

# Effects of Insomnia and Depression on CPAP Adherence in a Military Population

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Initial self-reported depression and insomnia prior to the diagnosis and treatment of obstructive sleep apnea with continuous positive airway pressure therapy did not reliably predict short- and long-term adherence in a sample of active-duty military and veteran patients.

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Continuous positive airway pressure therapy (CPAP) is the first-line treatment for obstructive sleep apnea (OSA) recommended by the American College of Physicians and the American Academy of Sleep Medicine.<sup>1,2</sup> CPAP reduces the apnea hypopnea index (AHI), improves oxyhemoglobin desaturation, and reduces cortical arousals associated with apneic/hypopneic events.<sup>3</sup> Despite being an effective treatment for OSA, a significant limitation of CPAP is treatment adherence. Factors associated with CPAP adherence include disease and patient characteristics, perceived self-efficacy, treatment titration procedure, device technology factors, adverse effects, and psychosocial factors.<sup>4</sup>

Recent studies suggest that insomnia and depression may be associated with OSA. According to a review by Luyster and colleagues, insomnia is present in 39% to 58% of patients with OSA.<sup>5</sup> Since OSA may disturb sleep by the number of nightly awakenings, OSA may cause or worsen insomnia. Furthermore, insomnia may exacerbate sleep apnea thus impeding the effectiveness of sleep apnea treatment.

In some studies, the presence of insomnia symptoms prior to initiating CPAP treatment has been found to be associated with reduced CPAP adherence. For example, in 2010, Wickwire and colleagues found that there was a negative association with the average nightly minutes of CPAP use for those patients with OSA that reported symptoms of sleep maintenance insomnia.<sup>6</sup> This was not found for those patients with OSA who reported symptoms of sleep onset insomnia or reported no insomnia at all. In another study by Pieh and col-

leagues, self-reported insomnia symptoms were predictive of CPAP adherence (defined as < 4 hours use/night) at a 6-month follow-up.<sup>7</sup> However, results from a separate study indicated that insomnia was not associated with 6-month CPAP adherence.<sup>8</sup>

Depressive symptoms are commonly reported by patients with OSA, and higher rates of depressive symptomatology in patients with OSA have been observed in a number of prevalence studies when compared with the general population.<sup>9,10</sup> Between 15% and 56% of patients with OSA are diagnosed with a depressive disorder compared with 6.6% of the general population.<sup>11</sup> OSA may be causally related with depression or coexist as a separate disorder. Apnea severity has been shown to exacerbate depressive symptoms, and treatment with CPAP can improve depressive symptoms.<sup>12,13</sup> Unfortunately, depression has been found to reduce CPAP adherence. For example, Law and colleagues found that depression was independently associated with poorer adherence during home-based auto-PAP titration.<sup>14</sup> Furthermore, in a study by Gurlanick and colleagues, depressive symptoms were independently associated with reduced CPAP adherence in surgical patients with OSA.<sup>15</sup>

To the best of our knowledge, the combined impact of both insomnia and depression on CPAP adherence has not been investigated. In military populations this may be especially important as CPAP adherence has been reported to be worse in military patients with posttraumatic stress disorder (PTSD) and other psychiatric disorders, and there are increasing rates of insomnia and OSA in the military.<sup>16,17</sup> We hypothesize that active-duty and retired military patients with

self-reported insomnia and depression will have reduced short and long-term CPAP adherence.

## METHODS

This is a retrospective cohort study that reviewed charts of active-duty and retired military members diagnosed with OSA by the Sleep Medicine Clinic at Naval Medical Center San Diego in California using a home sleep test (HST). The HSTs were interpreted by board-certified physicians in sleep medicine. Prior to the HST, all patients completed a sleep questionnaire that included self-reports of daytime sleepiness, using the Epworth Sleepiness Scale (ESS), depression using the Center for Epidemiologic Studies Depression Scale (CES-D) and insomnia using the Insomnia Severity Index (ISI).

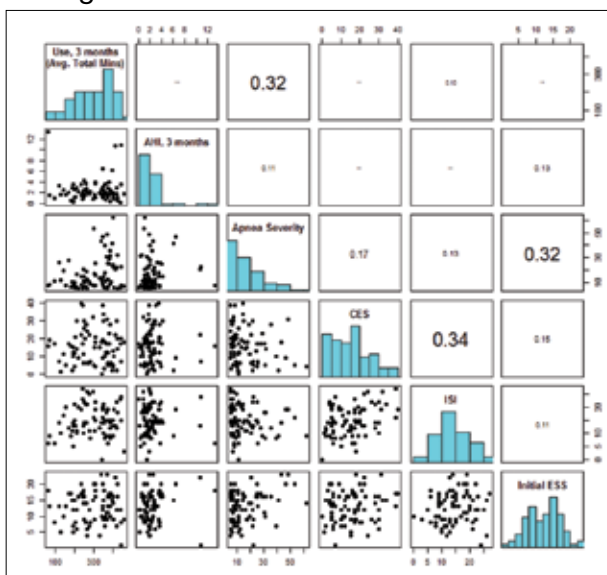
The study population included active-duty and veteran patients diagnosed with OSA who chose treatment with a CPAP and attended the sleep clinic's OSA educational class, which discussed the diagnosis and treatment of OSA. Inclusion criteria were patients aged > 18 years and diagnosed with OSA at the Naval Medical Center San Diego sleep lab between June 2014 and June 2015.

The study population was stratified into 4 groups: (1) those with OSA but no self-reported depression or insomnia; (2) those with OSA and self-reported depression but no insomnia; (3) those with OSA and insomnia but no depression; and (4) those with OSA and self-reported depression and insomnia. Charts were excluded from the review if there were incomplete data or if the patient selected an alternative treatment for OSA, such as an oral appliance. A total of 120 charts were included in the final review. This study was approved by the Naval Medical Center San Diego Institutional Review Board.

## Data Collection

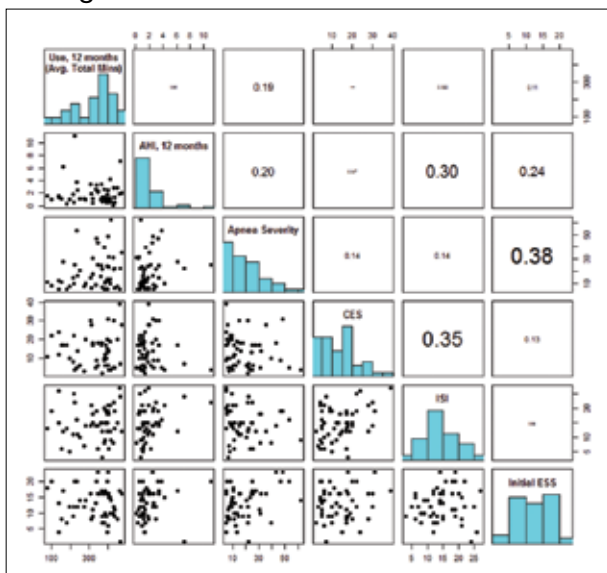
Data collected included the individual's age, sex, minimum oxygen saturation during sleep, body mass index (BMI), height, weight, ESS score at time of diagnosis, date of HST, and date of attendance at the clinic's OSA group treatment class. Diagnosis of OSA was based on the patient's  $\geq 5$  AHI. OSA severity was divided into mild (AHI 5-14), moderate (AHI 15-29), or severe

**FIGURE 1** 3-Month Scatterplot Matrices, Average Total Minutes<sup>a</sup>



<sup>a</sup>Only complete observations across all pairs of measures are included.

**FIGURE 2** 12-Month Scatterplot Matrices, Average Total Minutes<sup>a</sup>



<sup>a</sup>Only complete observations across all pairs of measures are included.

(AHI  $\geq 30$ ). A patient with a CES-D score > 14 was considered to have clinically significant depression, and a patient with an ISI score of > 14 was considered to have clinically significant insomnia. ISI is a reliable and valid instrument to quantify perceived insomnia severity.<sup>18</sup> The CES-D was used only as an indicator of symptoms relating to

**TABLE 1** Demographic Characteristics of Patients (108 male, 12 female)

Characteristics	No.	Mean	SD	Median	Min	Max
Age, y	120	41.9	9.7	41	22	65
Height, in	118	68.0	3.7	68.5	60	75
Weight, lb	120	206.7	33.3	205	135	315
O <sub>2</sub> saturation	119	0.82	0.06	0.83	0.55	0.91
Body mass index	118	30.6	5.3	29.8	7.7	57.2

**TABLE 2** CPAP Use

Variables	No.	Mean	SD	Median	Min	Max
Adherence						
3 mo, pressure	117	0.35	0.4	0.2	0	1
3 mo, d	33	13.1	10.2	11	0	30
12 mo, pressure	115	0.3	0.4	0	0	1
12 mo, d	20	17.7	10.6	17.5	0	30
Average total use						
3 mo	82	301.2	95.2	315	61	457
12 mo	54	328.8	102.3	363	74	472

Abbreviation: CPAP, continuous positive airway pressure.

depression, not to clinically diagnose depression. It also has been used extensively to investigate levels of depression without a psychiatric diagnosis.<sup>19</sup>

Follow-up CPAP adherence was collected at 3- and 12-month intervals after the date of the patient's OSA treatment group class and included AHI, median pressure setting, median days used, average time used per night, and percentage of days used for more than 4 hours for the previous 30 days. Data were obtained through Sleep Data and ResMed websites, which receive patient adherence data directly from the patient's CPAP device. Patients were considered to be adherent with CPAP usage based on the Medicare definition: Use of the CPAP device > 4 hours per night for at least 70% of nights during a 30-day period). The 3-month time frame was used as a short interval because that is when patients are seen in the pulmonary clinic for their initial follow-up appointment. Patients are seen again at 12 months because durable medical equipment supplies must be reordered after 12 months, which requires a patient visit.

## Statistical Analysis

Linear regression methods were used to characterize any potential relationships between the predictor variables and the target outcome variables associated with CPAP adherence at 3 and 12 months. Scatterplots were produced to assess whether linear structure was sufficient to characterize any detectable relationships, or whether there existed more complex, nonlinear relationships. The best-fitting linear regression line was examined in relation to the confidence bands of the corresponding LOESS line to determine whether a more complicated model structure was needed to capture the relationship.

Standard tests of assumptions required for these methods were also carried out: QQ plots of residuals to test for normality, the Durbin-Watson test for independence of residuals, and the nonconstant variance score test for heteroskedasticity (ie, Breusch-Pagan test). The results of these assumptions tests are reported only in cases in which the assumptions were revealed to be untenable. In cases in which suspicious outlying observations may have biased analyses, robust versions of the corresponding models were constructed. In no cases did the resulting conclusions change; only the results of the original analysis are reported. All analyses were carried out in R (R Foundation, r-project.org). Statistical significance was defined as  $P < .05$ .

## RESULTS

Our study population was predominately male (90%) with a median age of 41 years (range 22-65) and BMI of 29.8 (range 7.7-57.2)(Table 1). Subjects had a median ESS score of 13 (range 1-23), median ISI score of 14.3 (range 0-28), and a median CES-D score of 16 (range 0-42)(Tables 2 and 3). Most of the patients were on auto-CPAP (78%) and had mild OSA with an AHI of 11.1 (range 5.1-81.9). Median CPAP use at 3 months was 5 hours and 15 minutes, and the median CPAP use at 12 months was 6 hours and 3 minutes.

### Predictors of CPAP Adherence

OSA severity, as measured by the AHI, was the only promising predictor of CPAP use at 3 months (b, 2.128;  $t_{80}$ , 2.854;  $P = .005$ ;

adjusted  $R^2$ , 0.081). The severity of self-reported daytime sleepiness prior to a diagnosis of OSA, as measured by the ESS, did not predict 3-month CPAP adherence (b, 0.688;  $t_{77}$ , 0.300;  $P = .765$ ; adjusted  $R^2$ , -0.012). Self-reported depression as measured by the CES-D also did not predict CPAP use at 3 months (b, -0.078;  $t_{80}$ , -0.014;  $P = .941$ ; adjusted  $R^2$ , -0.012). Similarly, self-reported insomnia, as measured by the ISI, did not predict 3-month CPAP adherence (b, 1.765;  $t_{80}$ , 0.939;  $P = .350$ ; adjusted  $R^2$ , -0.001). Furthermore, a model that incorporated both depression and insomnia proved no better at accounting for variation in 3-month CPAP use ( $R^2$ , -0.012). Demographic variables, such as age, sex, or BMI did not predict 3-month CPAP adherence (all  $P$ s > .20). Finally, median CPAP pressure approached statistical significance as a predictor of 3-month CPAP adherence (b, 9.493;  $t_{66}$ , 1.881;  $P = .064$ ; adjusted  $R^2$ , 0.037) (Figure 1).

### CPAP Use at 12 months

The results for CPAP use at 12 months mirrored the results for 3 months with one main exception: OSA severity, as measured by the AHI, did not predict CPAP use at 12 months (b, 1.158;  $t_{52}$ , 1.245;  $P = .219$ ; adjusted  $R^2$ , 0.010). Neither adding a quadratic predictor nor log transforming the AHI values produced a better model ( $R^2$ , -0.0007 vs  $R^2$ , 0.0089, respectively). The severity of self-reported daytime sleepiness, as measured by the ESS, did not predict 12-month CPAP adherence (b, -2.201;  $t_{50}$ , -0.752;  $P = .456$ ; adjusted  $R^2 = -0.0086$ ). Self-reported depression as measured by the CES-D also did not predict CPAP use at 12 months (b, 0.034,  $t_{52}$ , 0.022;  $P = .983$ ; adjusted  $R^2$ , -0.092). Self-reported insomnia, as measured by the ISI, also did not predict 12-month CPAP adherence (b, 1.765;  $t_{80}$ , 0.939;  $P = .350$ ; adjusted  $R^2 = -0.001$ ). Furthermore, a model that incorporated both depression and insomnia proved no better at accounting for variation in 12-month CPAP use, ( $R^2$ , -0.0298). Demographic variables, such as age, sex, or BMI failed to predict 12-month CPAP adherence (all  $P$ s > .15). Finally, median CPAP pressure, in contrast to its promising value as a predic-

**TABLE 3** Key Measures

Measures	No.	Mean	SD	Median	Min	Max
AHI						
Baseline	120	16.4	13.8	11.1	5.1	81.9
3 mo	84	2.3	2.2	1.9	0	13.3
12 mo	56	1.8	1.9	1.3	0	11.1
Median pressure setting						
3 mo	101	5.4	4.2	6.4	0	13.9
12 mo	105	3.6	4.3	0	0	12.5
CES-D	120	15.5	10.0	16	0	42
ISI	120	14.3	5.9	14.3	0	28
Baseline ESS	116	12.6	4.8	13	1	23

Abbreviations: AHI, apnea hypopnea index; CES-D, Center for Epidemiologic Studies Depression Scale; ESS, Epworth Sleepiness Scale; ISI, Insomnia Severity Index.

tor of 3-month CPAP adherence, did not predict CPAP adherence at 12 months (b, -6.516;  $t_{20}$ , -1.021;  $P = .319$ ; adjusted  $R^2 = 0.002$ ) (Figure 2).

### DISCUSSION

Our study did not provide evidence that self-reported depressive and insomnia symptoms, as measured by the CES-D and ISI, can serve as useful predictors of short and long-term CPAP adherence in a sample of active-duty and retired military. OSA severity, as measured by the AHI, was the only promising predictor of CPAP adherence at 3 months.

Insomnia has been shown to improve with the use of CPAP. In a pilot study, Krakow and colleagues investigated the use of CPAP, oral appliances, or bilateral turbinectomy on patients with OSA and chronic insomnia.<sup>20</sup> Objective measures of insomnia improved with 1 night of CPAP titration. Björnsdóttir and colleagues evaluated the long-term effects of positive airway pressure (PAP) treatment on 705 adults with middle insomnia.<sup>21</sup> They found after 2 years of PAP treatment combined with cognitive behavioral therapy for insomnia, patients had reduced symptoms of middle insomnia. It is possible that persistent insomnia is associated with more severe OSA which was not studied in our population.<sup>22</sup>

As reported in other studies, it is possible that patients with depressive symptoms can improve with CPAP use, suggesting that

depression and CPAP use are not totally unrelated. Edwards and colleagues studied the impact of CPAP on depressive symptoms in men and woman. They found that depressive symptoms are common in OSA and markedly improve with CPAP.<sup>23</sup> Bopparaju and colleagues found a high prevalence of anxiety and depression in patients with OSA but did not influence CPAP adherence.<sup>24</sup>

The results of this study differ from some previous findings where depression was found to predict CPAP adherence.<sup>10</sup> This may be due in part to differences in the type of instrument used to assess depression. Wells and colleagues found that baseline depressive symptoms did not correlate with CPAP adherence and that patients with greater CPAP adherence had improvement in OSA and depressive symptoms.<sup>25</sup> Furthermore, patients with residual OSA symptoms using CPAP had more depressive symptoms, suggesting that it is the improvement in OSA symptoms that may be correlated with the improvement in depressive symptoms. Although soldiers with PTSD may have reduced CPAP adherence, use of CPAP is associated with improvement in PTSD symptoms.<sup>11,26</sup>

### Limitations

This study had several limitations, including a small sample size. Study patients were also from a single institution, and the majority of patients had mild-to-moderate OSA. A multicenter prospective study with a larger sample size that included more severe patients with OSA may have shown different results. The participants in this study were limited to members from the active-duty and retired military population. The findings in this population may not be transferrable to the general public. Another study limitation was that the ISI and the CES-D were only administered prior to the initiation of CPAP. If the CES-D and ISI were administered at the 3- and 12-month follow-up visits, we could determine whether short and long-term CPAP improved these symptoms or whether there was no association between CPAP adherence with insomnia and depressive symptoms. Another limitation is that we did not have access to information about potential PTSD symptomatology, which has been associated with reduced CPAP adherence and

is more common in a military and veteran population.<sup>11</sup>

### CONCLUSION

This study found little evidence that symptoms of depression and insomnia are useful predictors of CPAP adherence, in either short- or long-term use, in an active-duty and retired military sample. Although these were not found to be predictors of CPAP adherence, further research will be necessary to determine whether CPAP adherence improves symptoms of depression and insomnia in military and veteran populations. Apnea severity did predict CPAP adherence in the short term, but not for any length of time beyond 3 months. More research is needed to explore strategies to improve CPAP adherence in military populations.

### Author disclosures

The authors report no actual or potential conflicts of interest with regard to this article.

### Disclaimer

The opinions expressed herein are those of the authors and do not necessarily reflect those of *Federal Practitioner*, Frontline Medical Communications Inc., the US Government, or any of its agencies.

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