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Psychological comorbidity: Predictors of residential treatment response among U.S. service members with posttraumatic stress disorder

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Abstract

Residential posttraumatic stress disorder (PTSD) research in military samples generally shows that in aggregate, PTSD symptoms significantly improve over the course of treatment but can remain at elevated levels following treatment. Identifying individuals who respond to residential treatment versus those who do not, including those who worsen, is critical given the extensive resources required for such programs. This study examined predictors of treatment response among 282 male service members who received treatment in a U.S. Department of Defense residential PTSD program. Using established criteria, service members were classified as improved, indeterminate (referent), or worsened in terms of self-reported PTSD symptoms. Multinomial logistic regression results showed that for PTSD symptoms, higher levels of pretreatment PTSD symptom severity were associated with significantly lower odds of being in the improved group, adjusted odds ratio (aOR) = 0.955, p = .018. In addition, service members who completed treatment were significantly more likely to be in the improved group, aOR = 2.488, p = .048. Longer average pretreatment nightly sleep duration, aOR = 1.157, p = .035, and more severe pretreatment depressive symptoms, aOR = 1.109, p = .014, were associated with significantly higher odds of being in the improved group. These findings reveal clinical characteristics better suited for residential PTSD treatment and highlight implications for comorbid conditions.

Posttraumatic stress disorder (PTSD) can develop following exposure to life-threatening traumatic events, including those experienced during combat or military service (Hoge et al., 2004; Thomas et al., 2010). To address the symptoms, distress, and functional impairment typically associated with PTSD (Thomas et al., 2010), the U.S. Department of Defense (DoD) and Department of Veterans Affairs (VA) provide a range of care options for service members and veterans, such as outpatient, residential (i.e., a monitored, more comfortable medical setting), and inpatient (i.e., constant monitoring, secured hospital unit) treatment. Research has demonstrated that veterans who receive outpatient PTSD treatment differ from those who receive residential PTSD treatment in terms of demographic characteristics and symptom severity (Walter et al., 2014), indicating that a continuum of PTSD treatment options is both appropriate and necessary to treat various presentations of the disorder. Residential treatment, on the more extensive end of the continuum, may be a particularly suitable option for service members and veterans with PTSD who have comorbid substance use or other psychological disorders, a need for improved coping skills, or have not experienced sufficient benefit from outpatient care (VA, 2017).

Studies evaluating outcomes following residential PTSD treatment have demonstrated that in aggregate, service members and veterans report significantly decreased symptoms of PTSD (Campbell et al., 2016; Walter et al., 2014, 2021) and related mental health symptoms, such as depression (Alvarez et al., 2011; Libretto et al., 2015; Walter et al., 2014). However, research also shows that elevated symptom levels often remain following residential PTSD treatment (e.g., Alvarez et al., 2011; Currier et al., 2014; Murphy & Smith, 2018; Walter et al., 2014, 2021). Due to the considerable time, personnel, and financial resources required for the provision of residential PTSD treatment, it is critical to identify both the service members and veterans most likely to benefit as well as those who are unlikely to benefit—or may even deteriorate—following residential treatment. This determination would allow a larger proportion of resources to be allocated to individuals who are most likely to benefit from residential PTSD treatment while simultaneously directing those less likely to benefit from residential care toward treatment options that may be better suited to address their unique needs.

Many studies examining PTSD treatment response among service members and veterans have focused on outpatient treatment and shown heterogeneity in response trajectories. For instance, in a sample of U.S. veterans receiving outpatient cognitive processing therapy (CPT), Schumm and colleagues (2013) observed three response trajectories based on initial symptom severity. Within this sample, 19% of participants were classified as nonresponders and had the highest overall initial PTSD and depression severity scores, whereas two additional groups were classified as treatment responders, with one response group reporting higher initial PTSD severity scores (57%) than the other (24%). Among veterans receiving outpatient prolonged exposure (PE), Clapp and colleagues (2016) classified 18% of the sample as rapid responders, evidencing sudden decreases at Week 2 and again between Weeks 5 and 6 of treatment. Approximately 40% of participants were linear responders who displayed a steady decrease in symptoms throughout the treatment period, and 41% were delayed responders, revealing a stable pattern of symptoms over time. Importantly, these findings highlight how sudden gains served to predict enhanced treatment response in PE. In another veteran sample, Allen et al. (2017) found that most (82%) participants who received PE with components of behavioral activation were nonresponders, suggesting that this protocol modification may not be recommended for most veterans with PTSD. Finally, in a study of Army soldiers, 35% of those with PTSD and 45% of those with depression showed response or remission within 1–6 months following treatment (Hepner et al., 2020). However, most soldiers with PTSD (83%) were in a response trajectory that was categorized by no symptom improvement. Taken together, these findings show variability in

treatment response for veterans and service members, with some evidence-based PTSD interventions delivered in an outpatient setting demonstrating high rates of treatment response along with a sizeable minority of nonresponders.

Examinations of residential PTSD treatment response trajectories for veterans and service members are more limited in the literature. In a sample of 803 veteran patients who received residential PTSD treatment, 49% reported symptoms in the moderate range at pretreatment and improved over the course of treatment, 41% revealed a stable high level of symptoms, and 10% endorsed a consistently low level of symptoms (Currier et al., 2014). Of note, this study included a 4-month follow-up, and findings indicated that although PTSD symptom change was observed from pre- to posttreatment, symptoms rebounded by the 4-month follow-up. Among 960 veterans from the United Kingdom receiving residential treatment, Murphy and Smith (2018) found that a five-class model best described treatment response data from pretreatment through 12-month follow-up. Most veterans (71%) comprised three classes that evidenced PTSD symptom response, whereas two classes comprised 29% of participants who were not responsive to treatment. In the only study to date that has evaluated treatment response among U.S. active duty service members over the course of treatment in a DoD residential PTSD program, Walter and colleagues (2021) identified response trajectories based on the classification developed by Wise (2004). The results indicated that for self-reported PTSD symptoms, 24% of service members were classified as "reliably improved," with an additional 8% classified as "improved," 61% as "indeterminate," 4% as "worsened," and 3% as "deteriorated" over the course of residential PTSD treatment. Despite the higher levels of symptoms and impairment often associated with individuals who require residential treatment, the findings for residential PTSD treatment are relatively comparable to those for outpatient PTSD treatment in that although many individuals respond to treatment, many others do not.

Given the heterogeneity in trajectories of PTSD treatment response among veterans and service members, it is critical to understand the factors that predict treatment response. Several predictors of treatment response trajectories have emerged in the literature. For example, higher levels of PTSD symptom severity predict a higher likelihood of being classified as a treatment nonresponder (Currier et al., 2014; Murphy & Smith, 2018; Schumm et al., 2013). Although more severe PTSD symptoms predict poorer treatment response, there is evidence to suggest that veterans with a moderate symptom level, including symptoms of comorbid disorders or mental health concerns, are the most likely to benefit from PTSD residential treatment compared to those with either more or less severe PTSD symptoms (Currier et al., 2014). In addition to PTSD symptom severity, co-occurring symptoms, such as more severe pretreatment depression (Murphy & Smith, 2018; Phelps et al., 2018; Schumm et al., 2013), anxiety (Allan et al., 2017; Murphy & Smith, 2018), and guilt (Phelps et al., 2018), predict poorer response to outpatient and residential PTSD treatment. These symptoms, along with others, such as insomnia, are critical to examine given their comorbidity with PTSD in the military population (Hepner et al., 2018; Walter et al., 2018). Demographic characteristics have not been reliably shown to predict treatment response trajectories. Combat exposure has been shown to relate to a higher likelihood of treatment resistance (Murphy & Smith, 2018); however, this association has been more nuanced in some studies (Currier et al., 2014; Schumm et al., 2013). Similarly, the association between age and treatment response trajectories is more complex in that younger age has been associated with multiple response trajectories (Currier et al., 2014; Schumm et al., 2013). Although less frequently explored in the literature, treatment-related variables have also been examined as predictors of treatment response. Research among Army soldiers indicates that stronger patient-reported therapeutic alliance is associated with more improvement, whereas receiving more than a 30-day supply of benzodiazepines has been associated with poorer response for PTSD, depressive, and anxiety symptoms (Hepner et al., 2020). Given the heterogeneity within the literature, the precise delineation of symptom, demographic, and treatment factors that predict response trajectories to residential PTSD treatment can help identify individuals who are the most likely to benefit from this high-level treatment option, which is critical to optimize limited resources on behalf of patients, staff, and programs.

This study extends our previous work (Walter et al., 2021) evaluating symptom and functioning outcomes, as well as response trajectories, for PTSD symptoms among active duty service members receiving treatment in the DoD's only residential PTSD program. The aim of the current study was to investigate demographic and military (i.e., age, treatment completion status, fitness for duty), mental health symptoms (i.e., pretreatment PTSD and depressive symptoms), and functional and behavioral health (i.e., pretreatment functional impairment, resilience, sleep duration, and sleep quality) predictors of the previously identified treatment response trajectories. Based on the existing literature, we hypothesized that higher levels of PTSD and depressive symptom severity would predict a higher likelihood of classification in a nonresponse trajectory. Given the more limited data on demographic, military, and functional and behavioral health variables, the predictive nature of these variables was considered exploratory. Determining which active duty service members respond to residential treatment, do not respond

to treatment, or even experience symptom worsening is an important endeavor to provide effective and efficient care for PTSD within the DoD.

METHOD

Participants

A total of 302 male active duty service members were referred and admitted to the Overcoming Adversity Stress Injury Support (OASIS) program between October 2010 and December 2015. Admission into the OASIS program was contingent upon seven criteria: service members must (a) have a diagnosis of PTSD from a mental health provider, (b) have incurred their PTSD-related trauma during active duty service, (c) currently have active duty status or active orders, (d) be medically stable (e.g., not actively suicidal, homicidal, manic, psychotic, or experiencing untreated or incomplete treatment for substance use disorder), (d) be independently functional in activities of daily living, (e) have a service termination date of at least 9 weeks after the OASIS admission date, and (f) pass a final administrative review to evaluate the suitability of patient goals and the OASIS program. The administrative review was conducted by a registered nurse or licensed clinical social worker serving in a case management role, the supervising psychiatrist, and a clinical psychologist. The review evaluated each patient's alignment with admission criteria and considered whether the prospective patient failed to benefit from standard DoD outpatient PTSD treatment, with preference given to those who already attempted a course of outpatient treatment. Recommendations from the referring provider were also considered during the administrative review, including statements about the patient's motivation to participate and complete the OASIS program. Among admitted patients, 22 service members were removed from the present analyses for providing no mental health data, resulting in a final eligible study sample of 282. On average, service members were 31.3 years old ($SD = 6.9$, range: 20–56 years), married (67.3%), had completed high school (42.9%) or some college (44.3%), and identified as non-Hispanic White (55.2%), followed by Hispanic/Latino (28.3%), and Black or African American (7.2%). Most service members served in the Marine Corps (67.0%) or Navy (21.3%) and were enlisted (94.6%). Approximately 30% of service members were classified as fit for duty at admission, whereas the remainder were on limited duty, pending a physical evaluation, or not fit for duty. Fitness-for-duty in this context is a DoD administrative status related to a service member's ability to carry out the daily tasks and responsibilities of a military operational specialty necessary for immediate, worldwide deployment. Mental health

and other medical conditions can result in a designation of limited or full loss of fitness-for-duty, which was common in this sample. Table 1 includes additional sample characteristics, and Table 2 features pretreatment symptom and functioning scores.

Procedure

The OASIS program is a residential PTSD treatment program serving active duty service members from all U.S. military branches. This 10-week program delivers evidence-based PTSD treatments, such as CPT (Resick et al., 2014), eye movement desensitization and reprocessing (EMDR; Shapiro, 1999), PE (Foa et al., 2007), and pharmacological interventions. Most service members in the OASIS program received CPT. EMDR and PE were provided based on the unique training background of the individual clinical psychologist assigned to a service member. All service members in the program were assessed and treated by a psychiatrist, with most undergoing some form of pharmacological treatment; however, data for the specific percentages and types of prescribed medications were unavailable. In addition to traditional therapeutic approaches, service members in the OASIS program participated in 60-min, evidence-supported adjunctive interventions (e.g., acupuncture, yoga; see Sargent et al., 2013). For a more detailed description of the OASIS program see Walter et al. (2021). Study procedures related to analyzing OASIS clinic data were approved by the Naval Medical Center San Diego Institutional Review Board.

Measures

Demographic, military, and other variables

During the OASIS program intake process, service members provided demographic data, such as age, race/ethnicity, educational attainment, and marital status. Service members also provided data related to their military service, including service branch, rank/pay grade, deployment history, and medical board fitness-for-duty status (i.e., fit for duty, limited duty, not fit for duty/duty status pending medical evaluation). Treatment completion status (i.e., program completion vs. early discharge) was also examined and defined as whether the service member completed the 10-week program.

Pre- and posttreatment outcome measures

PTSD symptoms. PTSD symptom severity was assessed using the military version of the PTSD Checklist

TABLE 1 Sample characteristics and pretreatment symptom and functioning scores

Variable	Total sample (N = 282) N	%	Improved (n = 90) n	%	Worsened (n = 21) n	%	Indeterminate (n = 171) n	%
Race/ethnicity								
White	123	43.6	44	48.9	7	33.3	72	42.1
Hispanic, Latino, or Spanish origin	63	22.3	20	22.2	4	19.0	39	22.8
Black or African American	16	5.7	2	2.2	1	4.8	13	7.6
Asian	4	1.4	1	1.1	0	0.0	3	1.8
American Indian or Alaska Native	9	3.2	5	5.6	1	4.8	3	1.8
Native Hawaiian or other Pacific Islander	2	0.7	1	1.1	0	0.0	1	0.6
Not listed	8	2.8	2	2.2	0	0.0	6	3.5
Mixed	6	2.1	2	2.2	1	4.8	3	1.8
Educational attainment								
High school	117	41.5	45	50.0	8	38.1	64	37.4
Some college	121	42.9	30	33.3	8	38.1	83	48.5
Associate degree	12	4.3	6	6.7	2	9.5	4	2.3
Bachelor's degree	16	5.7	5	5.6	2	9.5	9	5.3
Master's degree	2	0.7	0	0.0	0	0.0	2	1.2
Graduate degree	5	1.8	3	3.3	0	0.0	2	1.2
Marital status								
Never married	37	13.1	14	15.6	3	14.3	20	11.7
Separated	32	11.3	8	8.9	1	4.8	23	13.5
Divorced	22	7.8	9	10.0	0	0.0	13	7.6
Married	187	66.3	58	64.4	16	76.2	113	66.1
Military branch								
Navy	60	21.3	25	27.8	3	14.3	32	18.7
Marine Corps	189	67.0	54	60.0	15	71.4	120	70.2
Air Force	3	1.1	2	2.2	0	0.0	1	0.6
Army	30	10.6	9	10.0	3	14.3	18	10.5
Rank								
E1–E4	78	27.7	29	32.2	3	14.3	46	26.9
E5–E6	152	53.9	40	44.4	12	57.1	100	58.5
E7–E9	33	11.7	16	17.8	2	9.5	15	8.8
WO1–WO5	1	0.4	1	1.1	0	0.0	0	0.0
O1–O3	7	2.5	1	1.1	2	9.5	4	2.3
O4–O10	7	2.5	3	3.3	1	4.8	2	1.8
Pretreatment duty status								
Full duty	83	29.4	30	33.3	4	19.0	49	28.7
Light/limited duty	145	51.4	43	47.8	13	61.9	89	52.0
Not fit for duty/pending physical evaluation	51	18.1	17	18.9	3	14.3	31	18.1
Program status								
Early discharge	37	13.1	7	7.8	3	14.3	27	15.8
Completion	242	85.8	83	92.2	17	81.0	142	83.0

Note: E = enlisted; WO = warrant officer; O = officer.

(PCL-M; Weathers et al., 1993) and administered weekly during the program. This commonly used 17-item self-report measure was designed to evaluate symptoms consistent with PTSD diagnostic criteria as defined in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text revision; American Psychiatric Association, 2000). Each item was rated on a scale ranging from 1 (*not at all*) to 5 (*extremely*). The items were summed to yield a continuous measure of PTSD symptom severity, where higher scores indicate higher symptom levels. In the present sample, internal consistency for the PCL-M was good at pretreatment, Cronbach's α = .85.

Depressive symptoms. The eight-item version of the Patient Health Questionnaire (PHQ-8; Kroenke et al., 2009) is a widely used measure that assesses depressive symptom severity. In this study, the PHQ-8 was administered to assess the frequency of symptom endorsement and was completed weekly during the program. Each symptom item was rated on a 4-point scale ranging from 0 (*not at all*) to 3 (*nearly every day*). A total score was created by summing the eight items, with higher scores reflecting more severe symptoms of depression. In the present sample, internal consistency for the PHQ-8 was acceptable at pretreatment, Cronbach's α = .79.

Resilience. The Response to Stressful Experiences Scale (RSES; Johnson et al., 2011) was administered at pre- and postprogram to evaluate service members' successful adaptation to stressful, traumatic, and adverse experiences. This 22-item measure evaluates trait resilience on six factors: positive appraisal, spirituality, active coping, self-efficacy, learning/meaning-making, and acceptance of limits. Items are scored on a 5-point Likert-type scale ranging from 0 (*not at all like me*) to 4 (*exactly like me*), and higher scores suggest more adaptive ways of responding to stressful experiences. In the present sample, internal consistency for the RSES was excellent at pretreatment, Cronbach's α = .91.

Functional impairment. The Sheehan Disability Scale (SDS; Sheehan, 1983) was used at pre- and postprogram

to assess disability and functional impairment. Participants rated their level of disability and impairment in the domains of work/school, social life, and family life, using a 10-item visual analog scale ranging from 0 (*not at all*) to 10 (*extremely*). Scores were totaled to yield a global functional impairment score, where higher scores indicated higher levels of functional impairment. In the present sample, internal consistency for the SDS was acceptable at pretreatment, Cronbach's α = .75.

Sleep problems. The current study examined two domains of sleep from the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989): sleep duration and sleep quality. Sleep duration consisted of the difference, in hours, between the average time participants turned off the lights to go to sleep and the average time participants got out of bed after sleeping. Sleep quality was examined using the single item "How would you rate your sleep quality overall?" Responses to this item ranged from 0 (*very bad*) to 3 (*very good*). The PSQI was administered at pre- and posttreatment.

Data analysis

To evaluate PTSD symptom response trajectories for service members in the OASIS program, established criteria from Wise (2004) were adapted for analyses. A reliable change index (RCI) was calculated in concert with existing clinical thresholds to determine whether observed changes in PTSD symptoms were reliably and clinically significant. An RCI of 1.96 or higher and a change in PTSD symptoms on the PCL-M of 10 points or more (National Center for PTSD, n.d.) met these thresholds, respectively. As reported in Walter and colleagues (2021), service members who met the criteria for both clinical significance and an RCI of 1.96 or greater were considered "reliably improved," whereas those who met one criterion were categorized as "improved," and those who met neither criterion for clinical significance nor a significant RCI

TABLE 2 Pretreatment symptom and functioning scores

Variable	Total sample (N = 282)		Improved (n = 90)		Worsened (n = 21)		Indeterminate (n = 171)	
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
PCL-M	68.32	9.45	67.70	9.02	66.48	8.18	68.87	9.91
PHQ-8	17.56	4.56	18.01	4.57	17.05	3.93	17.39	4.64
Resilience	42.08	16.50	41.01	16.75	36.95	14.06	43.25	16.58
Functional impairment	21.31	6.21	20.68	6.12	21.10	5.21	21.67	6.39
Sleep quality	0.75	0.93	.77	.92	.71	.96	.75	.94
Sleep duration	6.90	2.10	7.28	2.17	7.21	1.70	6.66	2.08

Note: PCL-M = Posttraumatic Stress Disorder Checklist–Military Version; PHQ-8 = eight-item Patient Health Questionnaire.

were classified as "indeterminate." Service members who met one criterion in the negative direction (i.e., increased symptoms) were categorized as "worsened," and those who met the criteria for both clinical significance and a significant RCI in the negative direction were classified as "deteriorated." For the present study, we collapsed these into three categories due to small cell sizes in negative response trajectories: improved, worsened, and indeterminate. Participants who met one or both criteria were described as having improved their symptoms. Individuals who met one or both criteria in the negative direction (i.e., increased symptoms) were classified as having worsened over the course of the study. Finally, participants who met neither the criterion for reliable change nor the criterion for clinical significance were categorized in the indeterminate trajectory.

Multinomial logistic regressions predicting treatment response trajectories for PTSD symptoms were conducted using *M*plus (Version 8.7; see Table 2) with maximum likelihood estimation to account for missing data on study predictors (Muthén & Muthén, 2017). Given the exploratory nature of the study, analyses were conducted in a stepwise fashion, whereby theoretically and empirically related demographic (i.e., age treatment completion status, fitness for duty), mental health (i.e., pretreatment PTSD and depressive symptoms), and functional and behavioral health factors (i.e., pretreatment functional impairment, resilience, sleep duration, and sleep quality) were modeled separately. Factors that were significantly related to treatment response trajectory ($p \leq .10$) from each model were carried forward into a final adjusted model. Adjusted odds ratios (a*OR*s) and 95% confidence intervals (CIs) were calculated.

RESULTS

Based on the classification system adapted from Wise (2004), 31.9% of participants were classified as improved, having met the criteria for clinical significance and/or an RCI of 1.96 or greater for PTSD symptom change. Of the remaining participants, 7.4% had worsened symptoms over the course of the study, and the majority of participants (60.6%) were categorized as indeterminate, meeting neither the criterion for clinical significance nor a significant RCI.

Results from separate multinomial logistic regressions revealed that at Step 1 (i.e., demographic factors), only treatment completion status met the established threshold to be included in the final model, $p = .067$. Next, mental health symptoms were evaluated, and pretreatment PTSD and depressive symptom severity met the established threshold, ps $= .038$ and $.043$, respectively. Func-

tional and behavioral health factors were entered in the third model, where resilience and average pretreatment nightly sleep duration met the threshold for inclusion (p values $= .093$ and $.031$, respectively). Functional impairment and average sleep quality did not meet the significance threshold of $.10$ or less. Thus, the final model included treatment completion status, pretreatment PTSD and depressive symptom severity, resilience, and average sleep duration.

When modeled together, higher pretreatment PTSD symptom severity, a*OR* $= 0.955$, 95% CI [0.919, 0.992], was associated with significantly lower odds of being in the improved group relative to the indeterminate group (see Table 3). Treatment completion, a*OR* $= 2.488$, 95% CI [1.007, 6.145]; higher average pretreatment nightly sleep duration, a*OR* $= 1.157$, 95% CI [1.010, 1.325]; and higher levels of depressive symptom severity, a*OR* $= 1.109$, 95% CI [1.021, 1.203], were associated with significantly higher odds of being in the improved group relative to indeterminate group. No factors were related to a higher or lower likelihood of being in the worsened group. An alternative model was tested wherein all model parameters were entered simultaneously; the findings from this model did not differ from the final model. In the interest of parsimony, the initial models were maintained.

DISCUSSION

Residential PTSD treatment can be an important option on the continuum of care for service members and veterans with PTSD, particularly for those who have not responded to outpatient treatment or who have comorbidities that can be more thoroughly addressed in this treatment setting. However, given that there are service members and veterans whose symptoms persist after completing a residential PTSD treatment program (Alvarez et al., 2011; Campbell et al., 2016; Libretto et al., 2015; Walter et al., 2014, 2021) and that these programs are resource-intensive, it is critical to identify factors that will enable better prediction of which individuals are most likely to benefit from residential PTSD treatment. The current study examined previously classified response trajectories (i.e., improved, indeterminate, worsened; Wise, 2004) following treatment in the DoD's only residential PTSD treatment program, OASIS, and aimed to determine if there were demographic, symptom, and functional and behavioral health predictors of these response trajectories. Overall, the results showed that certain demographic factors, symptom severity and comorbid symptoms, and health behaviors predicted treatment response trajectories. Specifically, early discharge from the program and higher pretreatment PTSD symptom severity were associated with a lower likelihood of

TABLE 3 Stepwise multinomial logistic regression predicting posttraumatic stress disorder (PTSD) symptom trajectory

	Models 1–3				Final model			
	Improved[a]		Worsened[a]		Improved[a]		Worsened[a]	
Variable	aOR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI
Model 1								
Age	1.01	[0.97, 1.05]	1.01	[0.95, 1.08]				
Fitness[b]								
Full duty	1.16	[0.54, 2.46]	0.87	[0.18, 4.22]				
Light/limited duty	0.88	[0.44, 1.77]	1.55	[0.41, 5.85]				
Program Status	2.27	[0.94, 5.47]	1.01	[0.28, 3.69]	2.49*	[1.01, 6.15]	1.16	[0.31, 4.39]
Model 2								
PTSD	0.96*	[0.93, 1.00]	0.96	[0.91, 1.19]	0.96*	[0.92, 0.99]	0.96	[0.90, 1.02]
Depression	1.09*	[1.00, 1.18]	1.04	[0.91, 1.19]	1.11*	[1.02, 1.20]	1.06	[0.92, 1.21]
Model 3								
Resilience	0.99	[0.97, 1.00]	0.98	[0.95, 1.00]	0.99	[0.97, 1.01]	0.98	[0.95, 1.00]
Impairment	0.98	[0.94, 1.02]	0.98	[0.91, 1.06]				
Sleep quality	1.05	[0.78, 1.40]	0.92	[0.55, 1.55]				
Sleep duration	1.16*	[1.01, 1.32]	1.14	[0.91, 1.42]	1.16*	[1.01, 1.33]	1.14	[0.91, 1.44]

Note: aOR = adjusted odds ratio.
[a]The reference category was "indeterminate." [b]The reference category was "not fit for duty/pending physical evaluation."
*$p < .05$.

being in the improved group, whereas higher average pre-treatment nightly sleep duration and depressive symptom severity were related to higher odds of being in the improved group relative to the indeterminate group. These results are encouraging in that predictors of treatment trajectories were predominately modifiable factors, such as self-reported symptom severity, comorbid symptoms, and treatment completion status.

Consistent with the study hypotheses, pretreatment PTSD symptom severity emerged as a significant predictor of response trajectories for PTSD symptoms in this study. Specifically, service members who started treatment with more severe PTSD symptoms were less likely to be in the improved group compared with the indeterminate group, which is consistent with the literature demonstrating that higher levels of PTSD symptom severity predict a higher probability of classification as a treatment non-responder (Currier et al., 2014; Murphy & Smith, 2018; Schumm et al., 2013). This finding seems at odds with the generally accepted notion that residential treatment is suited for individuals with more severe symptoms, and it highlights the need to develop other treatments or adjunctive options for service members with higher PTSD symptom levels.

In addition to PTSD symptom severity, comorbid symptoms were also related to the course of recovery during residential treatment. Service members who reported longer sleep duration at the onset of treatment and those with higher depressive symptom severity showed a greater like-lihood of being in the improved group compared with the indeterminate PTSD symptom trajectory group. The finding regarding longer sleep duration predicting improved outcomes in residential PTSD treatment is consistent with the literature showing that sleep dysregulation is a central feature of PTSD and, thus, an important target for treatment (Germain, 2013). In support of this, research has shown that more severe sleep problems among military service members predict PTSD symptom severity over time (McLay et al., 2010; Pigeon et al., 2013) and that sleep problems predict more severe PTSD symptoms rather than vice versa (Wright et al., 2011). However, recent research suggests a more bidirectional association between insomnia and PTSD symptoms that varies during and following treatment (Kartal et al., 2021). Indeed, on a more mechanistic level, sleep has significant implications for the learning processes that underlie many behavioral treatments for PTSD such that impaired sleep may impair the learning processes that drive outcomes (Colvonen et al., 2019). Thus, from a cognitive resources perspective, service members who enter residential PTSD treatment feeling rested may be better able to process, internalize, and benefit from treatment relative to those with more sleep problems, although more research is needed.

Regarding higher depression severity predicting treatment response, this was contrary to our hypothesis based on response trajectory studies but not entirely surprising given the conflicting results in the literature more generally. Specifically, a meta-analysis by Kline and

colleagues (2020) revealed that depression measured as a continuous construct predicted smaller PTSD treatment effect sizes, but when the construct was measured categorically, it was not predictive of treatment outcomes. Results from the current study diverge from the meta-analytic results of randomized controlled trials of outpatient trauma-focused treatment but are consistent with enhanced PTSD treatment outcomes for participants with higher levels of depressive symptom severity in trauma-focused treatment previously demonstrated in the literature (e.g., Rizvi et al., 2009). Nonetheless, the finding that service members with more severe depressive symptoms were more likely to be in the improved response group is promising given the common comorbidity of PTSD and depression, including among service members (Hepner et al., 2018; Walter et al., 2018). One potential explanation is that service members with the most severe depressive symptoms may have struggled to complete activities, such as preparing and eating meals, completing tasks, or interacting with others before entering the OASIS program. Although explicit behavioral activation protocols were not employed, the structured nature of the OASIS program (e.g., meals prepared, designated time to complete therapeutic tasks and adjunctive treatments, opportunities for social interaction) may have served as behavioral activation that, in turn, resulted in general improvements in mood that were more salient among individuals with more severe depression.

It should be noted that consistent with prior work (Walter et al., 2021), most participants (60.6) were classified in the indeterminate trajectory, which represented a PTSD treatment response that met neither clinical significance nor a significant RCI. Although the percentage of participants in the indeterminate trajectory exceeded the reported proportions of nonresponders in some studies of outpatient and residential PTSD treatment for military samples (19%–28%; Clapp et al., 2016; Murphy & Smith, 2018; Schumm et al., 2013), it was lower than reported in others (82%–83%; Allan et al., 2017; Hepner et al., 2020). Even if the percentage of participants in the indeterminate trajectory fell within the ranges found in the literature, it is critical to explore how to help these individuals move into the response category, whether by offering different treatments, providing adjunctive interventions, or identifying additional factors that may impede recovery.

These findings have important clinical implications. First, using appropriate screening and assessment measures can help providers identify service members who may be less likely to experience significant symptom improvements (i.e., service members with more severe PTSD symptoms, poor sleep, lower depressive symptom levels) and make treatment decisions before or during their time in residential treatment. This could include an increased length of treatment or adjunctive treatments that have demonstrated effectiveness; however, further research is necessary to identify optimal treatment variations for these service members and clarify which treatment components of residential treatment are the most effective at reducing symptoms and improving functioning. Second, the importance of sleep underscores our findings. Effective sleep therapies (i.e., cognitive behavioral therapy for insomnia) have demonstrated utility for improving sleep in the presence of comorbid psychiatric concerns (Taylor & Pruiksma, 2014), including among veterans with PTSD (Talbot et al., 2014). Given these findings, residential treatment programs should consider incorporating sleep treatments into the program or even providing such interventions before the start of PTSD treatment to optimize treatment response. More work is needed to determine the optimal sequencing or combination of sleep and PTSD treatments. Finally, it is interesting to note that higher self-reported depressive symptoms predicted clinical improvement in the current sample. Although more work is needed to explore the role of comorbid depression on PTSD treatment outcomes, especially considering the inconsistent results in the literature, this finding is encouraging given that over half of civilians and service members with PTSD experience co-occurring depression (Rytwinski et al., 2013; Walter et al., 2018). As such, although some studies suggest that comorbidity can predict poorer treatment outcomes (e.g., Kline et al., 2020), residential treatment may represent an effective modality to offset the negative impact of comorbidity.

The results of the current study should be interpreted considering some limitations. To begin, OASIS is a real-world treatment program within the DoD that was not designed as a research study; thus, there are some methodological limitations. The analyses relied solely on self-report measures of symptoms and functioning. Data from diagnostic assessments would have been informative to evaluate other factors that potentially influence treatment response but were unavailable for this study. Data detailing the exact psychotherapeutic and pharmacological interventions administered to individual participants were unavailable, so we were unable to ascertain the influence of specific interventions. Reasons for discharge were also not collected, precluding recommendations or strategies for treatment engagement or completion. Few participants reported an increase in symptoms over the course of treatment ($n = 21$); thus, the analyses may have been underpowered to detect differences between the worsened and indeterminate trajectories. Additionally, some measures could not be explored as outcomes or predictors because of concerns about statistical power and missing data. For example, hazardous alcohol use, which is commonly comorbid with PTSD, was not routinely assessed

among service members until later in the program. As such, response trajectories as a function of hazardous drinking prior to arriving at OASIS were only available for approximately half of the sample. Evaluating the influence of comorbid substance use on residential PTSD treatment outcomes is an important endeavor for future work. Furthermore, the PCL-M was administered during the period of data collection, which does not reflect the current diagnostic criteria for PTSD (i.e., *DSM-5*). Lastly, all study participants were male, which means that these findings may not generalize to the approximately 20% of active duty service members who are women (Defense Manpower Data Center, 2021). Similarly, these findings may not generalize to civilians receiving treatment in residential PTSD programs or to service members with PTSD who have not been referred to residential treatment.

Despite these limitations, the study featured several strengths. This longitudinal study of response to residential PTSD treatment included a large sample and spanned a period of over 5 years. Furthermore, the sample consisted of active duty service members, which adds to the existing literature given that much of the extant research focuses on veterans. Although self-report assessments were used exclusively for data collection, these measures are well-validated and commonly used in DoD and VA health care settings. The PCL-M was administered weekly over the course of residential PTSD treatment, offering the opportunity to examine treatment response across time rather than just at treatment outset and completion. Finally, the method used to identify outcome trajectories allowed a more nuanced examination of responses to treatment compared with a dichotomous (i.e., yes/no) treatment response outcome or a sole focus on treatment responders.

To our knowledge, this was the first study to examine predictors of treatment response for active duty service members in a military residential PTSD treatment setting. The results showed that higher PTSD symptom severity and early program discharge were associated with lower odds of improvement, whereas longer sleep duration and higher depressive symptom severity were associated with higher odds of improvement. These results have direct clinical implications, as these factors can be easily assessed to predict treatment response more accurately. Future research should aim to replicate this work in different populations to improve generalizability and expand the scope to include other important variables, such as treatment change processes, therapist factors, and additional patient characteristics that further predict treatment response. Continuing this research will allow clinicians to better predict treatment response and efficiently allocate the time and resources needed to help the largest number of service members seeking residential treatment for PTSD.

OPEN PRACTICES STATEMENT

AUTHOR NOTE

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