Cognitive Behavioral Therapy for Insomnia Among Active Duty Military Personnel Diagnosed With Obstructive Sleep Apnea

Tim Hoyt, PhD; Marquisha R.G. Lee, PhD, ABPP, CBSM; Jason D. Stolee, PhD; Joshua A. Breitstein, PsyD; Herbert P. Kwon, MD; Vincent Mysliwiec, MD

ABSTRACT

Introduction:
Insomnia and obstructive sleep apnea are common conditions among military service members, with high rates of comorbidity. Although cognitive behavioral therapy for insomnia (CBT-I) has been established as an effective treatment for insomnia, it is unclear whether or not CBT-I is effective among service members with comorbid insomnia and obstructive sleep apnea.

Materials and Methods:
This retrospective, observational study examined insomnia outcomes among a group of service member patients (N = 73) with comorbid insomnia and obstructive sleep apnea. All patients received individual CBT-I in a specialty sleep clinic at a military treatment facility. Seven outcomes associated with insomnia were evaluated before and after treatment.

Results:
On average, patients showed significant improvement in sleep onset latency, wake after sleep onset, sleep efficiency, number of awakenings, and symptoms reported on the Insomnia Severity Index. Twenty-six percent of patients showed clinically significant improvement in reported insomnia symptoms.

Conclusions:
These results suggest that CBT-I may be effective in treating military service members with comorbid insomnia and obstructive sleep apnea. Despite the limitations of data collected in a clinical setting, consistent findings across five of the seven outcome measures provide good evidence that this treatment can be implemented in military settings.

INTRODUCTION

Insomnia and obstructive sleep apnea (OSA) are common sleep disorders among military personnel, with peak annual rates over the past decade of 333.8 per 10,000 for OSA and 272.4 per 10,000 for insomnia.1 Furthermore, military personnel exhibit significant rates of comorbid insomnia and sleep apnea (COMISA), with approximately 38% of military patients referred for sleep evaluation meeting the criteria for both diagnoses.2 Diagnosis rates of both disorders among active duty service members significantly increased between 2005 and 2019.1 Insomnia and OSA have significant implications for medical readiness and have shown significant comorbidity with other behavioral health conditions, including anxiety, depression, and posttraumatic stress disorder (PTSD).3 These sleep disorder diagnoses also can persist after military service, with 57% of Veterans enrolling in health care with the Department of Veterans Affairs (VA) screening positive for insomnia and a range of 40%-83% of Veterans in PTSD treatment screening positive for OSA.4,5

Cognitive Behavioral Therapy for Insomnia (CBT-I) is considered the first-line behavioral intervention for the treatment of insomnia and has been recommended in the joint VA-DoD clinical practice guidelines.6 Because of differences in the etiology of insomnia versus OSA, the literature previously had been mixed regarding the treatment of COMISA.7 More recent studies have shown promising initial results in treating COMISA with CBT-I. In civilian samples, two studies have specifically evaluated CBT-I outcomes among groups with COMISA. A retrospective analysis of patients with and without OSA being treated with CBT-I showed improvement in insomnia symptoms and overall function, with equivalent outcomes between these groups.8 A randomized controlled trial of CBT-I combined with positive airway pressure (PAP) treatment showed that the combined treatment of both CBT-I and PAP showed better outcomes for insomnia symptoms than PAP alone.9 Related to the current population of interest, a study of Veterans with mild occult sleep-disordered breathing (i.e., not diagnosed using a sleep study) receiving CBT-I to treat insomnia showed significant improvement in sleep latency and overall sleep quality.10 A subsequent randomized controlled trial of Veterans receiving combined CBT-I with a PAP adherence program showed significant improvement in insomnia symptoms, sleep quality, and functional outcomes compared to a sleep education control condition.11
A few recent studies have examined specific outcomes of CBT-I for insomnia among active duty military personnel but have not included COMISA. One evaluation of service members receiving CBT-I in an outpatient specialized sleep clinic showed significant improvement in sleep latency, sleep efficiency (SE), mid-sleep awakenings, and self-reported insomnia symptoms, with pronounced outcomes in those who received four or more treatment sessions. However, this study specifically excluded service members with an OSA diagnosis. A randomized controlled trial among service members showed that CBT-I significantly improved SE, total sleep time (TST), sleep latency, and overall sleep quality. Follow-up analysis of these results showed that higher comorbid depression symptoms significantly impacted response to treatment.

Despite this emerging evidence for the use of CBT-I in active duty military samples, to date there have been no studies examining the effectiveness of CBT-I among active duty military personnel with COMISA. Building on the recent literature, the purpose of the current study was to examine the effectiveness of CBT-I in improving sleep among military personnel with COMISA. A randomized controlled trial among service members showed that CBT-I significantly improved SE, total sleep time (TST), sleep latency, and overall sleep quality. Follow-up analysis of these results showed that higher comorbid depression symptoms significantly impacted response to treatment.

The electronic medical records of 376 patients were reviewed, identifying 102 patients with OSA who had participated in individual CBT-I and met the inclusion criteria. Of these, 29 patients who lacked pre-treatment or follow-up data were excluded. Therefore, the current study included data from 73 patients. Patients were primarily enlisted Caucasian men, as shown in Table I. The modal rank was E-5 (n = 15; Sergeant). Rank ranged from E-2 (Private) to O-4 (Major). Fifty-six percent of the sample (n = 41) previously deployed to Iraq or Afghanistan. The majority of the sample (64.4%, n = 47) had comorbid behavioral health diagnosis (Table I).

### Measures and Procedures

The Institutional Review Board at the Madigan Army Medical Center approved the study protocol and retrospective data analysis. Demographic characteristics from the electronic medical record were documented for all participants including age, gender, ethnicity/race, marital status, rank, branch of service, and prior combat-related deployments.
Baseline assessment

At baseline (Time 1), participants completed a sleep diary, the ISI, and the Epworth Sleepiness Scale (ESS). The number of CBT-I sessions was extracted from the electronic medical record. Participants completed a standard sleep diary each morning for 2 weeks. The sleep diary provides the following sleep outcomes: SOL, WASO, time in bed, TST, SE, and number of awakenings.

The ISI consists of seven items assessing symptoms and severity of insomnia in the past week, with the total score ranging from 0 to 28.16 Scores between 0 and 7 suggest no clinical insomnia symptoms, scores between 8 and 14 suggest sub-threshold clinical insomnia symptoms, scores between 15 and 21 suggest moderate clinical insomnia symptoms, and scores 22 and greater suggest severe clinical insomnia symptoms. It shows concurrent validity with sleep diaries and is sensitive to detect changes in insomnia treatment.16 A six-point decrease in the ISI score, which has previously been identified as a clinically meaningful improvement in insomnia, was used to determine those who responded to CBT-I.17 Internal consistency for the ISI in the current study was good across both assessment points (α = .92).

The ESS consists of eight items on a Likert scale from “0 – would never doze or sleep” to “3 – high chance of dozing or sleeping.”18 The total score ranges from 0 to 24. Scores ≤10 suggest normal daytime sleepiness, and scores ≥10 suggest excessive daytime sleepiness. Internal consistency for the ESS in the current study was good across both assessment points (α = .89).

Follow-up assessment

At follow-up (Time 2), participants completed a sleep diary, ISI, and ESS. Time 2 varied for each patient since it was the last treatment session for which each particular patient completed and returned a sleep diary and also considered their final session of CBT-I.

Statistical Analysis

All statistical analyses were conducted using SPSS version 22. A repeated-measures analysis of variance examined changes in sleep parameters from baseline to follow-up. SOL, WASO, TST, SE, number of awakenings, and scores on the ISI and ESS were specified as repeated-measures dependent variables. Sleep medication was specified as a between-subjects factor. Of the 73 patients, 10 patients had at least one variable of interest that was missing. A multiple imputation technique that took into account the data from available intake and outcome measures was used to account for these missing variables. Patients with complete initial data but missing follow-up data (n = 12) were included as “intent to treat” with the same values analyzed for both pre- and post-treatment. Power analysis based on observed data showed 80% power for sample sizes over n = 45 to detect medium effects (ηp^2 > 0.10) based on the Pillai–Bartlett Trace estimate and an average correlation of r = 0.60 for repeated-measures analysis of the seven defined outcome measures across two time points.

RESULTS

Demographic Comparisons

There were no significant gender differences on any primary variables, t range = 0.02-1.57, all p > .10. History of combat deployment showed no significant differences on any outcome measures at pre- or post-treatment, t range = 0.20-1.45, all p > .15. Comparing excluded patients to the final sample showed no significant differences in any demographic or intake variables (t range = 0.32-1.43, all p > .20; χ2 range = 4.13-8.4, all p > .05).

Diagnosis and Treatment Data

Patients attended a mean number of 4.9 sessions (SD = 2.8) and completed a sleep diary for the majority of these sessions (M = 4.1, SD = 2.2). Thirty-four percent (n = 25) of patients were taking sleep medications (zolpidem, eszopiclone, or trazodone) at baseline and 22% (n = 16) at follow-up, with 14 patients discontinuing medications and three patients beginning medications over the course of treatment. Adherence data aggregated across the treatment episode time frame showed that patients utilized CPAP = continuous PAP (CPAP) or automatic PAP (APAP) devices for ≥4 hours in the course of the night approximately 56.8% (SD = 31.7) of the time on average. The average nightly use was 4.5 hours (SD = 1.8).

Sleep Outcomes

Results showed a significant multivariate change in outcome variables across measures, F(7, 65) = 6.33, p < .001, ηp^2 = 0.41, with specific changes in mean scores shown in Table II. This multivariate effect included a significant change in SOL, F(1, 71) = 16.95, p < .001, ηp^2 = 0.19, WASO, F(1, 71) = 19.50, p < .001, ηp^2 = 0.22, and SE, F(1, 71) = 17.74, p < .001, ηp^2 = 0.20, from pre- to post-treatment. SOL and WASO decreased, and SE increased over the course of treatment. There was also a significant improvement in the number of awakenings, F(1, 71) = 11.01, p = .001, ηp^2 = 0.13, from pre- to post-treatment. There was no significant change in TST over the course of treatment, F(1, 71) = 0.08, p = .78, ηp^2 = 0.001. Multivariate effects for sleep medications were not significant, F(7, 65) = 1.80, p = .10, ηp^2 = 0.16, nor was the interaction effect for sleep medication by assessment time point, F(7, 65) = 0.84, p = .56, ηp^2 = 0.08.

Insomnia severity improved on the ISI from pre- to post-treatment, F(1, 71) = 10.23, p = .002, ηp^2 = 0.13. Examining change in the ISI score over the course of treatment, 26% of the sample (n = 19) showed a clinically significant decrease of six points or more, with another 26% (n = 19) showing a decrease between one and five points on the ISI. Five patients
TABLE II. Sleep Outcomes in Patients at Baseline and Follow-up

<table>
<thead>
<tr>
<th>Sleep outcomes</th>
<th>Pre</th>
<th>Post</th>
<th>F(1, 71)</th>
<th>ηp²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep onset latency (hours)</td>
<td>0.69 (0.69)</td>
<td>0.41 (0.32)</td>
<td>16.95**</td>
<td>0.19</td>
</tr>
<tr>
<td>Wake after sleep onset (hours)</td>
<td>0.83 (0.61)</td>
<td>0.54 (0.45)</td>
<td>19.50**</td>
<td>0.22</td>
</tr>
<tr>
<td>Sleep efficiency (%)</td>
<td>77.87 (14.63)</td>
<td>85.37 (10.56)</td>
<td>17.74**</td>
<td>0.20</td>
</tr>
<tr>
<td>Total sleep time (hours)</td>
<td>5.81 (1.35)</td>
<td>5.80 (1.28)</td>
<td>0.08</td>
<td>0.001</td>
</tr>
<tr>
<td>Number of awakenings</td>
<td>2.04 (1.37)</td>
<td>1.50 (0.99)</td>
<td>11.01**</td>
<td>0.13</td>
</tr>
<tr>
<td>Insomnia Severity Index</td>
<td>17.12 (4.44)</td>
<td>15.20 (5.93)</td>
<td>10.23**</td>
<td>0.13</td>
</tr>
<tr>
<td>Epworth Sleepiness Scale</td>
<td>11.38 (5.10)</td>
<td>10.94 (5.64)</td>
<td>0.45</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Subsample of patients with comorbid insomnia, OSA, and at least one psychiatric diagnosis
(n = 47)

<table>
<thead>
<tr>
<th>Sleep outcomes</th>
<th>Pre</th>
<th>Post</th>
<th>F(1, 45)</th>
<th>ηp²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep onset latency (hours)</td>
<td>0.75 (0.71)</td>
<td>0.47 (0.35)</td>
<td>14.44**</td>
<td>0.24</td>
</tr>
<tr>
<td>Wake after sleep onset (hours)</td>
<td>0.87 (0.65)</td>
<td>0.65 (0.47)</td>
<td>6.51*</td>
<td>0.13</td>
</tr>
<tr>
<td>Sleep efficiency (%)</td>
<td>78.46 (11.44)</td>
<td>83.32 (11.35)</td>
<td>13.35**</td>
<td>0.23</td>
</tr>
<tr>
<td>Total sleep time (hours)</td>
<td>5.88 (1.35)</td>
<td>5.75 (1.27)</td>
<td>0.87</td>
<td>0.02</td>
</tr>
<tr>
<td>Number of awakenings</td>
<td>2.11 (1.40)</td>
<td>1.63 (1.05)</td>
<td>5.38*</td>
<td>0.11</td>
</tr>
<tr>
<td>Insomnia Severity Index</td>
<td>18.02 (4.33)</td>
<td>16.86 (5.94)</td>
<td>2.94</td>
<td>0.06</td>
</tr>
<tr>
<td>Epworth Sleepiness Scale</td>
<td>11.34 (4.95)</td>
<td>12.03 (4.83)</td>
<td>3.60</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Subsample of patients showing less than 70% adherence to CPAP/APAP
(n = 28)

<table>
<thead>
<tr>
<th>Sleep outcomes</th>
<th>Pre</th>
<th>Post</th>
<th>F(1, 27)</th>
<th>ηp²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep onset latency (hours)</td>
<td>0.57 (0.26)</td>
<td>0.40 (0.22)</td>
<td>14.47**</td>
<td>0.35</td>
</tr>
<tr>
<td>Wake after sleep onset (hours)</td>
<td>0.78 (0.44)</td>
<td>0.60 (0.46)</td>
<td>4.87*</td>
<td>0.15</td>
</tr>
<tr>
<td>Sleep efficiency (%)</td>
<td>77.40 (16.39)</td>
<td>84.13 (9.11)</td>
<td>3.74</td>
<td>0.12</td>
</tr>
<tr>
<td>Total sleep time (hours)</td>
<td>5.82 (1.23)</td>
<td>5.69 (1.22)</td>
<td>0.65</td>
<td>0.02</td>
</tr>
<tr>
<td>Number of awakenings</td>
<td>2.04 (1.24)</td>
<td>1.88 (0.97)</td>
<td>0.74</td>
<td>0.03</td>
</tr>
<tr>
<td>Insomnia Severity Index</td>
<td>17.16 (4.14)</td>
<td>15.18 (6.47)</td>
<td>4.22*</td>
<td>0.14</td>
</tr>
<tr>
<td>Epworth Sleepiness Scale</td>
<td>11.51 (5.05)</td>
<td>10.38 (5.71)</td>
<td>2.36</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Abbreviations: APAP = automatic positive airway pressure; CPAP = continuous positive airway pressure; OSA = obstructive sleep apnea.
Significant change from baseline to follow-up.
*p < .05.  **p < .01.

(6.8% of sample) showed a clinically significant increase of six points or more on the ISI. The remaining 41.1% of patients (n = 30) showed no change or a non-significant increase on the ISI. There was no change in daytime sleepiness on the ESS over time, F(1, 71) = 0.45, p = .51, ηp² = 0.01.

Comorbid Psychiatric Diagnosis

In order to further examine the potential impact of comorbid psychiatric diagnoses on CBT-I outcomes for patients with comorbid insomnia and OSA, the same analysis was again conducted using a restricted sample. The same repeated-measures analysis when limiting the sample to only those patients (n = 47) with an additional comorbid psychiatric diagnosis (i.e., patients with OSA, insomnia, and at least one psychiatric diagnosis) showed the same effects for multivariate change in sleep outcomes over time, F(7, 39) = 3.74, p = .003, ηp² = 0.40. Specific changes in mean scores for this subgroup also are shown in Table II. These effects included a significant change in SOL, F(1, 45) = 14.44, p < .001, ηp² = 0.24, WASO, F(1, 45) = 6.51, p = .014, ηp² = 0.13, and SE, F(1, 45) = 13.35, p = .001, ηp² = 0.23, from pre- to post-treatment. Similar to the analysis with the full sample, SOL and WASO decreased, and SE increased over the course of treatment. There was also a significant improvement in the number of awakenings, F(1, 45) = 5.57, p = .03, ηp² = 0.11, from pre- to post-treatment. There was no significant change in TST over the course of treatment, F(1, 45) = 0.87, p = .36, ηp² = 0.02. Multivariate effects for sleep medications were not significant, F(7, 39) = 1.01, p = .44, ηp² = 0.15, nor was the interaction effects for multivariate change in sleep outcomes over time, F(7, 39) = 3.74, p = .003, ηp² = 0.40. Specific changes in mean scores for this subgroup also are shown in Table II. These effects included a significant change in SOL, F(1, 45) = 14.44, p < .001, ηp² = 0.24, WASO, F(1, 45) = 6.51, p = .014, ηp² = 0.13, and SE, F(1, 45) = 13.35, p = .001, ηp² = 0.23, from pre- to post-treatment. Similar to the analysis with the full sample, SOL and WASO decreased, and SE increased over the course of treatment. There was also a significant improvement in the number of awakenings, F(1, 45) = 5.57, p = .03, ηp² = 0.11, from pre- to post-treatment. There was no significant change in TST over the course of treatment, F(1, 45) = 0.87, p = .36, ηp² = 0.02. Multivariate effects for sleep medications were not significant, F(7, 39) = 1.01, p = .44, ηp² = 0.15, nor was the interaction
effect for sleep medication by assessment time point, $F(7, 39) = 1.29$, $p = .28$, $\eta^2_p = 0.19$. ISI scores did not significantly change for this restricted sample, $F(1, 45) = 2.94$, $p = .09$, $\eta^2_p = 0.06$, and there was no significant change in ESS scores over time, $F(1, 45) = 3.60$, $p = .06$, $\eta^2_p = 0.07$.

Analysis Based on CPAP/APAP Adherence

In order to somewhat differentiate the effect of CPAP/APAP treatment from CBT-I, the same analysis again was conducted using a restricted sample. This restricted sample included only those patients undergoing CPAP/APAP treatment but showing less than 70% adherence using their device for $\geq 4$ hours per night. The same repeated-measures analysis with this less compliant sample $(n = 28)$ again showed similar effects for multivariate change in sleep outcomes over time, $F(7, 21) = 6.56$, $p < .001$, $\eta^2_p = 0.69$. Specific changes in mean scores for this subgroup also are shown in Table II. These effects included a significant change in SOL, $F(1, 27) = 14.47$, $p = .001$, $\eta^2_p = 0.35$, WASO, $F(1, 27) = 4.87$, $p = .036$, $\eta^2_p = 0.15$, and ISI, $F(1, 27) = 4.22$, $p = .049$, $\eta^2_p = 0.14$, from pre- to post-treatment. Similar to the analysis with the full sample, SOL, WASO, and ISI scores decreased over the course of treatment. There was no significant change in SE, TST, number of awakenings, or ESS scores in this secondary analysis.

DISCUSSION

In line with emerging research on the concurrent treatment of OSA and insomnia, the current study provides further evidence that CBT-I potentially can be effective in treating COMISA among active duty military personnel. Consistent with hypotheses, CBT-I significantly reduced SOL, WASO, SE, and ISI scores among service members diagnosed with COMISA. However, there were no significant changes in TST or ESS scores. The overall effect size across these outcomes was relatively large, with medium effect sizes for most of the outcomes. These findings are consistent with previous research showing equivalent CBT-I outcomes for civilian patients with and without OSA, improvements in insomnia outcomes among Veterans with occult sleep-disordered breathing receiving CBT-I, and retrospective evidence for the effectiveness of CBT-I among active duty military groups. Furthermore, secondary analyses in a subsample with psychiatric comorbidity generally showed the same outcomes, although findings for the ISI were not significant in this subsample. Similar secondary analyses limiting the sample to patients showing poor CPAP/APAP adherence also showed significant improvements in SOL, WASO, and ISI scores. This provides further evidence that CBT-I can be effective when addressing military patients with significant comorbidities.

Of note, the current study was based on data collected in a “real-world” clinical setting, with 26% of the sample showing a clinically significant decrease in the ISI score.

Other researchers have noted the difficulty of conducting manualized CBT-I interventions in military settings, citing difficulties such as required overnight duties, shift work, and unpredictable training schedules. Initial scores in the moderate range on the ISI and ESS also may have contributed to smaller effects in these groups, particularly among the subsample with comorbid psychiatric conditions. These potential difficulties notwithstanding, patients in the current study completed an average of 4.9 sessions of CBT-I, in line with clinical practice guidelines. This provides further evidence that empirically supported interventions for insomnia can be implemented successfully in military settings. As work on the implementation of CBT-I in military settings continues, future interventions may be able to leverage mobile applications and telehealth in the delivery of sleep interventions to accommodate military readiness needs.

Limitations

There are several limitations of the current study that suggest directions for future research. The primary limitation of this study was the lack of a control group, which makes it difficult to determine whether or not changes in insomnia symptoms were attributable to the CBT-I intervention. Future studies of this kind could be strengthened through the use of a clinical trial and control groups to differentiate the effects of CBT-I versus PAP treatment for patients with COMISA. Nonetheless, single-arm, retrospective studies of this kind can be valuable when extending established findings on empirically supported treatments to new populations, such as active duty service members. Because of the “real-world” nature of the treatment received by patients, the length of time between assessment Time 1 and Time 2 differed for each patient, with some patients receiving more sessions than others in this time frame. Although this limitation threatens the potential internal validity of the findings, the robust outcomes attributed to the CBT-I intervention appear to be effective even with inconsistent sessions because of other military priorities. The generalizability of the current study is also limited by the relatively homogenous sample of predominantly white men that was relatively small and drawn from only one treatment facility. Future research will be needed to ensure that treatments, such as CBT-I, are both equally accessible and effective for diverse groups of service members, men and women, from various duty stations.

The current study also had no data regarding the sequence of initiating PAP treatment versus CBT-I, with patients often involved with both treatments simultaneously. Previous research has suggested that insomnia symptoms can either improve or worsen when PAP treatment is initiated, suggesting that patients establish the fundamentals of CBT-I before initiating PAP treatment. Finally, although the results of the secondary analysis among patients with additional psychiatric diagnoses in addition to COMISA—including PTSD and major depressive disorder—were consistent with findings for
CONCLUSION
Although not all patients with COMISA showed a clinically significant benefit from CBT-I in the current sample, results from this study suggest that this empirically supported treatment can be beneficial for active duty service members who are diagnosed with insomnia and a number of comorbid conditions. Greater utilization of behavioral treatments of this kind has the potential to strengthen military readiness across a number of settings.

ACKNOWLEDGMENTS
None.

FUNDING
None declared.

CONFLICT OF INTEREST STATEMENT
V.M. has served as a consultant for Armed Forces HST, CPAP medical, Ebb Therapeutics, Jazz Pharmaceuticals, NightWare, NOCTEM Health, and SleepCare Inc.

DATA AVAILABILITY STATEMENT
The data underlying this article will be shared upon reasonable request to the corresponding author.

REFERENCES