Journal of Psychiatric Research 89 (2017) 55–64

Contents lists available at ScienceDirect

Journal of Psychiatric Research

journal homepage: www.elsevier.com/locate/psychires

Prospective post-traumatic stress disorder symptom trajectories in active duty and separated military personnel

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ARTICLE INFO

Article history:
Received 19 April 2016
Received in revised form
16 December 2016
Accepted 27 January 2017

Keywords:
PTSD
Veteran
Active duty
Military
Trajectory
Latent growth mixture model

ABSTRACT

Post-traumatic stress disorder (PTSD) is a serious mental illness that affects current and former military service members at a disproportionately higher rate than the civilian population. Prior studies have shown that PTSD symptoms follow multiple trajectories in civilians and military personnel. The current study examines whether the trajectories of PTSD symptoms of veterans separated from the military are similar to continuously serving military personnel. The Millennium Cohort Study is a population-based study of military service members that commenced in 2001 with follow-up assessments occurring approximately every 3 years thereafter. PTSD symptoms were assessed at each time point using the PTSD Checklist. Latent growth mixture modeling was used to compare PTSD symptom trajectories between personnel who separated (veterans; n = 5292) and personnel who remained in military service (active duty; n = 16,788). Four distinct classes (resilient, delayed-onset, improving, and elevated-recovering) described PTSD symptoms trajectories in both veterans and active duty personnel. Trajectory shapes were qualitatively similar between active duty and veterans. However, within the resilient, improving, and elevated recovering classes, the shapes were statistically different. Although the low-symptom class was the most common in both groups (veterans: 82%; active duty: 87%), veterans were more likely to be classified in the other three classes (in all cases, $p < 0.01$). The shape of each trajectory was highly similar between the two groups despite differences in military and civilian life.

Military personnel are often exposed to traumatic events while deployed in support of conflicts (Castro and McGurk, 2007; Hoge et al., 2004). Consequently, post-traumatic stress disorder (PTSD) is a significant health concern of current and former military service members (Hoge et al., 2004, 2006; Smith et al., 2008). A substantial proportion of combat-related PTSD research is conducted within the Department of Defense, examining current service members, and within the Department of Veteran Affairs (VA), examining veterans. However, research has demonstrated incongruent results in these populations. For example, studies report more prevalent PTSD among veterans than current service members (Dursa et al., 2014; Ramchand et al., 2010). Estimates of PTSD prevalence in current military personnel deployed in support of Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) were 7% in 2005 and 11% in 2008 (Bray et al., 2010). In contrast, between 2002 and 2008, 22% of all OEF/OIF veterans seen at the VA were diagnosed with PTSD at one or more encounter (Seal et al., 2009). Several potential reasons may contribute to this a discrepancy, including differences in the expression of PTSD among veterans and current service members and selection forces that result in a higher proportion of veterans with PTSD seeking VA care (Dursa et al., 2014).

A number of recent studies have described heterogeneity within the longitudinal course of PTSD using latent growth mixture modeling (LGMM) (Berntsen et al., 2012; Bonanno et al., 2012; deRoon-Cassini et al., 2010; Pietrzak et al., 2013). LGMM estimates latent classes containing different growth trajectories that

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http://dx.doi.org/10.1016/j.jpsychires.2017.01.016

define different subpopulations within a single analysis (Muthén et al., 2002; Muthén and Muthén, 2000; Nagin, 1999). These studies have shown that PTSD symptoms, like other forms of psychopathology, follow multiple, distinct trajectories (Bonanno, 2004). Within the military population, early research with the Millennium Cohort Study detailed four trajectories of PTSD among deployed service members, capturing delayed-onset, improving, chronic, and resilient trajectories (Bonanno et al., 2012). A study of deployed Danish soldiers found six distinct trajectories capturing different patterns of resilience, benefit, and delayed-onset PTSD (Berntsen et al., 2012).

Although of crucial importance, no study has compared PTSD symptom trajectories of current service members with those of separated military personnel. A number of factors could create differences in symptom trajectories between these two groups. LGMM is ideal for examining such situations because it is exploratory rather than confirmatory; Thus, different patterns can emerge that can inform a number of hypotheses. For example, because PTSD is associated with subsequent attrition, veterans may have more severe PTSD symptoms prior to their military separation (Hoge et al., 2006). This could emerge within an LGMM as veteran trajectories having higher intercepts and/or a higher proportion of veterans in trajectories with high pre-separation symptomatology. Another possibility is that separation from the military could create a significant disruption of routine, order, and structure, which may exacerbate PTSD symptoms (Iversen et al., 2005; Morin, 2011). This could emerge as a unique trajectory among veterans or a higher proportion of veterans in trajectories with higher PTSD symptoms post-separation. Further, we would expect this increase to decline across time as such individuals began adapting to civilian life. Still another potential cause of differences in PTSD symptom patterns is that the exposures of current military personnel are different from those of veterans. Current military personnel can still be deployed and exposed to additional traumatic military experiences that may result in newly occurring PTSD (Castro and McGurk, 2007; Hoge et al., 2004). Such traumatic exposures may cause increases in PTSD symptoms among current personnel but not among veterans.

In the current study, we used LGMM to examine trajectories of PTSD among military personnel across four time points measured approximately 3 years apart from 2001 to 2013. Using known class analyses (Muthén et al., 2002), we compared trajectories between individuals who separated prior to the second time point or remained in the military across the entire study period. Furthermore, because we used data obtained prior to separation, any difference in PTSD symptom trajectories around the transition from military to civilian life can be captured in the PTSD symptom trajectories.

1. Materials and methods

1.1. Study population

The Millennium Cohort Study began in 2001 with the goal of prospectively monitoring the health of service members across their military careers and into civilian life (Gray et al., 2002; Ryan et al., 2007). Participants provided informed consent upon enrollment in the study. Participants are asked to complete a self-administered survey approximately every three years. The current study examined participants in the first panel, which is a representative sample of the military in 2000 with oversampling for women, and personnel deployed to Bosnia, Kosovo, or Southwest Asia. The Naval Health Research Center Institutional Review Board approved the Millennium Cohort Study, which operates in accordance with the latest version of the Declaration of Helsinki.

In the current study, National Guardsmen and reservists were excluded due to less reliable separation data. Four waves of survey data (baseline and three follow-up assessments) collected between 2001 and 2012 were used in the current analysis. Veteran status was determined based on separation dates provided by the Defense Manpower Data Center (DMDC). Service members were considered veterans if they had a date of separation between their baseline and first follow-up assessment.

In the first panel, 43,877 active duty participants were enrolled in the Millennium Cohort Study. Of these, 13,931 participants were excluded because they separated from the military either before completing the baseline survey or after completing the first follow-up. Forty-eight participants were excluded because they began a deployment after their date of separation (indicating an erroneous separation). An additional 7818 were excluded because of missing outcome data at three or more time points or missing covariate data, leaving a final sample of 22,080.

1.2. Measures

1.2.1. Post-traumatic stress

PTSD screening and symptoms were assessed using the PTSD Checklist—Civilian (PCL) (Weathers et al., 1993; Ruggiero et al., 2003). This measure is composed of 17 items capturing symptoms of PTSD rated on a five-point Likert scale (1 = *Not at all*, 5 = *Extremely*). Treated continuously, the PCL has a range of 17–85, where higher scores correspond to more severe PTSD symptoms. Within the current study, the measure demonstrated good internal consistency at all time points (Cronbach's α's = 0.94 to 0.96). The PCL can also be used as a screening measure because it corresponds to the diagnostic criteria for PTSD in the DSM-IV (American Psychiatric Association, 1994; Brewin, 2005; Hoge et al., 2004). A positive screen for PTSD was defined as reporting at least three avoidance items, two hyperarousal items, and one intrusion item at a moderate or greater level.

1.2.2. VA care

The receipt of medical treatment from the Veterans Administration was assessed by the item "Have you ever received any medical care from VA facilities?" with response options of *none, some of my care,* and *all of my care*. This item was assessed only at the third follow-up time point and only among separated personnel.

1.2.3. Covariates

Sex, race, age, marital status, service branch, military occupation, and pay grade (enlisted or officer) data were obtained from DMDC databases in October 2000. Deployment in support of OEF/OIF prior to the first follow-up assessment and after the first follow-up assessment (for continuously serving personnel) was determined from the dates in theater from data maintained by DMDC. These dates, as well as roster files of personnel deployed to the Gulf War and Bosnia, Kosovo, and Southwest Asia between 1998 and 2001, were used to assess deployment prior to baseline. Time until separation was measured continuously in years from veterans' baseline completion date and date of separation obtained from DMDC.

The baseline survey was used to assess smoking status, alcohol misuse, physical health, combat exposure, and life stressors. Never smokers reported never having smoked 100 cigarettes in their lifetime. Past and current smokers were those who reported having successfully or unsuccessfully quit smoking. Alcohol misuse was measured as any affirmative response to any problem drinking item on the Patient Health Questionnaire (e.g., "You drove a car after having several drinks or after drinking too much") (Spitzer et al., 1994, 1999). These items have modest sensitivity and high

specificity relative to clinician diagnoses (Spitzer et al., 1999). Physical health was measured by the physical component summary (PCS) score of the Veterans RAND 36-Item Health Survey (Kazis et al., 2004a,b). The PCS score is a continuous variable that captures general physical health by integrating a number of domains (Ware and Kosinski, 2001).

Combat exposure from the baseline survey was combined with deployment to create three categories: not deployed, deployed without combat, and deployed with combat. Among participants previously deployed, exposure to combat was measured by endorsing one or more of the following items: personally witnessing or being exposed to a person's death due to war or disaster, physical abuse (torture, beating, rape), dead or decomposing bodies, maimed soldiers or civilians, or prisoners of war/refugees. These items were obtained from the National Health Survey of Gulf War Era Veterans and Their Families (Kang et al., 2000). Items assessing divorce, financial problems, sexual harassment, disabling illness/injury, and sickness/death of a loved one were summed to create an index of life stress. Items assessing a history of sexual and physical assault were treated as separate covariates.

1.3. Analysis plan

Descriptive univariate analyses were conducted to examine raw differences between veterans and active duty personnel in prevalence of positive PTSD screens and symptom severity of those meeting PTSD screening criteria. The differential likelihood of screening positive for PTSD at baseline between active duty service members and veterans was calculated using a chi-square test. Using chi-square tests, differences in new instances of meeting PTSD criteria at each subsequent wave were assessed among participants who had not screened positive for PTSD at any prior wave. Independent sample *t* tests were used to compare the severity of symptoms (assessed as the sum of the PCL) between veterans and active duty participants with positive PTSD screens at each time point.

We assessed trajectories of PTSD symptoms across baseline and three subsequent time points using LGMM. This method identifies heterogeneous growth within a given population by estimating latent classes containing parameters that define different growth trajectories using maximum likelihood estimation (Muthén et al., 2002; Muthén and Muthén, 2000; Nagin, 1999). The means of the intercepts, slopes, and quadratic factors of PTSD symptom trajectories were allowed to vary between each latent class. The variances of all quadratic factors were restricted to zero to promote model identification. To estimate the proper number of classes, a series of models were estimated, increasing the numbers of latent classes estimated from two to five among the combined population of veterans and active duty personnel. The model containing the optimal number of classes was selected by examining the adjusted Lo-Mendell-Rubin likelihood ratio test (LMR), bootstrapped likelihood ratio test, Bayesian information criterion, and entropy combined with the interpretability of the classes (Jung and Wickrama, 2008; Nylund et al., 2007). In addition, the proportion of participants in a given class was required to be greater than 0.02 to prevent unstable classes from forming. The selected number of classes was used for all remaining analyses.

After selecting the optimal number of classes, veteran status was entered as a separate known class (Muthén et al., 2002). Adding a known class crosses the previous latent class with a new class whose membership is entirely dictated by an observed categorical variable (in this case veteran status). The resulting model estimates twice the number of classes it would without a known class, half within veterans and half within active duty service members. Although simultaneously estimated, the known class parameter estimates are independent, so there are no restrictions placed on the means of the intercepts, slopes, or quadratic factors within a class across different levels of veteran status.

Each veteran class was matched with a similar active duty class to permit specific comparisons of trajectories and class membership (Schaeffer et al., 2006). An omnibus Wald chi-square test was used to determine whether the inclusion of the known class improved model fit over the original model. Significant results indicate superior fit from the model with the known class. Given significant findings, additional Wald chi-square tests were used to compare the trajectory parameters of the matched classes to determine which classes had statistically different trajectories. Chi-square analyses were calculated using posterior probabilities to determine differences in the proportion of veterans in a given class.

Within the fully adjusted model, class membership and veteran status were both regressed on all covariates. Covariates consisted of sex, race, marital status, education, age, deployment and combat history, military occupation, service branch, pay grade, alcohol problems, smoking status, history of sexual assault, history of physical assault, deployment in support of OEF/OIF, life stressors, and time until separation. Chi-square analyses were recalculated from this model to evaluate the proportion of veterans within classes, controlling for covariates. A subsequent model examined the receipt of VA care as a distal outcome (i.e., an outcome predicted by latent class membership). Because VA care was only assessed among separated personnel, the proportion of active duty service members receiving VA care was restricted to zero. This model included all the covariates of the fully adjusted model.

In order to detect potential biases associated with non-response, we conducted two sensitivity analyses. To determine if bias was introduced from excluding participants due to missing data, propensity scores were created from modeling likelihood of inclusion using covariates and baseline PCL scores. The inverse of these propensity scores were used to weight models such that the included participants were representative of the larger, eligible population. A second model was examined to detect bias from attrition and follow-up nonresponse. Propensity scores were created to estimate the probability of providing PCL scores at all follow-up assessments using covariates and baseline PCL scores. Based on these propensity scores, a 1:1 match with replacement was conducted to match participants with missing PCL scores at follow-up to those with complete data.

Mixture models were conducted using Mplus 7.3 (Muthén & Muthén, 1998–2012). All other manipulations and analyses were conducted using SAS 9.3 (SAS Institute, Inc., Cary, North Carolina).

2. Results

Table 1 describes demographics, service characteristics, and other exposures among veterans and active duty service members. Veterans were older than active duty service members ($p < 0.001$), more likely to have deployed before baseline ($p < 0.001$), but less likely to have deployed in support of OEF/OIF ($p < 0.001$). Veterans reported more sub-optimal health behaviors at baseline, such as problem drinking ($p < 0.001$) and smoking ($p < 0.001$). Veterans were more likely to have a history of sexual and physical assault (p's < 0.001) and more life stressors at baseline ($p < 0.001$). PCS scores were lower at baseline among veterans than active duty service members ($p < 0.001$). Response rate was high at each of the three follow-up time points among veterans (76.1%, 78.5%, and 81.1%) and active duty (84.0%, 80.5%, and 65.7%). Chi-square analyses indicate significant differences in response rates between the two groups at all follow-up waves (all p's < 0.01). All mixture models were examined 1) weighted to correct for exclusion and 2) matched by nonresponse propensities. No substantive differences

Table 1
Descriptive information about veterans and service members.

		Veteran ($N = 5292$)	Active duty ($N = 16,788$)
Sex	Female	1472 (27.8%)	3796 (22.6%)
	Male	3820 (72.2%)	12,992 (77.4%)
Race/ethnicity	American Indian	45 (0.9%)	137 (0.8%)
	Asian	536 (10.1%)	2418 (14.4%)
	Black	718 (13.6%)	2331 (13.9%)
	White	3621 (68.4%)	10,466 (62.3%)
	Hispanic	300 (5.7%)	1137 (6.8%)
	Other	72 (1.4%)	299 (1.8%)
Marital status	Single	990 (18.7%)	3400 (20.3%)
	Married	3652 (69.0%)	11,560 (68.9%)
	Divorced/separated	650 (12.3%)	1828 (10.9%)
Education	Bachelor's or higher	3748 (70.8%)	11,382 (67.8%)
	Some college or less	1544 (29.2%)	5406 (32.2%)
Age group, year	17–24	1113 (21.0%)	3764 (22.4%)
	25–34	1000 (18.9%)	9494 (56.6%)
	35–44	2555 (48.3%)	3244 (19.3%)
	45+	624 (11.8%)	286 (1.7%)
Deployment[a]	Deployed no combat	2312 (43.7%)	5569 (33.2%)
	Deployed w/combat	2646 (50.0%)	5820 (34.7%)
	Non-deployed	334 (6.3%)	5399 (32.2%)
Occupation	Combat	973 (18.4%)	3717 (22.1%)
	Healthcare	515 (9.7%)	1712 (10.2%)
	Other	3804 (71.9%)	11,359 (67.7%)
Service branch	Army	1965 (37.1%)	6846 (40.8%)
	Navy/Coast Guard	1547 (29.2%)	3581 (21.3%)
	Marines	418 (7.9%)	1071 (6.4%)
	Air Force	1362 (25.7%)	5290 (31.5%)
Pay grade	Officer	1078 (20.4%)	4734 (28.2%)
	Enlisted	4214 (79.6%)	12,054 (71.8%)
PCS score	High 15%	538 (10.2%)	2735 (16.3%)
	Low 15%	1376 (26.0%)	1888 (11.2%)
	Middle 70%	3378 (63.8%)	12,165 (72.5%)
Alcohol problems	Yes	638 (12.1%)	1658 (9.9%)
	No	4654 (87.9%)	15,130 (90.1%)
Smoking status	Current smoker	1049 (19.8%)	2877 (17.1%)
	Former smoker	1459 (27.6%)	3680 (21.9%)
	Never smoker	2784 (52.6%)	10,231 (60.9%)
Sexual assault	Yes	437 (8.3%)	964 (5.7%)
	No	4855 (91.7%)	15,824 (94.3%)
Physical assault	Yes	454 (8.6%)	1155 (6.9%)
	No	4838 (91.4%)	15,633 (93.1%)
Early OEF/OIF deployment[b]	Deployed	691 (13.1%)	5969 (35.6%)
	Not deployed	4601 (86.9%)	10,819 (64.4%)
Later OEF/OIF deployment[c]	Deployed	N/A	7775 (46.3%)
	Not Deployed	N/A	9013 (53.7%)
Stressors	1	2157 (40.8%)	7731 (46.1%)
	2+	2135 (40.3%)	4629 (27.6%)
	None	1000 (18.9%)	4428 (26.4%)
PTSD[d]	Positive screen	311 (5.9%)	504 (3.0%)
	Negative screen	4981 (94.1%)	16,284 (97.0%)

OEF/OIF, Operation Enduring Freedom/Operation Iraqi Freedom; PCS, physical component summary; PTSD, post-traumatic stress disorder.
[a] Combat and deployment occurred prior to baseline.
[b] OEF/OIF deployment occurring prior to first follow-up survey.
[c] OEF/OIF deployment occurring after the first follow-up survey.
[d] PTSD assessed at baseline.

were found between these models and the models presented which suggests that exclusion criteria and attrition had limited influence on results (results not shown).

Univariate analyses across veteran status indicate veterans had a higher likelihood of screening positive for PTSD at baseline, before separation ($p < 0.001$). Additionally, veterans were more likely to newly screen positive for PTSD at wave 2 ($p < 0.001$), wave 3 ($p < 0.001$), and wave 4 ($p < 0.001$). Of participants screening positive for PTSD, veterans had more severe symptoms compared with active duty personnel at baseline ($p < 0.001$), but not at any of the subsequent assessments (wave 2: $p = 0.07$, wave 3: $p = 0.09$, wave 4: $p = 0.08$).

2.1. Unconditional model without known class

Table 2 shows the measures of relative fit, entropy, and the distribution of participants among models fit with two to five classes without a known class. The model containing four classes was selected because the adjusted Lo-Mendell-Rubin test failed to achieve significance in the five-class model, indicating superior fit of the four-class model.

The largest proportion of participants were defined by the resilient class (86.8% of population), which had consistently low level of PTSD symptoms at each time point (Fig. 1). The delayed-onset class (5.1%) had low symptoms at the first two time points

Table 2
Fit statistics for models with two to five classes.

Fit statistics				
	2 class	3 class	4 class	5 class
AIC	491,258	482,139	477,131	472,753
BIC	491,370	482,283	477,307	472,961
Adjusted BIC	491,326	482,226	477,237	472,878
Entropy	0.975	0.972	0.952	0.951
Adjusted LMR	$p < 0.0001$	$p < 0.0001$	$p = 0.01$	$p = 0.35$
BLRT	$p < 0.0001$	$p < 0.0001$	$p < 0.0001$	$p < 0.0001$
Proportion in each class				
	0.935	0.896	0.868	0.833
	0.065	0.056	0.051	0.069
		0.048	0.048	0.044
			0.033	0.033
				0.021

AIC, Akaike information criterion; BIC, Bayesian information criterion; BLRT, bootstrapped likelihood ratio test; LMR, Lo-Mendell-Rubin likelihood ratio test.

and then began increasing. The improving class (4.8%) had high symptoms at baseline that declined to a moderate symptom level. The elevated-recovering class (3.3%) had moderate symptoms at baseline that increased substantially by the second time point and remained elevated until declining slightly at the final time point.

2.2. Unconditional model with known class

After including the known class, an omnibus test of the trajectories indicated significant differences in veteran and active duty trajectories ($p < 0.001$; see Fig. 2). The labels previously assigned to the original solution (i.e., resilient, delayed-onset, improving, and elevated-recovering) fit the classes estimated within veterans and active duty groups, thereby allowing comparisons of their class trajectories and proportions contained within each class. Significant differences were found between the trajectories of veterans and active duty personnel in the resilient ($p < 0.001$), improving ($p < 0.001$), and elevated-recovering classes ($p = 0.023$). The new-onset trajectory parameters did not significantly differ between veterans and active duty service members ($p = 0.35$). The improving, elevated-recovering, and new-onset classes are sub-optimal because they had high PTSD symptoms at one or more assessment, whereas the resilient class had low symptoms across the entire study period. Proportions of veterans and service members in each class are presented in Table 3. Veterans were more likely to be categorized in sub-optimal classes and less likely to be categorized in the resilient class (in all cases, $p < 0.01$).

2.3. Conditional model with known class

The associations between veteran status and class membership were examined after adjusting for covariates. Multicollinearity was not detected among covariates (variance inflation factors < 4). Veterans remained more likely to be classified within sub-optimal classes and less likely to be categorized within the resilient class.

Many covariates were associated with membership in sub-optimal classes (i.e., improving, elevated-recovering, and delayed-onset). Table 4 contains odds ratios and 95% confidence intervals for all associations between covariates and class membership (the resilient class is the reference). All sub-optimal classes were more common among Army soldiers than Air Force and Navy/Coast Guard personnel. Having a designation of combat specialist was associated with the delayed-onset class, but no other associations emerged between military occupation and class membership. Officers were less likely to be categorized in any of the sub-optimal classes than enlisted personnel.

There were no significant associations of sex with class membership. Participants in non-white racial/ethnic groups were more likely to be categorized in a sub-optimal class, with the exception of Asian participants, who had equivalent class membership to white participants. Younger age was positively associated with membership in sub-optimal classes. Married participants were less likely to be in the improving class than single or previously married

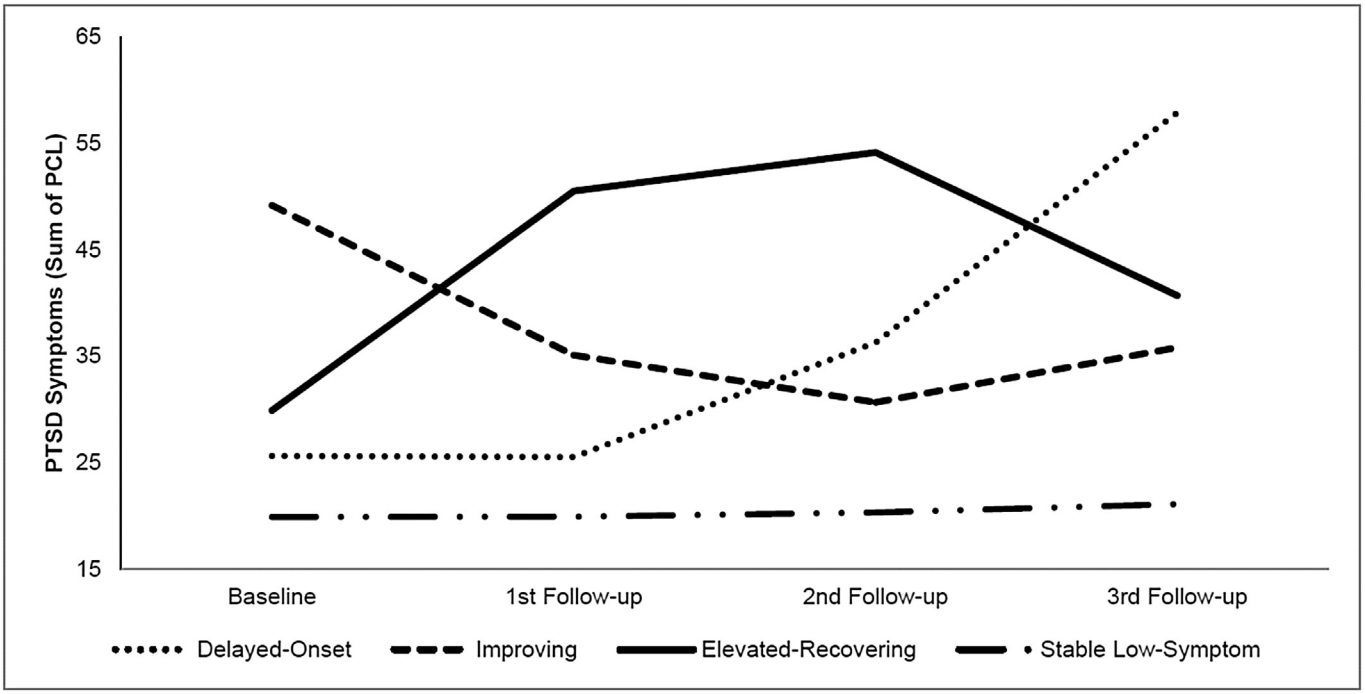

Fig. 1. Four-class latent growth mixture modeling across entire sample.

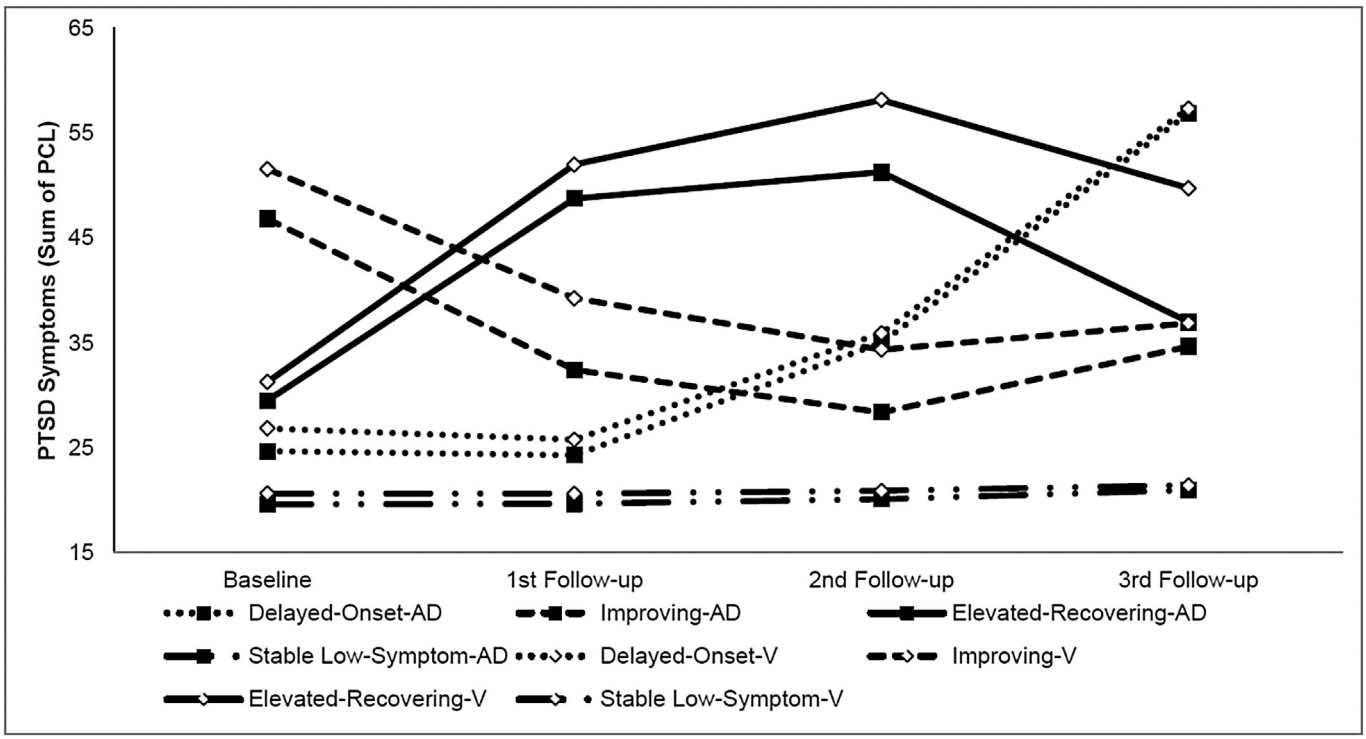

Fig. 2. Known class analysis unadjusted for covariates. AD, active duty; PCL, PTSD Checklist; PTSD, post-traumatic stress disorder; V, veteran.

Table 3
Proportion of participants in each class.

	Unadjusted for covariates			Adjusted for covariates		
	Active duty	Veteran	χ^2 (p)	Active duty	Veteran	χ^2 (p)
Delayed-onset	0.048	0.059	11.36 (<0.001)	0.051	0.061	7.02 (0.008)
Improving	0.041	0.069	69.43 (<0.001)	0.044	0.073	68.24 (<0.001)
Elevated-recovering	0.030	0.046	31.65 (<0.001)	0.032	0.050	36.02 (<0.001)
Stable low-symptom	0.881	0.826	108.87 (<0.001)	0.872	0.817	103.92 (<0.001)

participants.

Deployment with no combat experiences was associated with membership in the resilient class. Deployment with combat was associated with membership in the improving class. Deployment to OEF/OIF was associated with an increased likelihood of being categorized in the elevated-recovering class.

Histories of sexual and physical assault at baseline were both strongly associated with being categorized in all three sub-optimal classes. Similarly, reporting multiple stressors at baseline was associated with all sub-optimal PTSD classes. Current smoking and alcohol misuse were associated with all sub-optimal classes. Lower PCS score was strongly associated with all sub-optimal PTSD trajectories. However, higher PCS score was associated with the elevated-recovering and improving classes.

2.3.1. VA care as distal outcome

The inclusion of VA care into the model did not substantially affect the proportions of veterans in each class or the shape of the trajectories (results not shown). The patterns of care reported differed between each class (all p's < 0.05). Results indicate that participants in the resilient class were the least likely to reporting having received either some (24.2%) or all (8.6%) of their care from the VA. Participants in the recovering class were the next to least likely to receive either some (33.6%) or all (20.7%) of their care from the VA. Of participants in the delayed-onset class, 43.5% received some (the highest of the four classes) and 30.4% received all their care from the VA. Of the elevated-recovery class, 39.5% of participants received some of their care and 34.7% (the highest of the four classes) received all their care from the VA.

3. Discussion

These results demonstrate that PTSD symptom trajectories were similar between veterans and active duty personnel, with some minor exceptions. As can be seen in Fig. 2, the active duty and veteran trajectories were similar enough to match trajectory classes. However, because of high statistical power, the only class not statistically different between veterans and active duty personnel was the delayed-onset class. In many cases, these differences were so minor that they are not of clinical importance. In the improving group, there was a small difference in veterans and active duty service members PTSD symptoms across the study. Differences between the elevated-recovering classes grew over time, such that veterans did not recover as soon or as dramatically. Within the resilient classes, differences in trajectory shape are minimal and are likely the result of the large number of participants in these classes, making this comparison overly sensitive. However, higher estimated PTSD symptoms were observed among veterans in all

Table 4
Covariates predicting class membership in fully adjusted model.

		Delayed-onset OR (95% CI)	Improving OR (95% CI)	Elevated-recovering OR (95% CI)
Sex	Female	1.16 (0.96–1.41)	0.97 (0.81–1.16)	0.97 (0.78–1.21)
	Male	1	1	1
Race	American Indian	**2.46 (1.42–4.25)**	1.76 (0.99–3.12)	1.15 (0.52–2.56)
	Asian	1.23 (0.91–1.66)	1.10 (0.81–1.50)	0.94 (0.64–1.37)
	Black	**1.31 (1.06–1.61)**	**1.24 (1.01–1.51)**	1.10 (0.86–1.40)
	Hispanic	**1.73 (1.34–2.24)**	**1.39 (1.07–1.80)**	**1.87 (1.44–2.44)**
	Other	1.24 (0.75–2.06)	**1.70 (1.06–2.72)**	1.45 (0.85–2.46)
	White	1	1	1
Marital status	Single	0.90 (0.73–1.12)	**1.64 (1.37–1.96)**	0.96 (0.77–1.20)
	Divorced/separated	0.99 (0.79–1.24)	**1.50 (1.24–1.81)**	0.99 (0.78–1.26)
	Married	1	1	1
Education	Bachelor's or higher	1	1	1
	Some college or less	0.79 (0.60–1.04)	**0.75 (0.57–1.00)**	0.88 (0.64–1.21)
Age group, year	17–24	1	1	1
	25–34	1.15 (0.94–1.41)	**0.67 (0.57–0.80)**	**0.67 (0.55–0.83)**
	35–44	**0.78 (0.60–1.00)**	**0.47 (0.38–0.59)**	**0.47 (0.36–0.62)**
	45+	**0.55 (0.33–0.90)**	**0.49 (0.31–0.76)**	**0.43 (0.25–0.75)**
Deployment	Deployed w/combat	0.92 (0.77–1.11)	**1.27 (1.06–1.52)**	1.16 (0.95–1.43)
	Deployed no combat	**0.71 (0.58–0.87)**	**0.76 (0.62–0.93)**	**0.72 (0.57–0.92)**
	Non-deployed	1	1	1
Occupation	Combat	**1.23 (1.02–1.47)**	0.84 (0.70–1.02)	1.12 (0.91–1.37)
	Healthcare	1.15 (0.90–1.47)	0.90 (0.71–1.15)	0.92 (0.68–1.25)
	Other	1	1	1
Service branch	Marines	**0.73 (0.54–0.99)**	0.84 (0.65–1.09)	0.77 (0.58–1.04)
	Navy/Coast Guard	**0.56 (0.46–0.69)**	**0.75 (0.63–0.90)**	**0.43 (0.34–0.54)**
	Air Force	**0.34 (0.27–0.42)**	**0.50 (0.41–0.60)**	**0.30 (0.24–0.39)**
	Army	1	1	1
Pay grade	Officer	**0.53 (0.37–0.75)**	**0.54 (0.37–0.77)**	**0.46 (0.30–0.71)**
	Enlisted	1	1	1
PCS score	High 15%	1.07 (0.85–1.35)	**2.74 (2.29–3.27)**	**1.42 (1.12–1.81)**
	Low 15%	**2.62 (2.21–3.11)**	**3.38 (2.88–3.98)**	**2.84 (2.36–3.42)**
	Middle 70%	1	1	1
Alcohol problems	Yes	**1.41 (1.12–1.77)**	**2.69 (2.27–3.19)**	**1.86 (1.50–2.31)**
	No	1	1	1
Smoking status	Current smoker	**1.55 (1.28–1.87)**	**1.65 (1.39–1.96)**	**1.69 (1.38–2.06)**
	Former smoker	**1.21 (1.01–1.45)**	1.15 (0.97–1.38)	1.18 (0.96–1.44)
	Never smoker	1	1	1
Sexual Assault	Yes	**2.07 (1.60–2.69)**	**2.26 (1.81–2.82)**	**2.70 (2.07–3.52)**
	No	1	1	1
Physical Assault	Yes	**1.38 (1.08–1.76)**	**2.16 (1.79–2.61)**	**2.19 (1.74–2.76)**
	No	1	1	1
OEF/OIF deployed	OEF/OIF veteran	1.15 (0.98–1.35)	0.85 (0.71–1.00)	**1.54 (1.29–1.84)**
	None	1	1	1
Stressors	1	1.09 (0.89–1.34)	**1.81 (1.44–2.29)**	1.27 (1.00–1.63)
	2+	**1.61 (1.29–2.01)**	**3.66 (2.87–4.66)**	**2.18 (1.68–2.81)**
	None	1	1	1
Time until separation	Years after baseline (continuous)	1.08 (0.92, 1.28)	0.87 (0.75, 1.01)	**1.22 (1.02, 1.45)**

CI, confidence interval; OEF/OIF, Operation Enduring Freedom/Operation Iraqi Freedom; OR, odds ratio; PCS, physical component summary.
Bold indicates significant relationships ($p < 0.05$).

classes.

The most common class for both veterans and active duty personnel was the resilient class. This finding supports prior research which has shown that resilience is the most common PTSD trajectory following traumatic events (Berntsen et al., 2012; Bonanno et al., 2012; Pietrzak et al., 2013). Other hypotheses are supported among the less prevalent sub-optimal classes. The higher proportion of veterans in the improving class indicates that high levels of PTSD may be related to subsequent separation. Veterans were also more likely to be classified in the elevated-recovering class which had a large increase in PTSD symptoms between baseline and the first follow-up assessment. This is consistent with PTSD symptoms being exacerbated by the change in routine accompanying separation. However, more veterans were classified in the improving class which had a large decrease in PTSD symptoms over the same time period. Unfortunately, the current data cannot determine whether the increase or decrease in PTSD symptoms followed participants' actual dates of separation. The delayed-onset class had elevated PTSD symptoms at the second and third follow-up assessment. If active duty participants were developing PTSD from later deployments, a higher proportion would likely be in the delayed-onset class. However, fewer active duty (5.1%) than veteran (6.1%) participants were in this class despite the majority of active duty participants experiencing subsequent deployments. Prior research has demonstrated that PTSD symptoms often increase following a temporal lag relative to return from deployment (Milliken et al., 2007; Bliese et al., 2007; Thomas et al., 2010). One study of UK military personnel estimated the prevalence of delayed-onset PTSD to be 3.5%—approximately half of all cases of PTSD identified (Goodwin et al., 2012). The higher proportion of veterans in the delayed-onset class may represent this phenomenon on a longer time frame.

Several risk factors were associated with sub-optimal PTSD trajectories. Participants with lower physical well-being were more likely to be in all sub-optimal trajectories. However, contrary to our expectations, participants with higher PCS scores were more likely to be categorized in the improving and elevated-recovering classes. This may be due in part to the scoring of the PCS in which more

negative responses to mental health items can increase the PCS score (Simon et al., 1998). Thus, given the same level of physical health, individuals with poor mental health would have a higher PCS score. In the current study, a history of multiple life stressors had stronger associations with sub-optimal PTSD trajectories than prior physical assault or combat deployment. This finding supplements prior work that found associations between life stressors and resilience in response to traumatic events (Bonanno et al., 2007; Polusny et al., 2011).

The delayed-onset class may be a sub-population for which a targeted intervention should be considered. Average PTSD symptoms in the delayed-onset class remained low at the first follow-up but increased exponentially thereafter. The average PCL score for this group did not exceed 50 (a common cut point for PTSD screening) until the final time point, which indicates that, on average, most participants in this group may have presented subclinical PTSD symptoms over the majority of the study period. The early phase of the worsening of PTSD symptoms in this group might present an opportunity for an intervention to prevent progression or, in the best case, lead to remission of PTSD symptoms.

The resilient class was the most likely to report not receiving care from the VA which would be expected given the consistent lack of PTSD symptoms. Participants in the delayed-onset class reported high use of VA care. Although the type or timing of care received was not available, this class had the highest need for mental health treatment when VA care was assessed which may indicate a partial success for the VA in meeting the mental health needs of veterans with the highest need. However, because 26.1% reported no VA care indicates that continued effort should be put into identifying and addressing current PTSD symptoms.

Several limitations of the current study should be noted. The use of the PCL-C as a proxy for clinician assessment is imperfect. However, its use ensures how and which symptoms were assessed remained consistent across participants and timepoints. VA care was assessed from self-report, but could not be verified with VA medical records. Because this question had an open time frame ("Have you *ever* received any medical care from VA facilities") it is not clear how participants whose level of VA care changed since separation (e.g., three years of private care then received all care from the VA) answer this question. Furthermore, this variable was missing for approximately 25% of veterans (mostly due to wave non-response). It is possible that the relationship between PTSD trajectory classes and VA care differs between those with and without this item. Prior work has demonstrated that the five item combat measure used in the current study is less sensitive than longer measures, but that the associations with mental and behavioral outcomes are comparable which suggests that the use of this measure is not likely to have introduced substantial bias (Porter et al., unpublished manuscript). Additionally, internal reliability is not possible to calculate with single item measures (e.g., smoking status) and is not necessarily appropriate to calculate for formative scales (e.g., combat, life stressors) (Coltman et al., 2008).

Mixture modeling uses maximum likelihood estimation which permits the inclusion of participants with missing endogenous variables. Prior research has shown this method to be an efficient and unbiased estimation technique under certain circumstances (Enders and Bandalos, 2001). Specifically, this technique requires that data be missing at random or missing completely at random rather than missing not at random. This requirement means that missing data cannot be a function of data not included in the model (e.g., if missingness was a function of the missing data itself). Response rates dropped substantially among active duty participants at the final assessment. This is likely due to the restriction against separation being relaxed earlier for participants missing their final assessment because they had already provided sufficient responses while active duty. However, the sensitivity analyses using propensity scores did not indicate substantial bias introduced through exclusion or from non-response though the possibility of bias cannot ever be completely ruled out.

Future studies should examine additional distal outcomes to determine whether these trajectories are associated with long-term social functioning, well-being, mental health, and physical health outcomes. Additionally, trajectories of PTSD may predict outcomes that are of special interest in veteran populations (e.g., homelessness, employment). Furthermore, care should be taken in generalizing findings to all separated and separating personnel because separations in the current study occurred over a relatively brief time frame. Aspects of military and veteran life and support are constantly shifting the circumstances of service members' separation.

Given that reported combat exposure could have occurred either far in the past or very near the baseline assessment, we examined a model in which time since combat exposure was examined as a predictor of class membership. However, approximately 13% of the 8466 participants reporting combat exposure(s) did not indicate when exposure(s) occurred and had to be removed from this analysis. Time since combat (measured in years) was modestly associated with inclusion in the elevated-recovery class (Odds ratio: 0.97; 95% confidence interval: [0.94, 0.99]) but not significantly associated with inclusion in the improving or elevated-recovery classes. Furthermore, the shapes of trajectories were highly similar to the conditional model presented. The study team opted to exclude time since combat as a covariate in order to retain the 1087 participants with missing time since combat.

The current study was restricted by the Millennium Cohort Study sampling methodology. Millennium Cohort participants respond to questionnaires approximately every 3 years, which prohibits the examination of short-term fluctuations in PTSD symptoms. Short-term fluctuations in individuals' symptoms when they were taking the survey could have led to misclassification due to the small number of time points assessed. However, with the large sample size, the trajectories are likely to be stable despite the time between assessments. However, the infrequent sampling allows for a longer study period without creating undue participant burden. Several prior PTSD symptom trajectories studies assessed PTSD symptoms multiple times each year rather than once ever several years (Armour et al., 2012; Berntsen et al., 2012; Pietrzak et al., 2013). This difference in temporal sensitivity limits comparison of such results with those of the current study.

Despite these limitations, the current study has a number of strengths. Data were available both before and after separation, which allowed for observation of changes in PTSD symptoms relating to separation. Additionally, the extended time frame of the study allowed for examination of PTSD trajectories across more than a decade. The current study used a population-based sampling strategy, which is more likely to capture unbiased PTSD trajectories. Thus, this study was not limited by selection bias introduced by recruiting from a treatment-seeking population (e.g., those using VA health care). The large sample size of the study allowed for a stable solution to be found and provide stable trajectory estimates for latent classes with low prevalence.

4. Conclusion

The current study conducted an exploratory analysis contrasting the shape of PTSD symptom trajectories among veterans and active duty personnel and found that trajectory shapes were similar between veterans and active duty service members, suggesting consistency exists between these two groups in the experience of PTSD over time. The most common trajectory for both veterans (82%) and

active duty (87%) personnel was the resilient trajectory. However, veterans were less likely to be classified in resilient trajectory and were more likely to be classified in the other trajectories. These findings support the univariate analyses and suggest that veterans have a higher burden of PTSD than current military personnel given a higher proportion in sub-optimal PTSD symptom trajectories. Furthermore, this suggests that the experience of transitioning from the military into civilian life does not appear to affect most PTSD trajectories substantially. The current study also indicates that active duty personnel are not at greater risk of delayed-onset PTSD trajectories compared with recently separated service members, despite additional deployments occurring during the study period.

Role of funding source

Beyond providing funding, the sponsoring agencies had no further role in the study design, planning, data collection, analysis, interpretation, or manuscript preparation of this study.

Conflict of interest

None.

Contributors

All authors contributed to the development of the study design and implementation. Drs. Porter and Frasco conducted the analyses under the support of Dr. Bonanno. Dr. Porter wrote the initial draft of the manuscript. All authors revised the manuscript and approved the final article.

Acknowledgements

This work represents report 15–47 supported by the Bureau of Medicine and Surgery, under Work Unit No. 60002. The Millennium Cohort Study is funded through the Military Operational Medicine Research Program, U.S. Army Medical Research and Materiel Command (Fort Detrick, MD). Support for this project was provided under Federal Interagency agreement #2012-FRS-0028 as a collaboration between the Millennium Cohort Study, VA Office of Research & Development, and VA Office of Patient Care Services, Post-Deployment Health Services. Dr. Boyko's work on this project was supported by VA Puget Sound and the University of Washington Diabetes Research Center (NIH P30DK017047).

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We are indebted to the Millennium Cohort Study participants, without whom these analyses would not be possible. In addition to the authors, the Millennium Cohort Study includes Richard Armenta PhD; Lauren Bauer MPH; Deb Bookwalter PhD; Ania Bukowinski MPH; CPT Adam Cooper PhD; James Davies; Alex Esquivel; CDR Dennis Faix MD MPH; Lt Col Susan Farrish MD MPH; Toni Rose Geronimo; Gia Gumbs MPH; Isabel Jacobson MPH; Claire Kolaja MPH; Joyce Kong PhD; Cynthia LeardMann MPH; William Lee; Hector Lemus PhD; Kyna Long MS; Gordon Lynch; Denise Lovec-Jenkins; Rayna Matsuno PhD; Danielle Mitchell; Kristin Motylinski; Anna Nagel MPH; Chiping Nieh PhD; Chris O'Malley MPH; Serguey Parkhomovsky; Anet Petrosyan; Chris Phillips MD MPH; Teresa Powell MS; Rudy Rull PhD; Beverly Sheppard; Steven Speigle; Daniel Trone PhD; Jennifer Walstrom.

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REPORT DOCUMENTATION PAGE

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PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
14-03-2016	Journal article	2001-2012

4. TITLE AND SUBTITLE

Prospective post-traumatic stress disorder symptom trajectories in active duty and separated military personnel

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Porter, Ben; Bonanno, George A.; Frasco, Melissa A.; Dursa, Erin K.; Boyko, Edward J.

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

60002

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

16-17

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

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10. SPONSOR/MONITOR'S ACRONYM(S)

BUMED/NMRC

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Open access publication. Journal of Psychiatric Research v.89, p.55-64, June 2017; doi:10.1016/j.jpsychires.2017.01.016

14. ABSTRACT

Post-traumatic stress disorder (PTSD) is a serious mental illness that affects current and former military service members at a disproportionately higher rate than the civilian population. Prior studies have shown that PTSD symptoms follow multiple trajectories in civilians and military personnel. The current study examines whether the trajectories of PTSD symptoms of veterans separated from the military are similar to continuously serving military personnel. The Millennium Cohort Study is a population-based study of military service members that commenced in 2001 with follow-up assessments occurring approximately every 3 years thereafter. PTSD symptoms were assessed at each time point using the PTSD Checklist. Latent growth mixture modeling was used to compare PTSD symptom trajectories between personnel who separated (veterans; n = 5292) and personnel who remained in military service (active duty; n = 16,788). Four distinct classes (resilient, delayed-onset, improving, and elevated-recovering) described PTSD symptoms trajectories in both veterans and active duty personnel. Trajectory shapes were qualitatively similar between active duty and veterans. However, within the resilient, improving, and elevated recovering classes, the shapes were statistically different. Although the low-symptom class was the most common in both groups (veterans: 82%; active duty: 87%), veterans were more likely to be classified in the other three classes (in all cases, $p < 0.01$). The shape of each trajectory was highly similar between the two groups despite differences in military and civilian life.

15. SUBJECT TERMS

PTSD, latent trajectories, active duty, veterans, separated military personnel, military personnel

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Commanding Officer
U	U	U	UU	10	19b. TELEPHONE NUMBER *(Include area code)* COMM/DSN: (619) 553-8429