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Mental Health Over Time in a Military Sample: The Impact of Alcohol Use Disorder on Trajectories of Psychopathology After Deployment

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To identify trajectories of depression and posttraumatic stress (PTS) symptom groups after deployment and determine the effect of alcohol use disorder on these trajectories, depression symptoms were modeled using the 9-item Patient Health Questionnaire in 727 Ohio National Guard members, and PTS symptoms were modeled using the PTSD Checklist in 472 Ohio National Guard members. There were 55.8% who were resistant to depression symptoms across the 4 years of study, and 41.5% who were resistant to PTS symptoms. There were 18.7% and 42.2% of participants who showed resilience (experiencing slightly elevated symptoms followed by a decline, according to Bonanno et al., 2002) to depression and PTS symptoms, respectively. Mild and chronic dysfunction constituted the smallest trajectory groups across disorders. Marital status, deployment to an area of conflict, and number of lifetime stressors were associated with membership into different latent groups for depression (unstandardized β estimates range = 0.69 to 1.37). Deployment to an area of conflict, number of lifetime traumatic events and education predicted membership into different latent groups for PTS (significant unstandardized β estimate range = 0.83 to 3.17). AUD was associated with an increase in both symptom outcomes (significant unstandardized β estimate range = 0.20 to 9.45). These results suggested that alcohol use disorder may have contributed substantially to trajectories of psychopathology in this population.

It is well established that posttraumatic stress (PTS) and depression are more prevalent in military (Thomas et al., 2010) compared to civilian (Kessler et al., 2005) populations. Posttraumatic stress disorder (PTSD) prevalence estimates among Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) veterans range from about 5% to 20% (Kok, Herrell, Thomas, & Hoge, 2012; Ramchand et al., 2010; Smith et al., 2008); depression prevalence estimates range from about 2% to 16% (Tanielian & Jaycox, 2008; Wells et al., 2010). The experiences of OEF/OIF veterans suggest that the trajectories, or paths followed over time, of these disorders may reflect life-course civilian and combat experiences that depart from those of previous generations (Bonanno et al., 2012). Trajectories of mental health over time, however, have been predominately studied in civilian populations following specific traumatic event (TE) experiences (Lowe, Galea, Uddin, & Koenen, 2014; Nandi, Tracy, Beard, Vlahov, & Galea, 2009; Pietrzak, Van Ness, Fried, Galea, & Norris, 2013). Generally these trajectory groups include resilient (initial symptomology followed by a decline), resistant (consistently low or no symptomology), chronic dysfunction (consistently high symptomology), and typically one or two other groups of either increasing or stable mild symptoms (Bonanno et al., 2012; Norris, Tracy, & Galea, 2009).

We also know that alcohol use disorder (AUD) is prevalent among military personnel (Bray et al., 2010; Cohen, Fink,

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Sampson, & Galea, 2015), possibly due to efforts to self-medicate existing mental illness symptoms (Schumm & Chard, 2012). Although AUD frequently coexists with psychopathology in military populations (Thomas et al., 2010), we do not know how it interacts with trajectories of depression and PTS over time. There is a lack of longitudinal follow-up research among OEF/OIF veterans in general (Hoge, Auchterlonie, & Milliken, 2006), with few exceptions (Duma, Reger, Canning, McNeil, & Gahm, 2010; Milliken, Auchterlonie, & Hoge, 2007; Schaller et al., 2014; Seal et al., 2009; Thomas et al., 2010). Further, we are not aware of any published work that has documented trajectories of both depression and PTS in OEF/OIF personnel in a single U.S. study. We aimed to document trajectories of symptoms after deployment among OEF/OIF personnel, and to estimate how time-stable risk factors and time-varying covariates, including AUD, affected these trajectories across four waves of cohort data.

Method

Participants and Procedure

Participants were drawn from the Ohio Army National Guard using a simple random sample as part of the Ohio Army National Guard Mental Health Initiative (OHARNG MHI), drawn from all serving members between 2008 and 2009. After eliminating members who declined to participate, who did not have a valid telephone number, or who were deemed ineligible due to age, retirement status, or language, the official enrollment at baseline was 2,616, with a cooperation rate of 67.5% and a response rate of 43.2%. Detailed information on sampling methods are described elsewhere (Calabrese et al., 2011).

Respondents were interviewed from 2008–2012, with approximately 12 months between interviews for all subjects. A second round of baseline interviews for new participants ($n = 578$) was also initiated in 2010–2011 to replenish the sample after loss to follow-up. Every respondent included in this analysis participated in at least two waves. The final analytic samples consisted of 727 respondents for depression (those who completed two or more study waves, were deployed in the past 2 years from baseline assessment, and were nonmissing on all risk factors), and 472 respondents for PTS (those who completed two or more study waves, were nonmissing on all risk factors, had a TE during a deployment within 2 years of baseline assessment, and chose that same event as their "worst" event throughout all follow-up interviews, in order to consistently follow symptoms from the same event).

Table 1 presents the prevalence of risk factors for both analytical samples, as well as the percentage of respondents who completed each wave. The demographics of the analytical samples largely matched those of the entire OHARNG MHI sample, with the exception of a lower prevalence of female respondents in both of the analytical samples (not shown), which reflected the fact that our samples included only those who had been deployed within 2 years, and women tend to be deployed less frequently (Tanielian & Jaycox, 2008).

We ran additional analyses comparing respondents who completed all four waves with those who were lost to follow-up on risk factors, covariates, and outcomes. For the depression analytic sample, we found that married soldiers were more likely to have completed all waves ($p = .016$). The mean number of depression symptoms at baseline, however, was not associated with follow-up completion, so we were not concerned about potential respondent bias. For the PTS analytic sample, complete follow-up was not associated with any risk factors, time-varying covariates, or PTS symptoms at baseline (results not shown).

An alert letter with an opt-out was sent to all listed participants, and verbal informed consent was obtained from all participants prior to participation. Interviews (about 60 min in length) were administered via a computer-assisted telephone survey.

The Ohio National Guard and the institutional review boards of University Hospitals Case Medical Center, University of Toledo, University of Michigan, Ann Arbor Veterans Administration Medical Center, Columbia University, Boston University, and the Office of Human Research Protections of the U.S. Army Medical Research and Materiel Command approved this study protocol.

Measures

Depression symptoms were scored using a symptom count (0–9) from the Patient Health Questionnaire (PHQ; Kroenke, Spitzer, & Williams, 2001); symptoms present at all (in a yes/no format) during the last 30 days for at least 2 weeks were counted as positive. PTS symptoms were scored using the PTSD Checklist-Civilian Version (PCL), which includes 17 items, each scored from 1 = *not at all* to 5 = *extremely*, resulting in a range of 17 to 85 (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996). PTS symptoms had a Cronbach's α of .94 at baseline in our analytic sample.

Time-stable risk factors (assessed only at baseline) and time-varying covariates (collected at each time point) were selected for inclusion based on theoretical considerations, significance of terms when entered into models, and model convergence.

TEs were assessed with the Life Events Checklist-Civilian Version (Gray, Litz, Hsu, & Lombardo, 2004), the Deployment Risk and Resilience Inventory items (King, King, Vogt, Knight, & Samper, 2006), and events used by Breslau et al. (1998). Events could have occurred either during or outside of the most recent deployment. These were all events that met Criterion A1 for the definition of a TE according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association [APA], 2000); the full list of which are presented in the first part of Supplemental Table 1. A binary variable for a high level of TEs was created

Table 1
Baseline Prevalence of Risk Factors and follow-up completion by Subsample

	Depression subsample ($n = 727$)		PTS subsample ($n = 472$)	
Variable	*n*	%	*n*	%
Completed wave 2	628	86.4	412	87.3
Completed wave 3	478	65.8	304	64.4
Completed wave 4	395	54.3	252	53.4
Not married	332	45.7	212	44.9
High school/GED or less	173	23.8	109	23.1
10+ lifetime TEs	335	46.1	284	60.2
4+ lifetime stressful events	345	47.5	235	49.8

Note. PTS = posttraumatic stress; GED = general education development (degree); TEs = traumatic events.

using the median (10) of the count of total TEs in the sample. Stressors were events from the above-stated instruments that did not qualify for Criterion A1, and are presented in the second half of Supplemental Table 1. A binary variable for high level of stressors was also created using the median (4) of the count in the sample.

Being deployed to an area of conflict (AOC) was defined as deployment to either Iraq or Afghanistan during the most recent deployment at baseline. Considering everyone in this sample was deployed within 2 years of baseline, these deployments were to OEF/OIF. Low education was defined as having a high school diploma, general education development diploma, or less.

AUD was defined as having either past-year abuse or dependence according to the *DSM-IV-TR* (APA, 2000), as assessed by the Mini-International Neuropsychiatric Interview (Sheehan et al., 1998). Alcohol abuse and dependence were both validated among a random sample of 500 soldiers from the original baseline sample assessed by trained clinicians (Calabrese et al., 2011).

PTSD as a time-varying covariate (for TEs that occurred both in and outside of deployment) was defined as meeting criteria for past-year PTSD, according to the *DSM-IV-TR* using the PCL (Blanchard et al., 1996), which was validated using the Clinician-Administered PTSD Scale in the clinical sample described above and found to have high sensitivity (.92) and moderate specificity (.54; Prescott et al., 2014).

Past-year depression as a time-varying covariate was defined as reporting a period of at least 2 weeks with two or more co-occurring symptoms on the PHQ-9 (Kroenke et al., 2001), with one symptom being depressed mood or anhedonia. This definition included, but was not limited to, the *DSM-IV-TR* diagnosis of major depressive disorder. This inclusive definition was chosen due to higher sensitivity relative to major depressive disorder by itself (.51 compared to .35; both had specificity greater than .82) when validated against the Structured Clinical Interview for DSM-IV-TR (SCID; First, Spitzer, Gibbon, & Williams, 2002) in the clinical sample (Prescott et al., 2014).

Cumulative TEs were defined as reporting at least one TE (from deployment or not) since last study wave. For all participants, cumulative TEs at baseline were coded as zero to avoid colinearity with the time-stable measure of baseline TE count.

Data Analysis

Proc Traj, a SAS-callable add-on package that estimates discrete mixture models for longitudinal data (Jones, Nagin, & Roeder, 2001; Jung & Wickrama, 2008), was used to estimate trajectories in SAS version 9.4. Proc Traj is used for group-based latent class growth analysis, which fixes within-group variance to zero to more clearly identify latent classes (existing but not yet manifested) and therefore serves as a more hypothesis-generating method compared to more conventional growth modeling approaches (Jung & Wickrama, 2008). Proc Traj drops respondents who are missing any baseline risk factors from the analysis; consequently, our analytic samples only included participants with nonmissing risk factors ($n = 727$ for depression and $n = 472$ for PTS). Respondents missing time-varying variables, including outcomes and covariates, are kept in the model, and are estimated using other data points under the assumption that they are missing at random (Nagin, 2009). Because we had loss to follow-up across the four waves (see Table 1), these missing data points were estimated under this assumption.

Past-year depression symptoms were modeled assuming a zero-inflated Poisson distribution (ideal for a highly skewed outcome), and PTS symptoms were modeled assuming a censored normal distribution (considered appropriate for psychiatric scale data; Jones et al., 2001; Nagin & Tremblay, 1999).

Our first step in the analysis was to determine the ideal number of latent groups for each outcome using the Bayesian information criterion (BIC; an approximation of the Bayes factor) and mean posterior probability ($\geq .80$ on average for each group; Andruff, Thompson, Gaudreau, & Louvet, 2009). BIC indices suggested that a model with four groups was most appropriate for both outcomes, and all probabilities for these

models were ≥.79 for depression (Supplemental Table 2) and .84 for PTS (Supplemental Table 4), showing a high predictive probability. The order and shape of each trajectory was then determined by iteratively assessing the significance of each term. Covariates and risk factors were added to each model one at a time. Finally, predicted symptoms were graphed to specify the difference in predicted trajectory paths based on fixed values of each time-varying covariate (Jones et al., 2001).

Results

Most participants had low levels of depression symptoms throughout the study period. The means of the number of symptoms at each wave were as follows: $M = 1.04$ ($SD = 1.88$), $M = 1.07$ ($SD = 2.02$), $M = 0.92$ ($SD = 1.77$), and $M = 1.02$ ($SD = 2.09$). There were 406 respondents (55.8% of the depression sample) who were resistant to symptoms; 136 (18.7%) were resilient; 93 (12.8%) had a steady increase in symptoms throughout the study period; and 92 (12.7%) had a fairly stable high level of symptomatology throughout (referred to as the chronic dysfunction group). Figure 1 shows a graph of predicted symptoms across the four time points (Supplemental Table 2 presents data points).

Tables 2 and 3 present risk factors and time-varying covariates, respectively, that were significant in the final models, along with their corresponding unstandardized β estimates. For depression, baseline risk factors associated with group membership included marital status, AOC deployment, and lifetime stressors (Table 2). Having four or more lifetime stressors made respondents more likely to fall into the chronic dysfunction (unstandardized $\beta = 1.37$, $p < .001$) and increasing (unstandardized $\beta = 0.69$, $p = .018$) groups. AOC deployment was significantly associated with membership in the chronic dysfunction (unstandardized $\beta = 1.02$, $p < .001$) and resilient (unstandardized $\beta = 0.92$, $p < .001$) groups. Being unmarried was significantly associated with membership in the resilient group ($\beta = 0.80$, $p = .004$). All of these comparisons are with reference to the resistant group.

For depression, past-year AUD and PTSD both significantly contributed to a change in shape for all four trajectory groups (Table 3). Figure 2 shows the potential effect of AUD on each trajectory (data points presented in Supplemental Table 3). The solid lines represent predicted trajectories of symptoms as they are in Figure 1. The dotted lines represent predicted trajectories of symptoms where past-year PTSD was set to a constant 0 but past-year AUD was set to 1 at every time point. AUD at each point resulted in an increase of the number of symptoms of depression overall. The group affected most by AUD was the mild increasing group (unstandardized $\beta = 0.92$, $p < .001$). The gap between the predicted trajectories of the increasing group widened with time, whereas the resilient group showed a smaller gap between the two potential shapes as more time since deployment passed. The chronic dysfunction and resistant groups both showed the same general shape across time, with a small increase in symptoms.

The means of the PCL at each wave were as follows: $M = 28.92$ ($SD = 13.68$), $M = 25.35$ ($SD = 12.11$), $M = 24.44$ ($SD = 12.42$), and $M = 24.93$ ($SD = 13.93$). We observed a resistant group ($n = 196$; 41.5%), a resilient group ($n = 199$; 42.2%), a mild constant group ($n = 55$; 11.7%), and a chronic dysfunction group ($n = 22$; 4.7%) for PTS. Figure 3 shows a graph of these predicted symptoms across the four time points (data points specified in Supplemental Table 4).

Risk factors at baseline that were associated with group membership for PTS included education, TEs, and AOC deployment (Table 2). Reporting high lifetime TEs was significantly associated with membership in the chronic dysfunction (unstandardized $\beta = 3.17$, $p = .003$) and constant mild (unstandardized

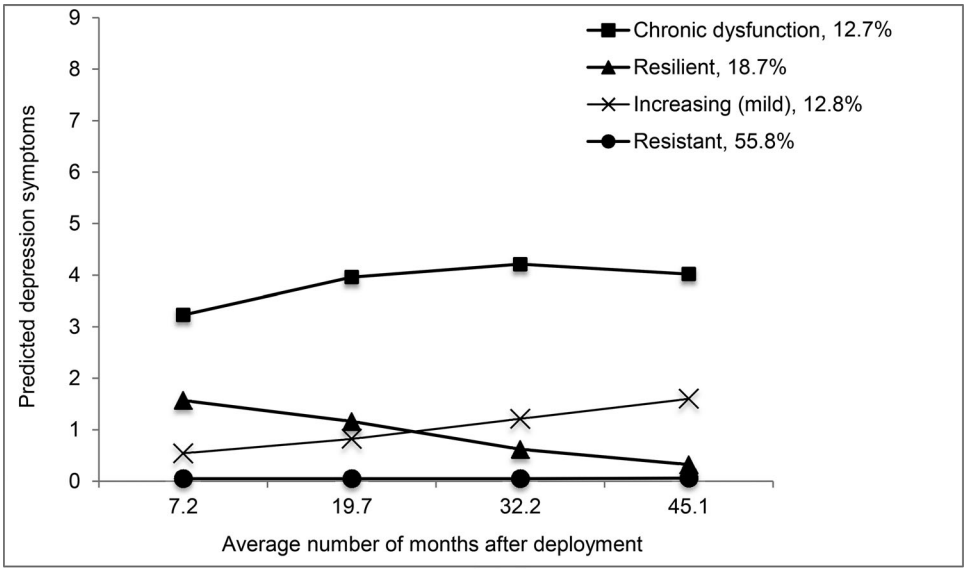

Figure 1. $n = 727$. Predicted trajectories of depression symptoms from the 9-item Patient Health Questionnaire in the depression subsample.

Table 2
Unstandardized β Estimates of Risk Factors by Subsample

Depression subsample ($n = 727$)			PTS subsample ($n = 472$)		
Latent group	Risk factor	Estimate	Latent group	Risk factor	Estimate
Resistant group ($n = 406$)	Referent		Resistant group ($n = 196$)	Referent	
Resilient group ($n = 136$)	Unmarried	0.80*	Resilient group ($n = 199$)	Deployed to AOC	0.52
	Deployed to AOC	0.92*		10+ lifetime TEs	1.54*
	4+ lifetime stressors	0.51		Low education	0.83*
Increasing group ($n = 93$)	Unmarried	–0.16	Constant group ($n = 55$)	Deployed to AOC	1.59*
	Deployed to AOC	0.13		10+ lifetime TEs	2.04*
	4+ lifetime stressors	0.69*		Low education	0.78
Chronic dysfunction group	Unmarried	–0.15	Chronic dysfunction ($n = 22$)	Deployed to AOC	1.24
($n = 92$)	Deployed to AOC	1.02*		10+ lifetime TEs	3.17*
	4+ lifetime stressors	1.37*		Low education	1.01

Note. AOC = area of conflict; TEs = traumatic events.
*$p < .05$.

β = 2.04, $p < .001$) groups. AOC deployment was significantly associated with membership in the mild constant group (unstandardized β = 1.59, $p = .001$). Having low education was associated with membership in the resilient group (unstandardized β = 0.83, $p = .032$). All of these comparisons are with reference to the resistant group.

AUD, cumulative TEs, and past-year depression were all significantly associated with trajectory shape (Table 3). Figure 4 shows the potential effect of AUD on PTS trajectories (data points are specified in Supplemental Table 5). Holding other time-varying covariates constant and setting AUD as positive at each time point flattened out the slope of all trajectory groups and produced elevated symptoms for all groups. The mild constant group showed the largest increase (unstandardized β = 9.45, $p < .001$ for AUD).

Discussion

Using data from a sample of National Guard service members followed across 4 years after deployment, discrete mixture

Table 3
Unstandardized β Estimates of Parameters and Time-Varying Covariates by Subsample

Depression subsample ($n = 727$)			PTS subsample ($n = 472$)		
Latent group	Parameter	Estimate	Latent group	Parameter	Estimate
Resistant group ($n = 406$)	Linear	−0.03	Resistant group ($n = 196$)	Alcohol use disorder	6.11*
	Quadratic	0.00*		Depression	3.57*
	Alcohol use disorder	0.75*		Cumulative TEs	−1.86
	PTSD	3.74*			
Resilient group ($n = 136$)	Linear	0.01	Resilient group ($n = 199$)	Linear	−0.15*
	Quadratic	0.00*		Alcohol use disorder	5.28*
	Alcohol use disorder	0.51*		Depression	8.32*
	PTSD	1.41*		Cumulative TEs	−1.30
Increasing group ($n = 93$)	Linear	0.03*	Constant group ($n = 55$)	Alcohol use disorder	9.45*
	Alcohol use disorder	0.92*		Depression	14.02*
	PTSD	−1.99*		Cumulative TEs	1.30
Chronic dysfunction group	Linear	0.03	Chronic dysfunction ($n = 22$)	Alcohol use disorder	5.72
($n = 92$)	Quadratic	0.00		Depression	9.65*
	Cubic	0.00		Cumulative TEs	4.17*
	Alcohol use disorder	0.20*			
	PTSD	0.40*			

Note. PTSD = posttraumatic stress disorder; TEs = traumatic events.
*$p < .05$.

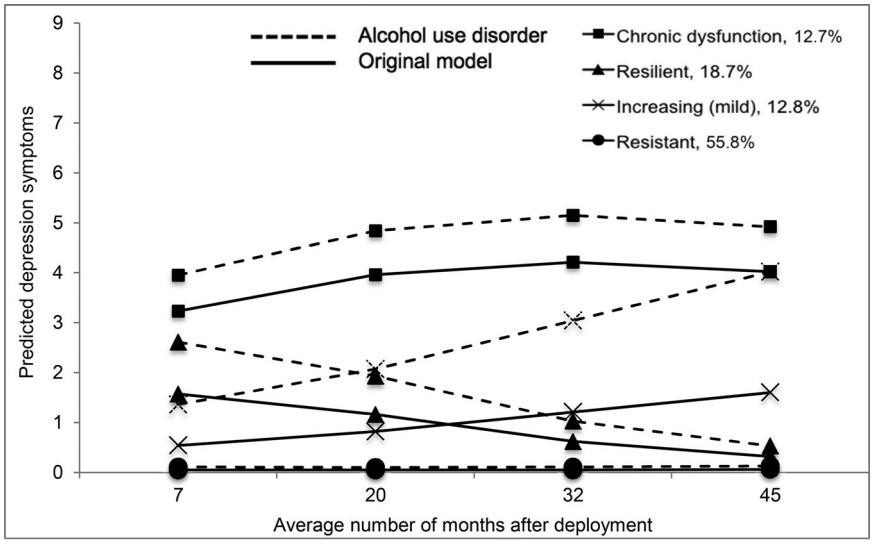

Figure 2. $n = 727$. Potential effect of alcohol use disorder on depression symptoms from the 9-item Patient Health Questionnaire in the depression subsample.

modeling documented four trajectory groups of both depression and PTS. For both outcomes, the majority of respondents fell into one of the two lowest-symptom groups, supporting previous studies that people are modally resistant to trauma (Bonanno, 2004; Bonanno et al., 2012; Lowe et al., 2014; Nandi et al., 2009). Both Lowe et al. (2014) and Bonanno et al. (2012), using samples exposed to TE experiences, estimated four groups for PTS as well, including a consistently low-level symptom group and a chronically high group with similar proportions of respondents in each group compared with our findings. Our study is the first, as far as we are aware, to have shown similar findings in a sample of U.S. military personnel.

We found that a high number of lifetime stressful events was associated with higher-symptom trajectory group membership for depression. Stressful events have been widely known to contribute to poor mental health symptoms in the military (Nash et al., 2010). Our finding that being unnmarried was associated with resilience might be explained by a lack of relationship/family stress, which has been shown to contribute to depression outcomes, particularly in military populations (Gibbs, Clinton-Sherrod, & Johnson, 2012; Martin et al., 2013).

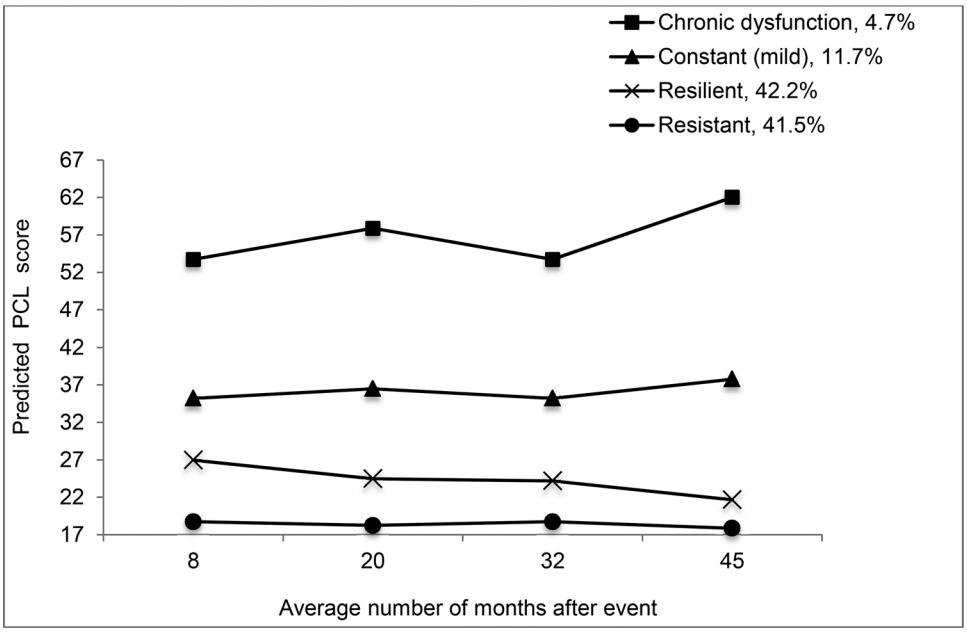

Figure 3. Predicted trajectories of posttraumatic stress symptoms using the Posttraumatic Stress Checklist (PCL) score.

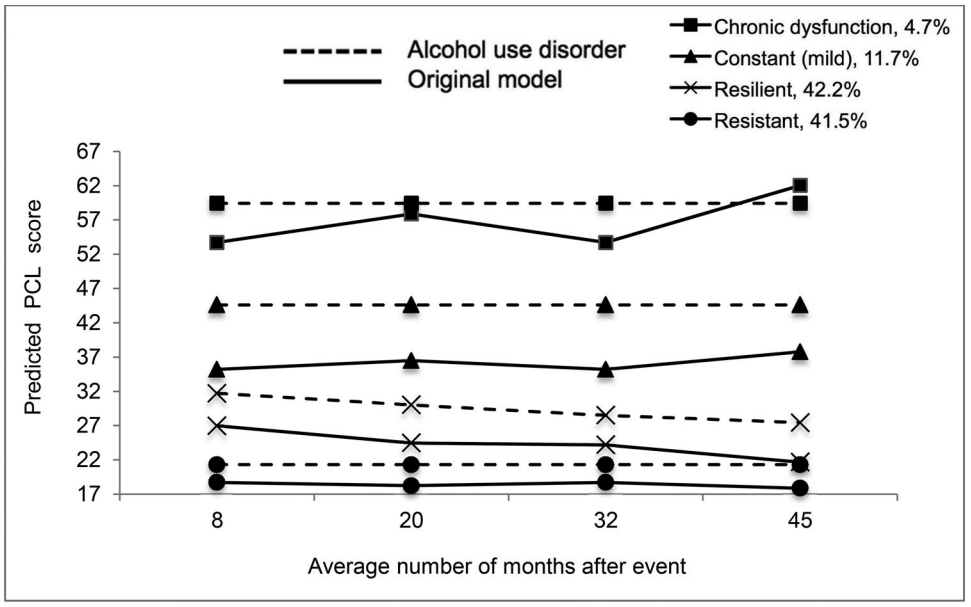

Figure 4. Potential effect of alcohol use disorder on posttraumatic stress symptoms using the Posttraumatic Stress Checklist (PCL) score.

For both trajectory outcomes, we found that soldiers deployed to an AOC were more likely to be in the higher-syptom groups. This is consistent with Hoge et al.'s (2006) findings that service members returning from Iraq or Afghanistan were more likely to have mental health problems compared to those deployed to other locations.

For PTS, we found that experiencing more lifetime TEs was associated with membership in higher-symptom trajectory groups, which agrees with civilian trajectories research (Lowe et al., 2014; Nandi et al., 2009).

AUD at all time points was associated with an increase in both depression and PTS symptoms, with the largest effect seen on the already higher-symptom trajectory groups. For the increasing depression symptom group, the gap between the original predicted trajectory and that with AUD present increased over time, suggesting that the addition of AUD contributed to a steeper increase in symptoms among those with increasing symptoms as more time passed since their initial deployment. In contrast, the depression-resilient group actually showed a smaller gap between the two potential shapes as more time from their deployment passed, suggesting that resilience toward depression symptoms after a deployment experience may put individuals in a better position to be resilient to the effect of AUD on depression as well. Similarly, AUD had the smallest effect on the resistant group for PTS, suggesting that if a respondent reported consistently low PTS symptoms after a traumatic event, the addition of AUD is not likely to change this outcome. In contrast, respondents who are already affected by PTS symptoms were more likely to worsen even more with co-occurring AUD.

These findings that AUD exacerbated both depression and PTS symptom trajectories build on previous literature that comorbidity can substantially, adversely affect outcomes in already vulnerable populations (Campbell et al., 2007; Guadiano & Zimmerman, 2010; Smith, 2012). Our findings also illustrated how the cumulative effect of AUD may manifest in a higher burden of psychopathology at multiple time points across the study period. This is especially important considering that AUD has been documented as a modifiable risk factor in U.S. service members (Pemberton et al., 2011).

A few limitations must be considered in interpreting our findings. First, we used median scores as cutoffs for some dichotomous risk factors, which means our conclusions for these variables may not be able to extend past our sample. Second, although this was a longitudinal study and we had estimates of AUD, depression, and PTS at every time point, we could not make any statements about direction or causation; it is possible that high depression/PTS symptoms lead to AUD, not the reverse.

Third, there was loss to follow-up across the 4 years of our study, requiring additional recruitment. This concern, however, is mitigated by a few observations: (a) attrition is a problem in most large-scale military cohorts like ours (Littman et al., 2010), including in another trajectory study (Boasso, Steenkamp, Nash, Larson, & Litz, 2015), particularly due to the fact that the military is a young and mobile population (Bush, Sheppard, Fantelli, Bell, & Reger, 2013); (b) the Proc Traj SAS procedure estimates missing data points using available data (Jones et al., 2001; Nagin, 2009); and (c) loss to follow-up in our samples was not associated with PTS or depression at baseline. Future longitudinal studies should aim to minimize attrition, as there are so few long-term military studies that keep participation rates constant across time. Additionally, longitudinal military studies should employ latent class analysis to allow for more comparison between studies. One direction could be to model AUD as an outcome or to investigate other

outcomes such as generalized anxiety. If a study has a large enough sample, it may be illuminating to observe the differences between male and female service members' trajectories.

Despite limitations, our findings suggested a longitudinal perspective is important when investigating psychopathology in service members. This is particularly so currently given that a greater proportion of service members are returning home with mental health burdens compared with past conflicts (Institute of Medicine Committee on the Initial Assessment of Readjustment Needs of Military Personnel, 2010). Finally, the role of AUD is key in understanding longer-term psychopathology as it modifies trajectories of depression and PTS.

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