Longitudinal Examination of the Influence of Individual Posttraumatic Stress Disorder Symptoms and Clusters of Symptoms on the Initiation of Cigarette Smoking

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Abstract

Objectives—The aim of this study was to determine whether specific individual posttraumatic stress disorder (PTSD) symptoms or symptom clusters predict cigarette smoking initiation.

Methods—Longitudinal data from the Millennium Cohort Study were used to estimate the relative risk for smoking initiation associated with PTSD symptoms among 2 groups: (1) all individuals who initially indicated they were nonsmokers (n = 44,968, main sample) and (2) a subset of the main sample who screened positive for PTSD (n = 1622). Participants were military service members who completed triennial comprehensive surveys that included assessments of smoking and PTSD symptoms. Complementary log-log models were fit to estimate the relative risk for subsequent smoking initiation associated with each of the 17 symptoms that comprise the PTSD Checklist and 5 symptom clusters. Models were adjusted for demographics, military factors, comorbid conditions, and other PTSD symptoms or clusters.

Results—In the main sample, no individual symptoms or clusters predicted smoking initiation. However, in the subset with PTSD, the symptoms "feeling irritable or having angry outbursts" (relative risk [RR] 1.41, 95% confidence interval [CI] 1.13–1.76) and "feeling as though your future will somehow be cut short" (RR 1.19, 95% CI 1.02–1.40) were associated with increased risk for subsequent smoking initiation.

Conclusions—Certain PTSD symptoms were associated with higher risk for smoking initiation among current and former service members with PTSD. These results may help identify individuals who might benefit from more intensive smoking prevention efforts included with PTSD treatment.

Keywords

smoking; PTSD; cohort; military; veteran

INTRODUCTION

Cigarette smoking is the largest cause of preventable death in the world (World Health Organization, 2011). Posttraumatic stress disorder (PTSD) has been identified as a potential risk factor for smoking, and associations between smoking and PTSD have been observed among the general population, women, members of the military, and veterans (Boyko et al., 2015; Feldner et al., 2007; Fu et al., 2007; B. Smith et al., 2008; Smith et al., 2014). Reviews by Feldner and Fu found that people with PTSD are more likely to smoke, more likely to smoke heavily, less likely to quit smoking, and more likely to relapse than people without PTSD (Feldner et al., 2007; Fu et al., 2007). Understanding the relationship between PTSD and smoking is complicated by bidirectional associations, emphasizing the need for longitudinal studies that can address these temporal issues (Feldner et al., 2007; Fu et al., 2007; Smith et al., 2014). Fu and Feldner identified several research gaps, including a lack of prospective studies that can assess more refined smoking measures, such as smoking initiation, and research examining the association between smoking and individual PTSD symptoms to identify potential targets for treatment to reduce the symptoms most associated with smoking (Feldner et al., 2007; Fu et al., 2007).

To date, studies of smoking in relation to individual PTSD symptoms or clusters have been inconsistent. Investigators have identified associations between smoking and PTSD arousal (Gabert-Quillen et al., 2015; Greenberg et al., 2012; Weaver et al., 2008), and smoking and dysphoria (Garey et al., 2015), while others have observed smoking was associated with the emotional numbing symptom cluster (Cook et al., 2009; Greenberg et al., 2012; Joseph et al., 2012; Mathew et al., 2015). Given these inconsistent findings, it is possible that certain smoking behaviors are impacted by certain clusters. For example, Greenberg et al, found that the hyperarousal cluster was more strongly associated with nicotine dependence than other clusters, while the emotional numbing cluster was independently associated with lifetime smoking (Greenberg et al., 2012). Additionally, these studies have been conducted in a variety of populations, and, though several were conducted among veterans, no studies have been conducted in a current military population, among whom the experience of PTSD may be more prevalent due to military- and combat-related stressors. Considering the heterogeneity in the PTSD diagnosis and the inconsistent findings to date, more research is

needed to identify and better understand if and how PTSD symptoms and symptom clusters may affect smoking behavior (Galatzer-Levy & Bryant, 2013).

The present longitudinal research builds on current knowledge by evaluating whether individual PTSD symptoms and PTSD symptom clusters are associated with subsequent smoking initiation in a large sample of US military service members who initially reported they were nonsmokers. Because the association between PTSD symptoms and symptom clusters and smoking initiation may be specific to those with PTSD, we also evaluated associations in the subsample of participants who initially reported they were nonsmokers and who screened positive for PTSD. We hypothesized that participants with emotional numbing, hyperarousal, and dysphoric arousal clusters would have a higher risk for smoking initiation than those without said clusters. Our analysis had the goal of identifying specific symptoms that may be independent risk factors for smoking initiation and might therefore serve as potential targets for intervention.

METHODS

Study Sample and Data Sources

The Millennium Cohort Study is a 67-year prospective cohort study designed to evaluate the health effects of US military service by enrolling service members and following them during and after their time in the military (Ryan et al., 2007). The first panel of participants, a cross-section of the military at the time, was enrolled in 2001–2003 (panel 1, n = 77,047); subsequent enrollments of newer military members occurred in 2004–2006 (panel 2, n = 31,110) and 2007–2008 (panel 3, n = 43,439). The baseline questionnaire was completed upon enrollment, and follow-up questionnaires were completed on a triennial basis. Those enrolled in the first panel, for example, had the opportunity to complete 4 follow-up questionnaires, while those in the second and third panels, had the opportunity to complete 3 and 2 follow-ups, respectively. The comprehensive questionnaires collected information on mental and physical health, tobacco and alcohol use, lifestyle, demographics, and military-related experiences. In addition, electronic personnel files, provided by the Defense Manpower Data Center, included data on demographics and military service. Additional details on Millennium Cohort methodology have been published elsewhere (Ryan et al., 2007).

The present study used 2 samples to examine cigarette smoking in relation to PTSD symptoms and clusters: a main sample and a PTSD sample. The main sample included participants who (1) enrolled in panel 1, 2, or 3 (2001-2003, 2004-2006, 2007-2008), (2) completed at least their first triennial follow-up questionnaire, and (3) indicated they had not smoked 100 cigarettes in their lifetime at baseline (nonsmokers). Using these criteria, 44,968 Millennium Cohort participants had complete exposure and outcome data and thus were included in these analyses. The PTSD subsample was derived from the main sample and included those who met DSM-IV symptom reporting criteria for a positive PTSD screen at baseline (positive endorsement of at least 1 intrusive symptom, 3 avoidance symptoms, and 2 hyperarousal symptoms at "moderately" or higher levels; n = 1622) (American Psychiatric Association, 2000; Weathers et al., 1993). We used the symptom reporting criteria because the prevalence of PTSD in the sample was expected to be low (Kessler et al., 2005; Smith et

al., 2011). DSM-5 criteria, and the related PCL-5, were not used because these data were collected 2001–2012, prior to the 2013 release of the DSM-5.

Study Design

PTSD symptoms and covariates were measured at baseline among a nonsmoking population, and smoking initiation was measured at follow-up, approximately 3 years later. We analyzed data from 2001 to 2012, which provided the maximum number of follow-up assessments for the 3 panels (3, 2, and 1, respectively). Subjects were followed until (a) they experienced the outcome (smoking initiation), (b) their last follow-up submission, or (c) the end of the study period (2012), whichever came first.

Outcome

Smoking initiation was defined as reporting current or former smoking on the self-administered questionnaire at follow-up. Current smokers were those who reported that they had smoked 100 cigarettes in their lifetime and had either not tried to quit or had been unsuccessful at quitting. Former smokers, those who initiated smoking after baseline but quit before the next follow-up, were those who reported both smoking 100 cigarettes in their lifetime and successfully quitting.

Exposures

Exposures of interest were the 17 PTSD symptoms of the PTSD Checklist–Civilian Version (PCL-C), and the 5 symptom clusters that have previously been validated among Iraq and Afghanistan veterans (re-experiencing, emotional numbing, anxious arousal, dysphoric arousal, and avoidance) measured at baseline (Pietrzak et al., 2012; Tsai et al., 2012). The Civilian Version was determined to be more suitable than the Military Version in this study due to the longitudinal follow-up (up to 67 years) that, while anchored by military service, extends much beyond that. The PCL-C asks respondents about symptoms related to "stressful experiences" and to indicate the level at which they experienced each symptom over the past month using a 5-item response scale (1 = *not at all*, 2 = *a little bit*, 3 = *moderately*, 4 = *quite a bit*, 5 = *extremely*). Participants who selected "moderately" or higher levels (levels 3–5) were considered to have the symptom. To examine the PCL-C symptom clusters, mean scores were calculated for each of the 5 clusters named above by summing the score for each item in the cluster and then dividing by the number of items in the cluster, allowing comparability between clusters. Among Millennium Cohort participants who submitted 2 surveys within 6 months, the PCL-C internal consistency was satisfactory (Cronbach's $\alpha = 0.94$), and among a population with similar prevalence of PTSD, the sensitivity was 0.99, and the specificity was 0.60 (Brewin, 2005; Smith, Smith et al., 2007).

Covariates

Demographic, military service-related, and health-related measures were included as covariates based on previous literature (Boyko et al., 2015; Bray et al., 2006; B. Smith et al., 2008; T. Smith et al., 2008). Demographic variables included age at study enrollment, sex, highest education attainment, marital status, race/ethnicity, and military pay grade. Military service-related variables included combat deployment during follow-up, deployment prior to

study enrollment, military separation, service branch, service component, and military occupation. Health-related variables included physical component summary score (based on the Medical Outcomes Study Short Form 36-Item Health Survey for Veterans; Stewart et al., 1988; Ware & Sherbourne, 1992); life stressors (based on a modified Holmes and Rahe Stress Inventory; Holmes & Rahe, 1967), depression, other anxiety/panic disorder (based on the Patient Health Questionnaire [PHQ]; Kroenke et al., 2001; Spitzer et al., 1999), body mass index (BMI), and alcohol misuse. Alcohol misuse was defined as a gender-specific report of risky drinking (men: >14 drinks/week or ≥5 drinks/day; women: >7 drinks/week or ≥4 drinks/day; National Institute on Alcohol Abuse and Alcoholism, 2014) and/or at least one alcohol-related consequence as assessed using the PHQ alcohol module (Dawson et al., 2013; Williams et al., 2015).

Statistical Analyses

Descriptive statistics and chi-square tests were used to assess differences in smoking initiation by population variables. Unadjusted and adjusted complementary log-log models were then fit to estimate the relative risks for smoking initiation in relation to individual PTSD symptoms and symptom clusters among both study samples. We tested for multicollinearity among the individual PTSD symptoms and among the symptom clusters in multivariable models. All variance inflation factors were <4, indicating a low likelihood for multicollinearity. Iterative models were fit with covariates added in groups. Model 1 included the individual PTSD symptom or cluster only (unadjusted). Model 2 added demographic variables. Model 3 included model 2 variables plus military-related characteristics. Model 4 included model 3 variables plus health-related covariates. Model 5 included the model 4 variables and the other PTSD symptoms (or clusters). While this technique required extensive modeling, it allowed determination of whether inclusion of certain covariate groups altered the association between PTSD symptoms and smoking initiation, and it allowed us to evaluate the association between each PTSD symptom or cluster, independent of the other symptoms and clusters. We did not adjust P values for multiple comparisons since each predictor was assessed independently of other clusters or symptoms.

RESULTS

Among all participants (the main sample), those who initiated cigarette smoking were proportionally different ($p < 0.05$) from those who did not on all demographic, military, and health-related characteristics, except military separation and BMI (Table 1). Among the subsample of those with PTSD (mean PCL-C score: 53), only age, education, military pay grade and alcohol misuse differed significantly by smoking initiation status. Overall, 6.5% of all participants and 10.4% of those with PTSD reported smoking initiation at follow-up (mean follow-up: 7.4 years). Both populations reflected the general distributions of demographic and service-related characteristics of the military: young, mostly white, male, married, in the Army, junior enlisted, and on active duty (Department of Defense, 2015).

In the main sample, a small proportion of participants endorsed each PCL-C item (Table 2). The mean cluster scores for each of the 5 clusters was approximately 1 (range: 1.20–1.46)

and the proportion of each individual PCL-C symptom endorsed ranged from 3% to 13% (3% reported physical reactions to stressful experiences from the past, 13% reported trouble sleeping). Among those in the PTSD subpopulation, the mean cluster scores were near 3 (range: 2.92–3.52) and the proportion of each individual symptom endorsed ranged from 45% to 88% (45% endorsed trouble remembering stressful experiences from the past, 88% reported feeling distant or cut off from other people).

Among all participants, unadjusted relative risk estimates suggested an elevated risk of smoking initiation among those reporting each PTSD symptom (Table 3). The magnitude of the relative risk diminished with addition of successive covariate group; none of the 17 PCL-C items were significantly associated with smoking initiation in the fully adjusted models. In the PTSD subpopulation, the results varied by item. Several PTSD symptoms were not associated with smoking initiation in any model, some were significant only in the unadjusted models, and 2 symptoms were significant in the fully adjusted models (Table 3). Specifically, those with PTSD who reported "feeling as though your future will somehow be cut short" had a 1.19-fold higher risk (95% confidence interval [CI] 1.02–1.40) than those who did not report that symptom, and those with PTSD who reported "feeling irritable or having angry outbursts" had a 1.41-fold higher risk (95% CI 1.13–1.76) compared with those without the symptom.

Similar to the individual symptoms, among all participants, each symptom cluster was significantly associated with subsequent smoking initiation in models 1–3 (unadjusted, adjusted for demographics, adjusted for demographics and service-related characteristics). After adjustment for health-related characteristics, and other PTSD symptoms (models 4 and 5), no symptom cluster was significantly associated with higher risk for smoking initiation (Table 4). Among the subpopulation with PTSD, the results were less consistent but followed the same general pattern in which each cluster was associated with smoking initiation when unadjusted (model 1) but not when fully adjusted (model 5).

DISCUSSION

Among military service members who were nonsmokers at baseline, no individual PTSD symptom nor PTSD symptom cluster predicted subsequent cigarette smoking initiation, after adjustment for military and health-related characteristics and other PTSD symptoms or clusters. However, specifically among nonsmoking participants who met screening criteria for PTSD at baseline, 2 individual symptoms (foreshortened future, and irritability/anger), but no symptom clusters, were independently associated with subsequent smoking initiation in fully adjusted models.

To our knowledge, smoking in relation to individual PTSD symptoms has been described in only one other publication (Weaver et al., 2008). That cross-sectional study of a small sample of refugees reported that, among current smokers, severity of nicotine dependence was associated with several PTSD symptoms: trouble sleeping, irritability, concentration difficulties, and hypervigilance (Weaver et al., 2008). Only the result for irritability was consistent with our findings, although we would not have expected the results to fully overlap since the sample and specific smoking outcomes were different. One novel finding

from the present study was the higher risk for smoking initiation among those who felt their future may somehow be cut short. Motivations for smoking include poor mood and alleviating stress (Beckham et al., 1997; Bray et al., 2006; Garey et al., 2015). We speculate that those who sensed a foreshortened future might experience poorer mood and greater stress, and also be less concerned about the health risks of smoking.

Our finding that no PTSD symptom cluster predicted smoking initiation in fully adjusted models, even among those with PTSD, was not consistent with findings from previous research. The emotional numbing and arousal clusters have been associated with smoking, even after adjustment for other symptoms, in prior cross-sectional research (Cook et al., 2009; Gabert-Quillen et al., 2015; Greenberg et al., 2012; Joseph et al., 2012; Weaver et al., 2008). Additionally, these clusters arguably have the most plausible link with smoking, since motivations to smoke among those with PTSD include reducing negative affect, easing tension, and decreasing perceived stress (Beckham et al., 1997; Garey et al., 2015). We examined smoking initiation among a sample who were nonsmokers at baseline, so it is possible that these motivations are factors in the continuation of smoking but not initiation of regular smoking among those with PTSD.

While we did not replicate previous findings related to PTSD symptom clusters, both the emotional numbing and dysphoric arousal clusters remained statistically significant until model 5. Additionally, it is noteworthy that the irritability/anger symptom is part of the emotional numbing cluster, and the sense of foreshortened future item is part of the dysphoric arousal cluster. It may be that these specific symptoms were the main contributors to the significant findings related to the emotional numbing and arousal clusters reported by others. If so, tailoring the clinical treatment of these specific symptoms in nonsmoking PTSD patients may decrease initiation of smoking in this population. Teaching emotional regulation strategies may be helpful in this context, as avoidant coping style is a risk factor for smoking initiation in young adults (Bricker et al., 2011).

It is important to note that all 17 PTSD symptoms assessed in the PCL-C were associated with a significantly higher risk of smoking initiation in unadjusted analyses conducted among all participants, but that none of these individual symptoms remained significantly associated with the outcome in fully adjusted analyses. There was a substantial diminution in risk for all symptoms after adjustment for demographic characteristics, demonstrating that PTSD symptoms are related to other important determinants of smoking initiation. Significant associations between smoking and individual PTSD symptoms that are not adjusted for associated factors like demographic characteristics, stress, or other PTSD symptoms may be a result of confounding. The approach used in the current study avoids such potential bias.

Several limitations must be considered regarding these analyses. There is an approximate 3-year interval between PTSD symptom measurement and the assessment of cigarette smoking status, and it is not possible to determine when either the outcome or exposure may have changed during the time between measurements. We sought to mitigate this potential misclassification by classifying those who newly indicated they were former smokers at follow-up as initiators. Relatedly, smoking status was based on self-report and not confirmed

with objective testing, although underreporting of smoking behavior compared with objective measurement has been demonstrated to be extremely low (Yeager & Krosnick, 2010). We defined nonsmokers as those who had never smoked 100 cigarettes in their life, which could include those who had previously initiated smoking but never progressed to regular smoking. People who had previously initiated smoking may be more likely to take up smoking regularly, especially if experiencing the stress of PTSD symptoms. This study examined the symptoms listed on the PCL-C since this is the measure that has been collected on the Millennium Cohort Study questionnaire since 2001. However future studies should examine the associations of the new PCL-5 instrument with smoking. Because we pre-specified all analyses, including the associations of interest and the covariates to be included in multivariable models, we did not adjust the threshold p-value for null hypothesis rejection for the number of comparisons performed. Nevertheless, the potential exists for type 1 error in our analysis given multiple statistical comparisons. Several PTSD symptoms are shared among different mental illnesses and not specific to PTSD alone, therefore we adjusted for depression, anxiety, panic, and life stressors in model 4 to account for that overlap as much as possible. Prior investigations into possible biases of this cohort have shown that the cohort is representative of the military, and that the data collected are reliable (Smith, Jacobson et al., 2007; Smith, Smith et al., 2007; Wells et al., 2008). Additionally, despite loss to follow-up (29%, 45%, and 50% of panels 1, 2, and 3, respectively), an examination of nonresponse to the first follow-up questionnaire revealed consistent results when comparing unweighted and inverse-probability weighted results (Littman et al., 2010).

CONCLUSIONS

Despite these limitations, the present study was conducted in a very large sample of military personnel and is the first longitudinal study to our knowledge to address whether individual PTSD symptoms and PTSD symptom clusters are predictive of subsequent cigarette smoking initiation among those who were previously nonsmokers. No individual symptom or cluster appeared to independently increase the risk for smoking initiation in this general military population. However, among those with PTSD, feeling irritable or having angry outbursts, and feeling as though your future may be cut short, were significantly associated with higher risk for smoking initiation. Given the substantial morbidity and mortality associated with smoking, healthcare providers treating those with PTSD should consider these symptoms among their nonsmoking patients as signaling a higher risk of smoking initiation. Interventions teaching emotion regulation strategies may be particularly useful to prevent smoking initiation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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TABLE 1

Baseline Characteristics of Nonsmoking US Service Members by Smoking Initiation Status (2001–2012)[*]

Characteristics	All Participants (N)	Initiated Smoking by Follow-up (%)	Subsample With PTSD[†] (N)	Initiated Smoking by Follow-up (%)
Sample	**44,968**	**6.5**	**1622**	**10.4**
Demographic covariates				
Age at enrollment (years)				
17–24	13,532	9.7	726	12.9
25–34	17,452	5.5	558	7.7
35–44	10,566	4.8	257	10.9
45 or older	3418	4.8	81	3.7
Sex				
Male	30,301	6.1	963	10.7
Female	14,667	4.4	659	9.9
Race/ethnicity				
White, non-Hispanic	31,043	5.8	1057	10.7
Black, non-Hispanic	5812	3.7	239	10.5
Other	8113	5.8	326	9.2
Education				
High school or less	5924	10.6	347	13.3
Some college/associate degree	20,801	7.4	928	10.6
Bachelor's degree or higher	18,243	4.2	347	6.9
Marital status				
Never married	14,637	7.8	664	11.1
Married	26,105	5.8	706	9.6
Divorced/separated/widowed	4226	6.6	252	10.3
Military pay grade				
Junior enlisted	23,783	8.3	1235	11.4
Senior enlisted	7736	5.7	194	7.7
Officer/warrant officer	13,449	3.9	193	6.2
Military service-related covariates				
Service branch				
Army	19,520	7.4	915	10.7
Navy/Coast Guard	8135	5.9	265	9.1
Marine Corps	3050	8.5	181	11.0
Air Force	14,263	5.3	261	10.0
Occupation				
Combat specialist	8363	6.1	271	11.1
Healthcare	5774	5.6	184	11.4
Other	30,831	6.8	1167	10.0
Service component				
Reserve/National Guard	17,750	5.5	545	10.1

Characteristics	All Participants (N)	Initiated Smoking by Follow-up (%)	Subsample With PTSD[†] (N)	Initiated Smoking by Follow-up (%)
Active duty	27,218	5.6	1077	10.5
Combat deployment during follow-up[‡]				
Not deployed	35,994	6.2	1067	10.0
Deployed, no combat	3798	6.8	98	11.2
Deployed, with combat	5176	8.4	457	10.9
Deployed prior to enrollment				
No	37,112	6.8	1443	10.7
Yes	7856	5.4	179	7.8
Separated from military service				
No	32,437	6.4	944	9.6
Yes	12,531	6.9	678	11.4
Health-related covariates				
Physical component summary score[§]				
1–15	5029	7.4	546	11.4
16–85	32,079	6.5	741	10.8
86–100	7860	6.1	335	7.8
Life stressors[‖]				
None	27,621	6.3	553	9.4
1 events	11,508	6.6	463	10.4
2+ events	5839	7.3	606	11.2
Panic or anxiety disorder[¶]				
No	44,002	6.4	1099	9.7
Yes	966	10.2	523	11.7
Depression[¶]				
No	43,742	6.5	943	10.9
Yes	1226	8.9	679	9.6
Alcohol misuse[**]				
No	24,938	4.9	739	7.3
Yes	20,030	8.5	883	12.9
BMI (kg/m^2)				
<24.9	19,423	6.5	649	11.4
25–29.9	21,432	6.7	725	10.2
30	4113	5.7	248	8.1

[*] For all participants, all characteristics differed significantly ($p < 0.05$) by smoking status, except military separation and body mass index (BMI). For the subpopulation with posttraumatic stress disorder (PTSD), the characteristics that differed by smoking status were age, education, military pay grade, and alcohol misuse.

[†] Subsample of all participants who screened positive on the PTSD Checklist using *Diagnostic and Statistical Manual, Fourth Edition* criteria.

[‡] Combat was defined as report of witnessing (1) a person's death due to war, disaster, or tragic event; (2) instances of physical abuse (torture, beating, rape); (3) dead and/or decomposing bodies; (4) maimed soldiers/civilians; or (5) prisoners of war/refugees.

[§] Scored using the Medical Outcomes Study Short Form 36-Item Health Survey for Veterans.

//Life stressors include items such as divorce, bankruptcy, sexual assault, death of loved one.

¶Identified using the Patient Health Questionnaire (PHQ).

**Positive screen for alcohol-related problems on the PHQ or self-report of drinking over recommended daily or weekly limits (men: >5 drinks/occasion or >14 drinks/week, women: >4 drinks/occasion or >7 drinks/week).

TABLE 2

PTSD Symptoms, Mean PCL Cluster Score, and Percent who Initiated Smoking (2001–2012)[*]

PTSD Symptoms	All Participants N = 44,968		Subsample With PTSD N = 1622	
	Endorsed Each Symptom (N)	Initiated Smoking (%)	Endorsed Each Symptom (N)	Initiated Smoking (%)
Re-experiencing cluster				
Repeated, disturbing memories of stressful experiences from the past	2675	8.8	1148	10.7
Repeated, disturbing dreams of stressful experiences from the past	1745	9.8	874	11.3
Suddenly acting or feeling as if stressful experiences were happening again	1927	9.3	1053	10.7
Feeling very upset when something happened that reminds you of stressful experiences from the past	2671	8.8	1271	9.9
Physical reactions when something reminds you of stressful experiences from the past	1378	10.4	888	11.6
Emotional numbing cluster				
Trouble remembering important parts of stressful experiences from the past	1630	22.4	737	10.9
Loss of interest in activities that you used to enjoy	3392	9.1	1257	11.1
Feeling distant or cut off from other people	4206	8.9	1423	10.0
Feeling emotionally numb, or being unable to have loving feelings for those close to you	3072	8.7	1179	10.0
Feeling as if your future will somehow be cut short	2164	9.5	983	11.2
Anxious arousal cluster				
Feeling "super alert" or watchful or on guard	2940	8.2	994	9.7
Feeling jumpy or easily startled	2014	8.8	928	10.2
Dysphoric arousal cluster				
Trouble falling asleep or staying asleep	6043	8.2	1292	10.5
Feeling irritable or having angry outbursts	4524	9.1	1372	10.8
Difficulty concentrating	3315	9.3	1246	10.0
Avoidance cluster				
Efforts to avoid thinking about your stressful experiences from the past or avoid having feelings about them	2293	9.0	1088	10.1
Efforts to avoid activities or situations because they remind you of stressful experiences from the past	1761	9.7	1006	10.3
PTSD symptom cluster scores, mean (SD)				
Re-experiencing cluster	1.22 (0.51)	1.29 (0.61)	2.99 (0.90)	3.09 (0.94)

PTSD Symptoms	All Participants N = 44,968		Subsample With PTSD N = 1622	
	Endorsed Each Symptom (N)	Initiated Smoking (%)	Endorsed Each Symptom (N)	Initiated Smoking (%)
Emotional numbing cluster	1.28 (0.55)	1.36 (0.65)	3.16 (0.76)	3.21 (0.83)
Anxious arousal cluster	1.27 (0.71)	1.34 (0.81)	2.92 (1.35)	2.91 (1.42)
Dysphoric arousal cluster	1.46 (0.70)	1.56 (0.82)	3.52 (0.84)	3.61 (0.92)
Avoidance cluster	1.20 (0.57)	1.26 (0.66)	3.01 (1.15)	2.97 (1.17)

*
For all symptom clusters, those who did not initiate smoking had a significantly lower mean score than those who initiated smoking by follow-up ($p < 0.001$).

PCL-C, PTSD Checklist – Civilian Version; PTSD, posttraumatic stress disorder.

TABLE 3

Risk for Smoking Initiation by 17 PCL-C Symptoms (2001–2012)

PCL-C Item	Iterative Models	All Participants N=44,968 RR (95% CI)	Subsample With PTSD N=1622 RR (95% CI)
Re-experiencing			
Repeated, disturbing memories of stressful experiences from the past	Model 1: Unadjusted	**1.50 (1.29, 1.73)**	**1.64 (1.20, 2.23)**
	Model 2: Adjusted for demographic characteristics	**1.14 (1.06, 1.21)**	**1.20 (1.02, 1.42)**
	Model 3: Model 2 + service-related characteristics	**1.11 (1.04, 1.19)**	**1.21 (1.02, 1.43)**
	Model 4: Model 3 + health-related characteristics	1.04 (0.97, 1.12)	1.17 (0.98, 1.39)
	Model 5: Model 4 + other PCL symptoms	1.02 (0.92, 1.14)	1.16 (0.96, 1.41)
Repeated, disturbing dreams of stressful experiences from the past	Model 1: Unadjusted	**1.58 (1.33, 1.87)**	**1.47 (1.11, 1.95)**
	Model 2: Adjusted for demographic characteristics	**1.17 (1.08, 1.26)**	1.17 (0.99, 1.36)
	Model 3: Model 2 + service-related characteristics	**1.14 (1.05, 1.23)**	1.17 (0.99, 1.36)
	Model 4: Model 3 + health-related characteristics	1.06 (0.97, 1.15)	1.14 (0.97, 1.34)
	Model 5: Model 4 + other PCL symptoms	0.99 (0.88, 1.13)	1.04 (0.87, 1.25)
Suddenly acting or feeling as if stressful experiences were happening again	Model 1: Unadjusted	**1.61 (1.36, 1.90)**	**1.45 (1.09, 1.94)**
	Model 2: Adjusted for demographic characteristics	**1.15 (1.06, 1.23)**	1.12 (0.96, 1.31)
	Model 3: Model 2 + service-related characteristics	**1.12 (1.04, 1.21)**	1.11 (0.95, 1.30)
	Model 4: Model 3 + health-related characteristics	1.03 (0.95, 1.12)	1.08 (0.91, 1.27)
	Model 5: Model 4 + other PCL symptoms	1.01 (0.89, 1.14)	1.04 (0.87, 1.24)
Feeling very upset when something happened that reminds you of stressful experiences from the past	Model 1: Unadjusted	**1.48 (1.27, 1.71)**	1.29 (0.95, 1.76)
	Model 2: Adjusted for demographic characteristics	**1.10 (1.03, 1.18)**	1.05 (0.88, 1.24)
	Model 3: Model 2 + service-related characteristics	**1.08 (1.01, 1.16)**	1.05 (0.88, 1.24)
	Model 4: Model 3 + health-related characteristics	1.00 (0.93, 1.08)	0.99 (0.83, 1.18)
	Model 5: Model 4 + other PCL symptoms	0.95 (0.84, 1.06)	0.88 (0.72, 1.07)
Physical reactions when something reminds you of stressful experiences from the past	Model 1: Unadjusted	**1.69 (1.40, 2.03)**	**1.39 (1.05, 1.84)**
	Model 2: Adjusted for demographic characteristics	**1.16 (1.07, 1.26)**	1.15 (0.99, 1.34)
	Model 3: Model 2 + service-related characteristics	**1.14 (1.05, 1.24)**	1.15 (0.98, 1.34)
	Model 4: Model 3 + health-related characteristics	1.04 (0.95, 1.14)	1.09 (0.93, 1.29)
	Model 5: Model 4 + other PCL symptoms	1.05 (0.92, 1.20)	1.07 (0.90, 1.28)
Emotional numbing			

PCL-C Item / Iterative Models	All Participants N=44,968 RR (95% CI)	Subsample With PTSD N=1622 RR (95% CI)
Trouble remembering important parts of stressful experiences from the past		
Model 1: Unadjusted	**1.63 (1.35, 1.98)**	1.31 (0.99, 1.74)
Model 2: Adjusted for demographic characteristics	**1.15 (1.06, 1.25)**	1.08 (0.93, 1.26)
Model 3: Model 2 + service-related characteristics	**1.12 (1.03, 1.22)**	1.07 (0.92, 1.25)
Model 4: Model 3 + health-related characteristics	1.03 (0.94, 1.13)	1.03 (0.88, 1.21)
Model 5: Model 4 + other PCL symptoms	1.03 (0.91, 1.15)	1.06 (0.90, 1.25)
Loss of interest in activities that you used to enjoy		
Model 1: Unadjusted	**1.50 (1.31, 1.71)**	1.38 (1.00, 1.90)
Model 2: Adjusted for demographic characteristics	**1.12 (1.05, 1.19)**	1.15 (0.97, 1.37)
Model 3: Model 2 + service-related characteristics	**1.10 (1.03, 1.16)**	1.15 (0.97, 1.37)
Model 4: Model 3 + health-related characteristics	1.04 (0.97, 1.12)	1.15 (0.95, 1.38)
Model 5: Model 4 + other PCL symptoms	1.02 (0.93, 1.12)	1.10 (0.91, 1.33)
Feeling distant or cut off from other people		
Model 1: Unadjusted	**1.47 (1.30, 1.66)**	1.26 (0.89, 1.77)
Model 2: Adjusted for demographic characteristics	**1.10 (1.04, 1.16)**	1.06 (0.87, 1.28)
Model 3: Model 2 + service-related characteristics	**1.08 (1.02, 1.14)**	1.05 (0.87, 1.28)
Model 4: Model 3 + health-related characteristics	1.02 (0.96, 1.08)	1.02 (0.84, 1.25)
Model 5: Model 4 + other PCL symptoms	0.97 (0.89, 1.07)	0.90 (0.73, 1.10)
Feeling emotionally numb, or being unable to have loving feelings for those close to you		
Model 1: Unadjusted	**1.51 (1.32, 1.74)**	1.26 (0.93, 1.70)
Model 2: Adjusted for demographic characteristics	**1.09 (1.02, 1.16)**	1.05 (0.89, 1.23)
Model 3: Model 2 + service-related characteristics	**1.07 (1.01, 1.14)**	1.06 (0.90, 1.25)
Model 4: Model 3 + health-related characteristics	1.00 (0.93, 1.07)	1.02 (0.86, 1.21)
Model 5: Model 4 + other PCL symptoms	0.99 (0.90, 1.08)	0.97 (0.82, 1.15)
Feeling as if your future will somehow be cut short		
Model 1: Unadjusted	**1.64 (1.40, 1.92)**	**1.57 (1.18, 2.09)**
Model 2: Adjusted for demographic characteristics	**1.17 (1.09, 1.26)**	**1.27 (1.09, 1.49)**
Model 3: Model 2 + service-related characteristics	**1.15 (1.07, 1.23)**	**1.28 (1.10, 1.50)**
Model 4: Model 3 + health-related characteristics	**1.08 (1.01, 1.17)**	**1.27 (1.08, 1.49)**
Model 5: Model 4 + other PCL symptoms	1.08 (0.98, 1.20)	**1.19 (1.02, 1.40)**
Anxious arousal		
Feeling "super alert" or watchful or on guard		
Model 1: Unadjusted	**1.54 (1.33, 1.77)**	1.23 (0.93, 1.63)
Model 2: Adjusted for demographic characteristics	**1.09 (1.02, 1.16)**	1.04 (0.90, 1.22)
Model 3: Model 2 + service-related characteristics	1.06 (0.99, 1.14)	1.04 (0.90, 1.22)
Model 4: Model 3 + health-related characteristics	1.00 (0.93, 1.07)	0.99 (0.84, 1.16)

PCL-C Item / Iterative Models	All Participants N=44,968 RR (95% CI)	Subsample With PTSD N=1622 RR (95% CI)
Model 5: Model 4 + other PCL symptoms	0.99 (0.90, 1.09)	0.97 (0.82, 1.15)
Feeling jumpy or easily startled		
Model 1: Unadjusted	**1.57 (1.33, 1.85)**	1.22 (0.92, 1.61)
Model 2: Adjusted for demographic characteristics	**1.11 (1.03, 1.19)**	1.03 (0.89, 1.20)
Model 3: Model 2 + service-related characteristics	**1.08 (1.01, 1.17)**	1.03 (0.88, 1.20)
Model 4: Model 3 + health-related characteristics	1.00 (0.92, 1.08)	0.96 (0.81, 1.13)
Model 5: Model 4 + other PCL symptoms	0.97 (0.87, 1.08)	0.93 (0.77, 1.11)
Dysphoric arousal		
Trouble falling asleep or staying asleep		
Model 1: Unadjusted	**1.42 (1.28, 1.57)**	**1.46 (1.03, 2.07)**
Model 2: Adjusted for demographic characteristics	**1.09 (1.04, 1.14)**	**1.25 (1.03, 1.52)**
Model 3: Model 2 + service-related characteristics	**1.07 (1.02, 1.12)**	**1.25 (1.03, 1.52)**
Model 4: Model 3 + health-related characteristics	1.01 (0.96, 1.06)	1.22 (0.99, 1.49)
Model 5: Model 4 + other PCL symptoms	1.03 (0.96, 1.09)	1.03 (0.84, 1.24)
Feeling irritable or having angry outbursts		
Model 1: Unadjusted	**1.59 (1.42, 1.79)**	**2.32 (1.56, 3.44)**
Model 2: Adjusted for demographic characteristics	**1.14 (1.08, 1.20)**	**1.35 (1.10, 1.67)**
Model 3: Model 2 + service-related characteristics	**1.12 (1.06, 1.18)**	**1.37 (1.11, 1.69)**
Model 4: Model 3 + health-related characteristics	1.06 (0.99, 1.12)	**1.36 (1.10, 1.69)**
Model 5: Model 4 + other PCL symptoms	1.06 (0.99, 1.15)	**1.41 (1.13, 1.76)**
Difficulty concentrating		
Model 1: Unadjusted	**1.47 (1.28, 1.67)**	1.02 (0.76, 1.38)
Model 2: Adjusted for demographic characteristics	**1.11 (1.04, 1.17)**	1.00 (0.85, 1.18)
Model 3: Model 2 + service-related characteristics	**1.09 (1.02, 1.15)**	1.01 (0.86, 1.19)
Model 4: Model 3 + health-related characteristics	1.02 (0.95, 1.09)	0.97 (0.81, 1.15)
Model 5: Model 4 + other PCL symptoms	0.98 (0.90, 1.07)	0.85 (0.71, 1.01)
Avoidance		
Efforts to avoid thinking about your stressful experiences from the past or avoid having feelings about them		
Model 1: Unadjusted	**1.45 (1.23, 1.70)**	1.31 (0.98, 1.74)
Model 2: Adjusted for demographic characteristics	**1.09 (1.02, 1.17)**	1.02 (0.87, 1.20)
Model 3: Model 2 + service-related characteristics	1.07 (0.99, 1.15)	1.02 (0.87, 1.19)
Model 4: Model 3 + health-related characteristics	0.98 (0.91, 1.06)	0.97 (0.82, 1.14)
Model 5: Model 4 + other PCL symptoms	0.94 (0.83, 1.06)	0.94 (0.78, 1.14)
Efforts to avoid activities or situations because they remind you of stressful experiences from the past		
Model 1: Unadjusted	**1.51 (1.26, 1.80)**	1.26 (0.95, 1.67)
Model 2: Adjusted for demographic characteristics	**1.12 (1.04, 1.21)**	1.07 (0.91, 1.24)

PCL-C Item		All Participants N=44,968 RR (95% CI)	Subsample With PTSD N=1622 RR (95% CI)
Iterative Models			
	Model 3: Model 2 + service-related characteristics	**1.10 (1.02, 1.19)**	1.07 (0.91, 1.24)
	Model 4: Model 3 + health-related characteristics	1.01 (0.92, 1.10)	1.02 (0.87, 1.20)
	Model 5: Model 4 + other PCL symptoms	1.00 (0.87, 1.14)	0.99 (0.82, 1.19)

Demographic characteristics: age, sex, race/ethnicity, education, marital status, military pay grade.

Service-related characteristics: service branch, service component, occupation, combat deployment, deployment prior to baseline, separation from military service.

Health characteristics: physical component summary score, life stressors, panic/anxiety, depression, body mass index, alcohol misuse.

PCL-C, PTSD Checklist – Civilian Version; PTSD, posttraumatic stress disorder; CI, confidence interval; RR, risk ratio.

TABLE 4

Risk for Smoking Initiation by 5 PCL-C Symptom Clusters (2001–2012)

PCL-C Clusters	Models	All Participants N=44,968 RR (95% CI)	Subsample With PTSD N=1622 RR (95% CI)
Re-experiencing	Model 1: Unadjusted	**1.27 (1.20, 1.36)**	**1.27 (1.11, 1.45)**
	Model 2: Model 1 + demographic characteristics	**1.15 (1.09, 1.22)**	**1.21 (1.04, 1.09)**
	Model 3: Model 2 + service-related characteristics	**1.12 (1.06, 1.19)**	**1.21 (1.04, 1.41)**
	Model 4: Model 3 + comorbid conditions/health status	1.02 (0.95, 1.10)	1.17 (0.98, 1.39)
	Model 5: Model 4 + other PTSD symptom clusters	1.02 (0.90, 1.15)	1.17 (0.94, 1.44)
Emotional numbing	Model 1: Unadjusted	**1.29 (1.21, 1.37)**	**1.27 (1.09, 1.47)**
	Model 2: Model 1 + demographic characteristics	**1.14 (1.08, 1.21)**	**1.22 (1.03, 1.44)**
	Model 3: Model 2 + service-related characteristics	**1.12 (1.05, 1.18)**	**1.23 (1.04, 1.45)**
	Model 4: Model 3 + comorbid conditions/health status	1.03 (0.96, 1.11)	**1.22 (1.01, 1.49)**
	Model 5: Model 4 + other PTSD symptom clusters	1.04 (0.93, 1.17)	1.06 (0.85, 1.33)
Anxious arousal	Model 1: Unadjusted	**1.20 (1.14, 1.26)**	**1.15 (1.04, 1.27)**
	Model 2: Model 1 + demographic characteristics	**1.09 (1.04, 1.14)**	1.10 (0.98, 1.23)
	Model 3: Model 2 + service-related characteristics	**1.07 (1.02, 1.12)**	1.10 (0.98, 1.23)
	Model 4: Model 3 + comorbid conditions/health status	1.02 (0.97, 1.07)	1.05 (0.94, 1.18)
	Model 5: Model 4 + other PTSD symptom clusters	1.01 (0.94, 1.07)	1.03 (0.92, 1.16)
Dysphoric arousal	Model 1: Unadjusted	**1.22 (1.16, 1.28)**	**1.28 (1.11, 1.48)**
	Model 2: Model 1 + demographic characteristics	**1.11 (1.06, 1.16)**	**1.25 (1.07, 1.46)**
	Model 3: Model 2 + service-related characteristics	**1.08 (1.03, 1.13)**	**1.26 (1.07, 1.47)**
	Model 4: Model 3 + comorbid conditions/health status	1.00 (0.94, 1.06)	**1.28 (1.06, 1.54)**
	Model 5: Model 4 + other PTSD symptom clusters	1.00 (0.92, 1.09)	1.13 (0.92, 1.39)
Avoidance	Model 1: Unadjusted	**1.20 (1.13, 1.27)**	1.12 (0.99, 1.25)
	Model 2: Model 1 + demographic characteristics	**1.11 (1.05, 1.17)**	1.05 (0.93, 1.19)
	Model 3: Model 2 + service-related characteristics	**1.09 (1.03, 1.15)**	1.05 (0.93, 1.19)
	Model 4: Model 3 + comorbid conditions/health status	1.01 (0.94, 1.07)	1.00 (0.88, 1.15)
	Model 5: Model 4 + other PTSD symptom clusters	0.97 (0.88, 1.07)	0.91 (0.79, 1.06)

Demographic characteristics: age, sex, race/ethnicity, education, marital status, military pay grade.

Service-related characteristics: service branch, service component, occupation, combat deployment, deployment prior to baseline, separation from military service.

Health characteristics: physical component summary score, life stressors, panic/anxiety, depression, body mass index, alcohol misuse.

CI, confidence interval; PCL-C, PTSD Checklist – Civilian Version; PTSD, posttraumatic stress disorder; RR, risk ratio.

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