly, there were no significant group differences at baseline on any of the outcome measures with the following exceptions: Internet participants reported feeling less restored upon awakening (p=.03) and had lower scores on the MRSI-Vigor subscale (p=.02).

Ninety-six percent of participants reported that they felt at least “comfortable” using the Internet and 82% of participants reported checking email at least once per day. There were no significant differences between the Internet and control groups in Internet comfort or use.

Insomnia Severity

All participants completed the ISI at both time points and were included in the analysis. There was a significant group x time interaction effect with the Internet group showing a marked improvement in insomnia severity from pre- to post-assessment, and the control group showing no significant change ($F_{1,26}$=22.8; p<.01). More specifically, the Internet group dropped from an ISI score of 17.1 at pre-assessment to 8.2 at post-assessment, (t(13)=10.15, p<.01), while the control group showed no significant change: ISI of 15.9 at pre-assessment and 14.4 at post-assessment, (t(13)=1.24, p=0.2; see Figure 2). Per Cohen’s guidelines [54], the adjusted ES indicates a large SHUTi treatment effect for insomnia severity (d=1.85).

Gains made by participants who used SHUTi were also clinically significant. At baseline, 9 out of 14 participants (64%) in each group had ISI scores in the “clinically significant” range of insomnia, as defined by an ISI score of greater than 14 [19]. The remaining five participants in each group all had ISI scores in the “subthreshold insomnia” range (ISI score in the range of 8 to 14); no participant had an ISI score in the “no insomnia” range (ISI <8). After using SHUTi, only 2 of the 14 (14%) Internet participants still had “clinically significant” levels of insomnia symptoms (ISI >14), compared to 8 of 14 control participants (57%). In addition, 7 of 14 (50%) Internet participants had ISI scores in the “no insomnia” range, compared to just 2 of 14 (14%) control participants.

Sleep Diary Variables

All participants completed 10 diaries at baseline assessment, and 26 of 28 (93%) completed 7 or more diaries at post assessment, and were therefore included in the repeated-measures analysis of variance (Table 2). Regarding sleep efficiency, a significant group x time interaction was found ($F_{1,24}$=11.45; p<.01). Internet participants improved their sleep efficiency by 19% over baseline (t(12)=−6.83, p<.01), while control participants improved by just 6% (t(12)= −2.19, p<0.05). Of note, at pre-assessment, the average sleep efficiency of participants in both groups (72.16% for Internet participants; 75.55% for control participants) fell below 85%, as is typically seen in patients with insomnia [20]. At post-assessment, however, the average sleep efficiency of Internet participants had increased to 85.67%, exceeding the 85% mark, while the average of those in the control group was just 79.75%, still in line with the <85% sleep efficiency associated with insomnia. Adjusted ES signifies a medium-to-large treatment effect (d=.72) for sleep efficiency. There was not, however, a significant group x time interaction for total sleep time (TST; p=.16), the other primary outcome variable in this study; however, there was a small-to-medium treatment effect (d=.32).

Analysis for sleep onset latency (SOL) also revealed a significant group x time interaction ($F_{1,24}$=5.18; p=.03). More specifically, participants who used the Internet program shortened their SOL by 59% (t(12)=3.14, p<.01), compared to a 14% decrease for control participants (t(12)=1.24, p=0.24). As with sleep efficiency, adjusted ES revealed a medium-to-large treatment effect (d=.67) for SOL. Although there was no significant interaction for wake after sleep onset (WASO; p=.32), time in bed (TIB; p=.12), or number of awakenings (p=.09), adjusted ES for these variables ranged from .22 (WASO) to .43 (number of awakenings).

Participants were asked to rate both the soundness of their previous night's sleep, as well as how restored they felt upon awakening as part of their sleep diaries. A significant interaction was found for both variables, with Internet users showing significantly more improvements than those in the control group on soundness of sleep ($F_{1,24}$=9.34, p<.01) and feeling restored ($F_{1,24}$=11.95, p<.01). Adjusted ES for these subjective ratings were both large (1.21 and 1.35, respectively).

Fatigue, Mood, and Quality of Life

All participants completed the online questionnaires for fatigue, mood, and quality of life and were included in the analyses. As seen in Table 3, a significant group x time interaction was found for the overall measure of fatigue, MFSI-SF ($F_{1,26}$=13.88, p<.01). Participants in the Internet group had significantly improved fatigue scores from 22.86 to 9.50 (t(13)=3.63, p<.01); control participants' scores did not improve over time, changing from 13.71 to 19.79 (t(13)= −1.64, p=.12). Several MFSI-SF subscales also had significant group x time interactions, including general fatigue ($F_{1,26}$=9.46, p<.01), mental fatigue ($F_{1,26}$=8.65, p<.01), and vigor ($F_{1,26}$=14.79, p<.01), with Internet participants showing improvements compared to control participants in all cases. While some subscales lacked significant group x time interactions (physical fatigue, p=.11; emotional fatigue, p=.08), adjusted ES for the fatigue variables ranged from a low of .47 to a high of 1.63, indicating a SHUTi treatment effect for fatigue.

On the total HADS score, a measure of anxiety and depression, the group x time interaction was not significant (p=.09). However, the adjusted effect sizes for the total was d=.52; and the subscales, depression and anxiety, were d=.54 and d=.42, respectively. Regarding the SF-12, a measure of quality of life, the group x time interaction for the mental subscale was not significant (p=.09), but the adjusted ES indicated a small-to-medium treatment effect (d=.48). On the physical subscale of the SF-12, the group x time interaction also did not reach significance (p=.52), but the adjusted ES indicated a small treatment effect for SHUTi (d=.21).

Intervention Evaluation

Overall, the intervention was well-received by participants. All of the participants (14/14 participants) indicated that the program was mostly or very easy to use (ratings of 3 and 4 on the 0–4 Likert scale, respectively), and 93% (13/14 participants) described it as mostly or very convenient to use. All participants (14/14 participants) indicated that the intervention material was mostly or very understandable, and 86% (12/14 participants) described the intervention material as useful. Lastly, 71% (10/14 participants) reported that the Internet intervention was mostly or very effective. Participants' also self-reported whether they felt able to follow through with program recommendations with 86% (12/14 participants) indicating that they were at least somewhat (at least a 2 on the Likert scale) able to follow-through with them (64% reporting that they were mostly or very able), and 100% reporting that they were able to keep the sleep diaries during the intervention at least "somewhat well" (57%, 8/14 participants, indicated mostly or very well).

Program Usage

All participants (14/14) in the SHUTi group logged in to the program during the nine week intervention period, ranging from 15 to 61 times (X=38, SD=16). Logins had to be at least five minutes apart to be considered a unique login. Twelve of the 14 (86%) SHUTi users completed all of the six SHUTi cores. One non-completer finished 4 out of 6 cores; the other finished 3 cores. Although SHUTi participants were encouraged but not required to continue to keep their sleep diary during the intervention period, all participants continued to enter diaries, ranging from 31 to 67 diaries completed (X=54, SD=13).

DISCUSSION

Data from previous studies have already established face-to-face CBT-based interventions as effective treatments for cancer survivors with insomnia [25–31]. Research has also shown that CBT-I delivered as an online intervention can successfully help patients with primary insomnia in the general population [38–41]. The current study provides an important link between these two areas of research by demonstrating that CBT-I delivered in an online format can be a feasible and efficacious method for improving insomnia in cancer survivors seeking help for their sleep problems.

Use of the SHUTi program by cancer survivors not only resulted in statistically significant changes but also produced clinically meaningful improvements. These improvements were seen both in insomnia severity, with half the participants in the Internet group having ISI scores in the “no insomnia” range at post-assessment compared to just 14% of those in the control group, and in sleep efficiency, in which the average post-assessment sleep efficiency for those in the control group remained in the clinical range of insomnia, while those in the Internet group exceeded, on average, the 85% cut-off. It is also important to note that all sleep variables demonstrated small to large treatment effects for SHUTi. The data also suggest that addressing cancer survivors’ insomnia may have an impact beyond improving their sleep, as the use of online CBT-I was associated with improvements in fatigue, mood and quality of life.

The dissemination of an insomnia intervention via the Internet has a number of potential benefits to cancer survivors: It can reach large numbers of patients who might not otherwise be able to receive adequate non-pharmacological treatment options for their insomnia; it can provide increased flexibility and convenience for patients already burdened by frequent medical appointments; and it can likely reduce treatment expenses [55]. When evaluating the merits of this intervention for cancer survivors with insomnia, it is also important to note that the treatment effects for the online intervention (which is fully automated and requires no human support) were on par with what has been found in face-to-face delivered group CBT-I for cancer survivors. In fact, the SHUTi effect sizes for insomnia severity (d=2.24), sleep efficiency (d=1.05), sleep onset latency (d=.83), and wake after sleep onset (d=.72) were comparable to those found in a study of face-to-face group CBT-I for cancer survivors (ISI d=1.78; sleep efficiency d=1.33; SOL d=.95; WASO d=1.30) [25].

The results of the current study were also similar to the findings of our previous study of SHUTi and primary insomnia patients [39]. In both studies, adults who received the Internet intervention demonstrated improvements in the main sleep variables, including insomnia severity and sleep efficiency. When SHUTi was used with patients with primary insomnia, large treatment effects were found for insomnia severity (d=2.37), sleep efficiency (d=1.02), and wake after sleep onset (d=1.05); a medium SHUTi treatment effect was observed for SOL (d=.55).

While the present study is characterized by some methodological strengths, including random assignment and control of treatment administration, findings should be placed in context of several limitations. We did not use a stratification scheme when randomizing participants, and, as a result, the Internet and control groups were unbalanced in terms of sex and cancer type. Although there are sex differences in prevalence of insomnia and rates of seeking health information online, a recent study of CBT-I in cancer survivors found that sex did not have a significant impact on response to treatment [26], thus we speculate this sex imbalance did not substantively effect the intervention outcome. Regarding cancer type, breast cancer survivors comprised a disproportionate percentage of the Internet intervention group. Although one prior study found a significant interaction between cancer type and treatment outcome, this effect was no longer significant when tested in a model that also included treatment site (the study was completed at two different locations [26]). However, generalizability of findings may be compromised by this imbalance of cancer type across treatment group and more work needs to be done with non-breast cancer survivors. Lastly, although the trial was adequately powered to detect changes in sleep efficiency based on our previous primary insomnia trial, it was, nonetheless, a relatively small sample. Given the small sample size, some of the non-significant effects may have been significant if the study had been appropriately powered.

As with other studies of CBT-I in cancer survivors [25–27], the fact that participants were predominantly highly-educated Caucasian women of non-Hispanic ethnicity may limit generalizability of findings to men and those with different racial, ethnic, and educational backgrounds. In addition, participants in this study volunteered to be included and were not, for example, identified consecutively in a clinic. Thus, the particular sample may be more motivated to obtain treatment or concerned about their insomnia, further limiting generalizability. Outcomes of the current study should also be considered in light of the extremely low attrition (all participants completed the ISI and other online measures; only 2 of the 28 participants (7%) did not complete sufficient post-assessment diaries). A further potential limitation is the use of subjective sleep diaries to measure sleep rather than more objective means such as polysomnography. However, sleep diaries measured over many nights may actually provide a more accurate picture of sleep disturbance than a single (or even two) nights of polysomnography given the night-to-night variability typically seen in insomnia [24]. Finally, the waitlist control design may not account for nonspecific effects such as participant expectation, and the lack of long-term follow-up in the present study prevents us from ascertaining whether treatment gains were maintained.

Nonetheless, the findings presented here provide supportive evidence that CBT-I delivered over the Internet is a viable treatment option for cancer survivors with insomnia. To extend these findings, future research will need to examine whether cancer survivors maintain these treatment gains over time. Additional research should also compare the online CBT-I intervention with a non-waitlist control group. One option would be to compare the automated, interactive intervention with a static website to determine whether the additional features of an Internet intervention (e.g., tailored treatment recommendations) are warranted. Additionally, online CBT-I could be compared directly with face-to-face CBT-I to better examine possible differences in treatment response. Lastly, findings need to be replicated in a large national trial with a more heterogeneous sample to ensure that findings generalize across a broader sample. In sum, these results indicate that delivering an Internet intervention for cancer survivors with insomnia may be both feasible and efficacious, warranting further examination of this treatment modality.

Acknowledgments

This research was supported by the University of Virginia Cancer Center through the Mary Semmes Scripps Fund for Integrative Medicine. The SHUTi program was initially developed with funds from the National Institute of Mental Health, National Institutes of Health grant R34MH70805. We thank the physicians and patients who participated in this study. We would also like to thank Michelle Hilgart, M.Ed., Samantha Edington, Phoebe Larner, and Desi Vasquez, Ph.D. for their contributions.

References

1. Davidson JR, MacLean AW, Brundage MD, Schulze K. Sleep disturbance in cancer patients. Social Science & Medicine. 2002; 54:1309–21. [PubMed: 12058848]
2. Engstrom C, Strohl R, Rose L, Lewandowski L, Stefanek ME. Sleep alterations in cancer patients. Cancer Nurs. 1999; 22:143–8. [PubMed: 10217030]
3. Savard J, Morin CM. Insomnia in the context of cancer: A review of a neglected problem. J Clin Oncol. 2001; 19:895–908. [PubMed: 11157043]
4. Savard J, Simard S, Blanchet J, Ivers H, Morin CM. Prevalence, clinical characteristics, and risk factors for insomnia in the context of breast cancer. Sleep. 2001; 24:583–90. [PubMed: 11480655]
5. Koopman C, Nouriani B, Erickson V, Anupindi R, Butler LD, Bachmann MH, Sephton SE, Spiegel D. Sleep disturbances in women with metastatic breast cancer. The Breast Journal. 2002; 8:362–70. [PubMed: 12390359]
6. Fiorentino L, Ancoli-Israel S. Sleep dysfunction in patients with cancer. Curr Treat Options Neurol. 2007; 9:337–46. [PubMed: 17716597]
7. Mao JJ, Armstrong K, Bowman MA, Xie SX, Kadakia R, Farrar JT. Symptom burden among cancer survivors: Impact of age and comorbidity. J Am Board Fam Med. 2007; 20:434–43. [PubMed: 17823460]
8. Morin CM, LeBlanc M, Daley M, Grégoire JP, Mérette C. Epidemiology of insomnia: prevalence, self-help treatments, consultations, and determinants of help-seeking behaviors. Sleep Med. 2006; 7:123–30. [PubMed: 16459140]
9. Foley D, Ancoli-Israel S, Britz P, Walsh J. Sleep disturbances and chronic disease in older adults: Results of the 2003 National Sleep Foundation Sleep in America Survey. J Psychosom Res. 2004; 56:497–502. [PubMed: 15172205]
10. Hatoum HT, Kong SX, Kania CM, Wong JM, Mendelson WB. Insomnia, health-related quality of life and healthcare resource consumption. A study of managed-care organisation enrollees. PharmacoEconomics. 1998; 14:629–37. [PubMed: 10346415]
11. Leger D, Massuel MA, Metlaine A. Professional correlates of insomnia. Sleep. 2006; 29:171–8. [PubMed: 16494084]
12. O'Donnell JF. Insomnia in cancer patients. Clinical Cornerstone. 2004; 6:S6–S14.
13. Bardwell WA, Profant J, Casden DR, Dimsdale JE, Ancoli-Israel S, Natarajan L, Rock CL, Pierce JP. The relative importance of specific risk factors for insomnia in women treated for early-stage breast cancer. Psycho-Oncology. 2008; 17:9–18. [PubMed: 17428006]
14. Fleming L, Gillespie S, Espie CA. The development and impact of insomnia on cancer survivors: a qualitative analysis. Psycho-Oncology. 2010; 19:991–6. [PubMed: 20014075]
15. Holbrook AM, Crowther R, Lotter A, Cheng C, King D. Meta-analysis of benzodiazepine use in the treatment of insomnia. CMAJ. 2000; 162:225–33. [PubMed: 10674059]
16. Nowell PD, Mazumdar S, Buysse DJ, Dew MA, Reynolds CF, Kupfer DJ. Benzodiazepines and zolpidem for chronic insomnia: a meta-analysis of treatment efficacy. JAMA. 1997; 278:2170–7. [PubMed: 9417012]
17. National Institutes of Health. NIH State-of-the-Science Conference Statement on Manifestations and Management of Chronic Insomnia in Adults. NIH Consens State Sci Statements. 2005; 22:1–30.
18. Mendelson WB. Pharmacotherapy of insomnia. Psychiatr Clin North Am. 1987; 10:555–63. [PubMed: 3332318]

19. Morin, CM. Insomnia: Psychological assessment and management. The Guilford Press; New York: 1993.
20. Morin, CM.; Espie, CA. Insomnia: A Clinical Guide to Assessment and Treatment. Kluwer Academic/Plenum Publishers; New York: 2003.
21. Espie CA. Insomnia: conceptual issues in the development, persistence, and treatment of sleep disorder in adults. Annu Rev Psychol. 2002; 53:215–43. [PubMed: 11752485]
22. Morin CM. Cognitive-behavioral Therapy of Insomnia. 2006; 1:375–86.
23. Morin CM, Bootzin RR, Buysse DJ, Edinger JD, Espie CA, Lichstein KL. Psychological and behavioral treatment of insomnia: update of the recent evidence (1998–2004). Sleep. 2006; 29:1398–414. [PubMed: 17162986]
24. Morin CM, Hauri PJ, Espie CA, Spielman AJ, Buysse DJ, Bootzin RR. Nonpharmacologic treatment of chronic insomnia: An American Academy of Sleep Medicine review. Sleep. 1999; 22:1134–56. [PubMed: 10617176]
25. Savard J, Simard S, Morin CM. Randomized study on the efficacy of cognitive-behavioral therapy for insomnia secondary to breast cancer, part I: Sleep and psychological effects. J Clin Oncol. 2005; 23:6083–96.10.1200/JCO.2005.09.548 [PubMed: 16135475]
26. Espie CA, Fleming L, Cassidy J, Samuel L, Taylor LM, White CA, Douglas NJ, Engleman HM, Kelly HL, Paul J. Randomized controlled clinical effectiveness trial of cognitive behavior therapy compared with treatment as usual for persistent insomnia in patients with cancer. J Clin Oncol. 2008; 26:4651–8. [PubMed: 18591549]
27. Fiorentino L, McQuaid JR, Liu L, Natarajan L, Cornejo M, Lawton S, Parker BA, Sadler GR, Ancoli-Israel S. Individual cognitive behavioral therapy for insomnia in breast cancer survivors: A randomized controlled crossover pilot study. Nature Sci Sleep. 2010; 2:1–8.
28. Davidson JR, Waisberg JL, Brundage MD, MacLean AW. Nonpharmacologic group treatment of insomnia: a preliminary study with cancer survivors. Psycho-Oncology. 2001; 10:389–97. [PubMed: 11536417]
29. Quesnel C, Savard J, Simard S, Ivers H, Morin CM. Efficacy of cognitive-behavioral therapy for insomnia in women treated for nonmetastatic breast cancer. J Consult Clin Psychol. 2003; 71:189–200.10.1037/0022-006X.71.1.189 [PubMed: 12602439]
30. Epstein DR, Dirksen SR. Randomized trial of a cognitive-behavioral intervention for insomnia in breast cancer survivors. Oncol Nurs Forum. 2007; 34:E51–9. [PubMed: 17878117]
31. Simeit R, Deck R, Conta-Marx B. Sleep management training for cancer patients with insomnia. Support Care Cancer. 2004; 12:176–83. [PubMed: 14760542]
32. Perlis ML, Smith MT, Cacialli DO, Nowakowski S, Orff H. On the comparability of pharmacotherapy and behavior therapy for chronic insomnia. Commentary and implications. J Psychosom Res. 2003; 54:51–9. [PubMed: 12505555]
33. Perlis ML, Smith MT. How can we make CBT-I and other BSM services widely available? J Clin Sleep Med. 2008; 4:11–3. [PubMed: 18350955]
34. Barak A, Hen L, Boniel-Nissim M, Shapira N. A comprehensive review and a meta-analysis of the effectiveness of Internet-based psychotherapeutic interventions. J Tech Hum Serv. 2008; 26:109–60.
35. Marks, IM.; Cavanagh, K.; Gega, L. Hands-on Help: Computer-aided Psychotherapy. Psychology Press; Hove, England and New York: 2007.
36. Murray E, Burns J, See TS, Lai R, Nazareth I. Interactive Health Communication Applications for people with chronic disease. Cochrane Database Syst Rev. 2005:CD004274. [PubMed: 16235356]
37. Espie CA. “Stepped care”: a health technology solution for delivering cognitive behavioral therapy as a first line insomnia treatment. Sleep. 2009; 32:1549–58. [PubMed: 20041590]
38. Vincent N, Lewycky S. Logging on for better sleep: RCT of the effectiveness of online treatment for insomnia. Sleep. 2009; 32:807–15. [PubMed: 19544758]
39. Ritterband LM, Thorndike FP, Gonder-Frederick L, Magee JC, Bailey ET, Saylor DK, Morin CM. Efficacy of an Internet-based behavioral intervention for adults with insomnia. Arch Gen Psychiatry. 2009; 66:692–8. [PubMed: 19581560]
40. Ström L, Pettersson R, Andersson G. Internet-based treatment for insomnia: a controlled evaluation. J Consult Clin Psychol. 2004; 72:113–20. [PubMed: 14756620]

41. Suzuki E, Tsuchiya M, Hirokawa K, Taniguchi T, Mitsuahashi T, Kawakami N. Evaluation of an Internet-based self-help program for better quality of sleep among Japanese workers: A randomized controlled trial. J Occup Health. 2008; 50:387–99. [PubMed: 18716392]
42. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 4. American Psychiatric Association; Washington, D.C: 2000. Text Revision
43. Ritterband LM, Thorndike FP, Cox DJ, Kovatchev BP, Gonder-Frederick LA. A behavior change model for internet interventions. Ann Behav Med. 2009; 38:18–27. [PubMed: 19802647]
44. Thorndike FP, Saylor DK, Bailey ET, Gonder-Frederick L, Morin CM, Ritterband LM. Development and Perceived Utility and Impact of an Internet Intervention for Insomnia. E J Appl Psychol. 2008:4.
45. Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. Sleep Med. 2001; 2:297–307. [PubMed: 11438246]
46. Thorndike, FP.; Ritterband, LM.; Saylor, DK.; Magee, JC.; Gonder-Frederick, L.; Morin, CM. Insomnia Severity Index as a web-based measure. in press
47. Stein KD, Martin SC, Hann DM, Jacobsen PB. A multidimensional measure of fatigue for use with cancer patients. 1998; 6:143–52.
48. Stein KD, Jacobsen PB, Blanchard CM, Thors C. Further validation of the multidimensional fatigue symptom inventory-short form. J Pain Symptom Manage. 2004; 27:14–23. [PubMed: 14711465]
49. Zigmond AS, Snaith RP. The Hospital Anxiety and Depression Scale. Acta Psychiatr Scand. 1983; 67:361–70. [PubMed: 6880820]
50. Bjellanda I, Dahlb AA, Haugc TT, Neckelmannd D. The validity of the Hospital Anxiety and Depression Scale: An updated literature review. J Psychosom Res. 2002; 52:69–77. [PubMed: 11832252]
51. Ware JE, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care. 1996; 34:220–33. [PubMed: 8628042]
52. Ritterband LM, Ardalan K, Thorndike FP, Magee JC, Saylor DK, Cox DJ, Sutphen JL, Borowitz SM. Real world use of an Internet intervention for pediatric encopresis. J Med Internet Res. 2008; 10:e16. [PubMed: 18653440]
53. Kline, R. Beyond Significance Testing: Reforming Data Analysis Methods in Behavioral Research. American Psychological Association; Washington, D.C: 2004.
54. Cohen J. A power primer. Psychol Bull. 1992; 112:155–9. [PubMed: 19565683]
55. Tate DF, Finkelstein EA, Khayjou O, Gustafson A. Cost effectiveness of internet interventions: review and recommendations. Annals of Behavioral Medicine. 2009; 38:40–5. [PubMed: 19834778]

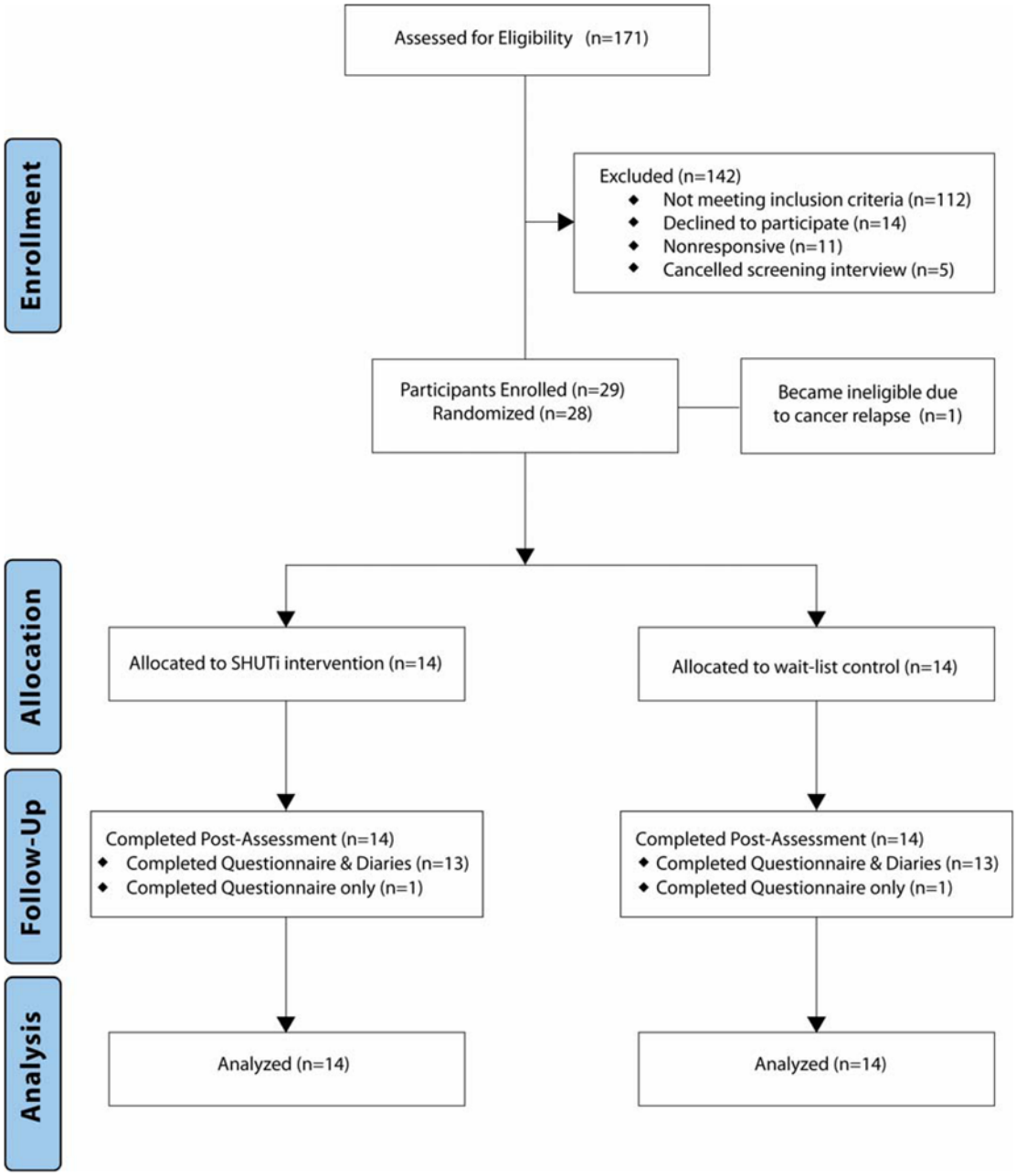

Figure 1.
Study enrollment flow.

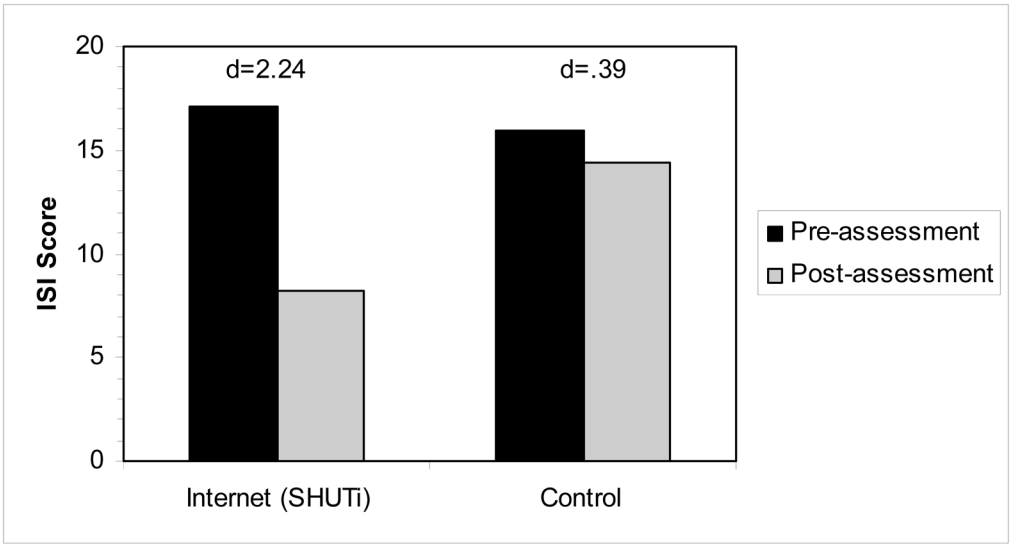

Figure 2.
Insomnia Severity Index (ISI) scores by group at pre- and post-assessment.

Table 1

Demographic and Clinical Characteristics of the Sample

Characteristic	Internet Participants (n=14)	Control Participants (n=14)	All Participants (N=28)	*P* Value[a]
Age in years, mean (SD)	53.7 (10.8)	59.6 (12.3)	56.7 (11.7)	0.186
Sex				
Female	14	10	24	0.03
Male	0	4	4	
Race				
White	13	13	26	
Black	1	0	1	0.37
More than one race	0	1	1	
Marial status				
Married/living with partner	12	10	22	
Divorced/separated	0	3	3	0.24
Widowed	1	1	2	
Never married	1	0	1	
Years of education, mean (SD)	17.7 (2.2)	16.2 (2.1)	17.0 (2.2)	0.08
Cancer type at diagnosis				
Breast	13	5	18	0.002
Other[b]	1	9	10	
Cancer stage at diagnosis				
Stage I	8	5	13	
Stage II	4	2	6	
Stage III	2	3	5	0.24
Stage IV	0	1	1	
Unknown	0	3	3	
Years since completion of active treatment, mean (SD)	4.6 (3.1)	3.2 (2.9)	3.9 (3.0)	0.22
Duration of sleep difficulties in years, mean (SD)	6.4 (5.1)	6.5 (5.5)	6.4 (5.2)	0.96
Frequency of difficult sleep, nights per week (SD)	5.5 (1.2)	6.1 (1.4)	5.8 (1.3)	0.26

[a] *P* values are based on t-tests or Pearson χ^2 tests.

[b] Other cancer diagnoses included colorectal, prostate, cervical cancer, esophageal cancer, Hodgkin's lymphoma, melanoma, sarcoma, and vagal paraganglioma.

Table 2

Sleep Diary Data Changes by Treatment Condition

	Internet Participants (n=13)		Control Participants (n=13)				
Sleep Variable and Period	**Mean (SD)**	**Pre-Post ES (d)***	**Mean (SD)**	**Pre-Post ES (d)***	**$F_{1,24}$**	***P* Value**	**Overall Adjusted ES (d)**
Sleep Efficiency, %							
Pre	72.16 (9.56)	1.05	75.55 (14.13)	0.33	11.45	< 0.01	0.72
Post	85.67 (6.50)[a]		79.75 (11.45)[b]				
Total Sleep Time, min							
Pre	361.62 (68.36)	0.46	362.46 (73.39)	0.14	2.11	0.16	0.32
Post	396.05 (49.64)		373.05 (63.60)				
SOL, min							
Pre	48.42 (32.37)	0.83	40.73 (30.57)	0.16	5.18	0.03	0.67
Post	19.88 (16.79)[a]		35.23 (22.31)				
WASO, min							
Pre	55.88 (30.52)	0.72	47.54 (31.25)	0.50	1.03	0.32	0.22
Post	31.99 (21.76)		30.99 (19.72)				
Time In Bed, min							
Pre	498.69 (47.45)	0.63	481.04 (58.58)	0.23	2.56	0.12	0.40
Post	461.42 (39.55)		467.31 (42.56)				
Awakenings, no.							
Pre	2.64 (1.19)	0.69	1.98 (.51)	0.26	3.05	0.09	0.43
Post	1.87 (.90)		1.69 (.59)				
Soundness of sleep, scale score[c]							
Pre	2.55 (.61)	1.42	2.85 (.43)	0.21	9.34	< 0.01	1.21
Post	3.38 (.59)[a]		2.98 (.69)				
Restored, scale score[d]							
Pre	2.38 (.38)	1.51	2.82 (.54)	0.16	11.95	< 0.01	1.35
Post	3.21 (.60)[a]		2.91 (.58)				

Abbreviations: SOL, sleep onset latency; WASO, wake after sleep onset.

*A positive ES (d) indicates an improvement in symptoms; a negative ES indicates worsening of symptoms

[a] Paired-samples *t* tests to examine time effects within treatment condition are significant at p<.01.

[b] Paired-samples *t* tests to examine time effects within treatment condition are significant at p<.05.

[c] Scored on a scale from 1 to 5, with 1 indicating "very restless" and 5 indicating "very sound"

[d] Scored on a scale from 1 to 5, with 1 indicating "exhausted" and 5 indicating "very refreshed"

Table 3

Fatigue, Mood, and Quality of Life Data Changes by Treatment Condition

	Internet Participants (n=14)		Control Participants (n=14)				
Variable	**Mean (SD)**	**Pre-Post ES (d)***	**Mean (SD)**	**Pre-Post ES (d)***	**$F_{1,26}$**	***P* Value**	**Overall Adjusted ES (d)**
MFSI-SF: Total							
Pre	22.86 (15.56)	0.80	13.71 (16.06)	−0.36	13.88	< 0.01	1.16
Post	9.50 (18.32)[a]		19.79 (20.64)				
MFSI-SF: General							
Pre	13.43 (5.75)	0.70	9.93 (5.15)	−0.21	9.46	< 0.01	0.91
Post	9.36 (5.67)[b]		11.14 (5.53)				
MFSI-SF: Physical							
Pre	3.93 (3.85)	0.27	4.50 (4.54)	−0.20	2.83	0.11	0.47
Post	2.79 (2.83)		5.36 (4.47)				
MFSI-SF: Emotional							
Pre	6.57 (4.57)	0.40	5.86 (4.28)	−0.37	3.44	0.08	0.77
Post	4.79 (4.26)		7.50 (7.02)				
MFSI-SF: Mental							
Pre	7.43 (4.65)	0.47	4.79 (3.98)	−0.19	8.65	< 0.01	0.66
Post	5.29 (4.20)[b]		5.64 (3.93)				
MFSI-SF: Vigor[c]							
Pre	8.50 (2.82)	1.20	11.36 (3.41)	−0.43	14.79	< 0.01	1.63
Post	12.71 (5.14)[a]		9.86 (4.50)				
HADS: Total							
Pre	14.64 (7.45)	0.73	14.00 (5.19)	0.21	3.18	0.09	0.52
Post	9.93 (5.53)		12.64 (6.01)				
HADS: Depression							
Pre	5.21 (3.58)	0.63	5.43 (2.65)	0.09	2.08	0.16	0.54
Post	3.21 (2.42)		5.14 (4.02)				
HADS: Anxiety							
Pre	9.43 (4.29)	0.70	8.57 (3.27)	0.28	3.15	0.09	0.42
Post	6.71 (3.85)		7.50 (2.98)				

	Internet Participants (n=14)		Control Participants (n=14)				
Variable	**Mean (SD)**	**Pre-Post ES (d)***	**Mean (SD)**	**Pre-Post ES (d)***	**$F_{1,26}$**	***P* Value**	**Overall Adjusted ES (d)**
SF-12: Mental							
Pre	43.02 (13.51)	0.48	46.86 (7.95)	0.00	3.14	0.09	0.48
Post	48.51 (8.73)		46.82 (10.06)				
SF-12: Physical							
Pre	48.96 (10.36)	0.15	45.56 (7.22)	−0.06	0.44	0.52	0.21
Post	50.36 (9.76)		44.96 (10.34)				

Abbreviations: MFSI-SF, Multidimensional Fatigue Symptom Inventory-Short Form; HADS, Hospital Anxiety and Depression Scale, SF-12, Short Form 12-item Health Survey.

*A positive ES (d) indicates an improvement in symptoms; a negative ES indicates worsening of symptoms

[a]Paired-samples t tests to examine time effects within treatment condition are significant at p<.01.

[b]Paired-samples t tests to examine time effects within treatment condition are significant at p<.02.

[c]Increases on the MSFI: Vigor subscale represent a reduction (improvement) in fatigue.