Soc Psychiatry Psychiatr Epidemiol (2017) 52:715–725
DOI 10.1007/s00127-017-1374-0

ORIGINAL PAPER

Dimensionality of *DSM-5* posttraumatic stress disorder and its association with suicide attempts: results from the National Epidemiologic Survey on Alcohol and Related Conditions-III

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Received: 13 October 2016 / Accepted: 20 March 2017 / Published online: 11 April 2017

Abstract
Background Emerging confirmatory factor analytic (CFA) studies suggest that posttraumatic stress disorder (PTSD) as defined by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) is best characterized by seven factors, including re-experiencing, avoidance, negative affect, anhedonia, externalizing behaviors, and anxious and dysphoric arousal. The seven factors, however, have been found to be highly correlated, suggesting that one general factor may exist to explain the overall correlations among symptoms.
Methods Using data from the National Epidemiologic Survey on Alcohol and Related Conditions-III, a large, national survey of 36,309 U.S. adults ages 18 and older, this study proposed and tested an exploratory bifactor hybrid model for *DSM-5* PTSD symptoms. The model posited one general and seven specific latent factors, whose associations with suicide attempts and mediating psychiatric disorders were used to validate the PTSD dimensionality.
Results The exploratory bifactor hybrid model fitted the data extremely well, outperforming the 7-factor CFA hybrid model and other competing CFA models. The general factor was found to be the single dominant latent trait that explained most of the common variance (~76%) and showed significant, positive associations with suicide attempts and mediating psychiatric disorders, offering support to the concurrent validity of the PTSD construct.
Conclusions The identification of the primary latent trait of PTSD confirms PTSD as an independent psychiatric disorder and helps define PTSD severity in clinical practice and for etiologic research. The accurate specification of PTSD factor structure has implications for treatment efforts and the prevention of suicidal behaviors.

Keywords Posttraumatic stress disorder · PTSD · PTSD symptoms · Suicide attempts · *DSM-5* PTSD diagnostic criteria · NESARC-III

Introduction

Posttraumatic stress disorder (PTSD) is a complex, multifaceted psychiatric disorder. In the U.S. general population, the 12-month prevalence estimates ranged from 2.7 to 3.7% [1–3] and the lifetime prevalence estimates from 5.7 to 6.8% [1, 3–5] for Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) PTSD [6]. The corresponding 12-month and lifetime prevalence estimates according to the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III) were 4.7% and 6.1%, respectively [7], for Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) PTSD [8]. Among U.S. veterans, the 12-month prevalence estimate of *DSM-5* PTSD was 4.7% [9], and the lifetime prevalence estimate was 8.1% [9] or 6.9% (NESARC-III) [10]. Recognizing the heterogeneity of PTSD clinical features, *DSM-5* [8] removes PTSD from anxiety disorders and creates a new class of trauma- and

Electronic supplementary material The online version of this article (doi:10.1007/s00127-017-1374-0) contains supplementary material, which is available to authorized users.

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stressor-related disorders, with four clusters including intrusion, avoidance, negative alterations in cognitions and mood, and alterations in arousal and reactivity [11]. Nevertheless, various confirmatory factor analytic (CFA) models that have been proposed so far suggest that the PTSD factor structure is more complex or with a different configuration than envisioned by *DSM-5*, including dysphoria [12, 13], dysphoric arousal [13, 14], externalizing behaviors [14], anhedonia [13], and hybrid models [15–21]. In particular, the 7-factor hybrid model combines key features of the 6-factor anhedonia and externalizing behavior models, where anhedonia is characterized by loss of interest, detachment, and restricted affect, and the externalizing behaviors are characterized by irritability/anger and self-destructive/reckless behavior. Although the hybrid model is deemed superior to other CFA models empirically in terms of better fit to data, the seven PTSD factors are highly correlated with one another, prompting some researchers to question whether the high intercorrelations actually reflect one single general latent factor [22]. Because the hybrid model was tested among selected samples of small size (e.g., veterans), whether it applies to the U.S. general population is uncertain.

Studies have shown a relationship between PTSD and suicidal ideation or suicide attempts in both the general [23, 24] and veteran populations [25–28], as well as between PTSD and completed suicide in both the general [29] and veteran populations [30, 31]. The underlying relationship between PTSD dimensionality and suicide attempts, however, is not well established. Studies that proposed the 7-factor CFA hybrid model have not examined the discriminant validity in relation to suicide attempts, even though one study [17] found that suicidal ideation was significantly and positively associated with negative affect, anhedonia, and externalizing behaviors but was negatively associated with avoidance among a U.S. veteran sample, and another study [32] found that suicidal ideation was only significantly and positively associated with negative affect among an Australian adult sample.

There is a paucity of evidence in the extant literature to clarify the pathways by which PTSD dimensionality develops into suicide attempts [33]. Conner and colleagues [25] proposed a conceptual model with the pathways from the PTSD diagnosis to suicide death through other psychiatric disorders. Because completed suicide has been theorized as the endpoint of a process including suicidal ideation, planning, and attempts [34], the relationship with suicide attempts presumably holds for the dimensionality of PTSD. Specifically, particular PTSD symptom clusters may lead to mood and anxiety disorders or substance use disorders (SUDs) [35], which then lead to suicide attempts [36]. Combination of specific PTSD symptoms or comorbid psychiatric disorders such as depression may also lead to suicide attempts by exacerbating PTSD and co-occurring problems [33, 37].

To confirm our hypothesis, we examine PTSD dimensionality and validate its association directly with suicide attempts and indirectly through other correlates in the U.S. general population of adults using data from a large national survey. Specifically, we propose an exploratory structural equation modeling (ESEM) bifactor hybrid model (Fig. 1) built upon the 7-factor hybrid model proposed by Armour and colleagues [16] and the conceptual model proposed by Conner and colleagues [25], except with no reference to suicidal ideation. Our bifactor modeling, including one general factor and seven orthogonal specific factors, is used to explore the extent to which the multidimensional data with multiple subdomains of PTSD yield one target dimension of our interest [38]. In this bifactor paradigm, the general factor is intended to measure the primary trait of PTSD, whereas the specific factors are merely "nuisance" traits that account for residual correlations among the PTSD symptoms. The identification of one single dominant factor that reflects the overall PTSD symptomatology would help address the problem with differential predominance of clinical features of PTSD.

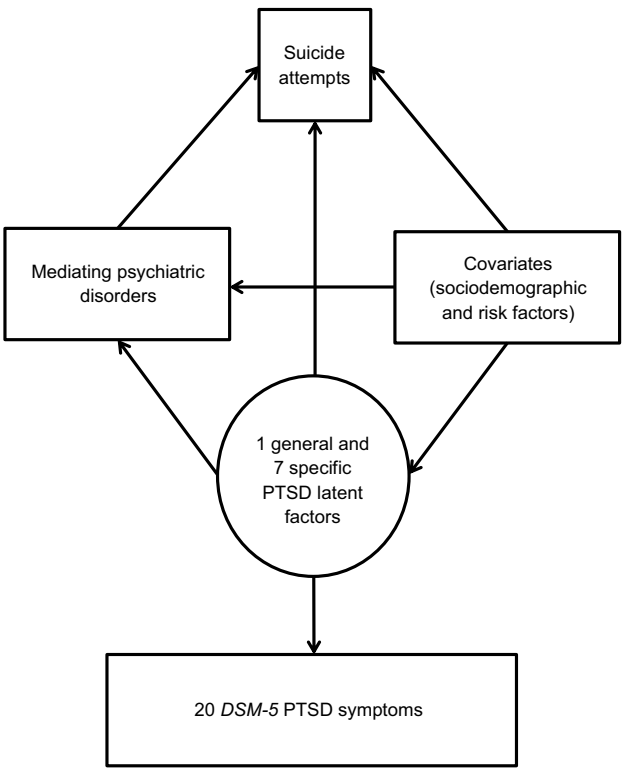

Fig. 1 Exploratory structural equation modeling of the posttraumatic stress disorder (PTSD) factor structure and its relationship with suicide attempts, mediating psychiatric disorders, and covariates

Methods

Study design

The study sample was drawn from the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III), a nationally representative survey of the non-institutionalized U.S. civilian population ages 18 or older in 2012–2013, including persons in households and group quarters (e.g., group homes, worker dormitories) and veterans of the U.S. Armed Forces. Among other areas, the NESARC-III collected detailed information on demographics, substance use, and mental health, especially PTSD and suicide attempts, which are central to our study. The NESARC-III was sponsored by the National Institute on Alcohol Abuse and Alcoholism (NIAAA); the fieldwork was conducted by Westat (Rockville, MD). Through a multistage probability sample design, a total of 36,309 respondents completed the face-to-face Alcohol Use Disorder and Associated Disabilities Interview Schedule, *DSM-5* Version (AUDADIS-5) interview—a fully structured, computer-assisted diagnostic interview designed for trained lay interviewers [39, 40]. The response rate of NESARC-III was 60.1%, comparable to most current U.S. national health surveys [41, 42].

For the preliminary analysis, the full NESARC-III sample was selected to examine the association between PTSD diagnoses and suicide attempts in the lifetime, as was a subsample of 23,936 respondents (2457 veterans and 21,479 non-veterans) who reported at least one trauma event in their lifetime. For the final analysis, the subsample was used to investigate the factor structure of PTSD and the associations with suicide attempts and mediating psychiatric disorders.

Measures

Suicide attempts

Lifetime suicide attempts were the distal outcome in our study. In the medical conditions section, NESARC-III asked respondents whether they had ever attempted suicide. In addition, in two separate sections on mood disorders for depression (low mood) and mania (high mood), it asked 35% of respondents who ever had a period of low mood and 4% of respondents who ever had a period of high mood whether they attempted suicide or tried to kill themselves. In our study, a positive response to any of these questions denotes having a suicide attempt in the lifetime.

PTSD symptoms and criteria

The NESARC-III assessed PTSD on a lifetime basis using AUDADIS-5, which queried respondents about 34 types of traumatic experiences that operationalize *DSM-5* Criterion A [43], including 20 types that they experienced and 14 types that they personally witnessed happening to others, learned about, or were repeatedly exposed to. Respondents endorsing at least one event type (i.e., Criterion-A sample) were further asked 33 questions about their reactions after experiencing their worst traumatic or stressful event. These questions operationalize 20 PTSD symptoms for *DSM-5* Criteria B–E, including 5 for criterion B (intrusion), 2 for criterion C (avoidance), 7 for criterion D (change in cognition/mood), and 6 for criterion E (change in arousal/activity). Because the NESARC-III was developed during the transition from *DSM-IV* to *DSM-5*, the requisite number of symptoms for PTSD Criteria D and E in AUDAIS-5 is 3 or more, as opposed to 2 or more required by *DSM-5* [44], resulting in a more narrowly defined PTSD diagnosis than the current *DSM-5* one. For comparison, a broadly defined PTSD diagnosis in accord with the requirements of *DSM-5* Criteria A–E but with no consideration for Criteria F (duration ≥1 month) and G (≥1 impairment or distress item endorsed) also was proposed. Reliability and validity of the AUDADIS-5 PTSD are substantial [45, 46].

Other selected psychiatric disorders

Selected *DSM-5* lifetime diagnoses of psychiatric disorders, as assessed by AUDADIS-5, were hypothesized as intermediary variables in this study, including major depressive disorder (MDD), bipolar 1 disorder, any anxiety disorder (i.e., specific phobia, social phobia, panic disorder, agoraphobia, and generalized anxiety disorder), borderline personality disorder, and antisocial personality disorders (ASPDs). Consistent with *DSM-5*, all these diagnoses excluded substance- and medical illness-induced disorders. In addition, mediating SUDs included alcohol use disorder (AUD), tobacco use disorder, and any drug use disorder (i.e., sedative, cannabis, opioid, cocaine, stimulant, hallucinogen, inhalant/solvent, club drug, heroin, and other drug use disorders). The AUDADIS-5 measures of psychiatric disorders generally have good reliability and validity [46, 47].

Covariates

Covariates included the following: age group (18–29, 30–44, 45–64, 65+); sex (male, female); race/ethnicity (non-Hispanic White, non-Hispanic Black, non-Hispanic American Indian/Alaska Native, non-Hispanic Asian/Native Hawaiian/Pacific Islander, Hispanic); education

(less than high school, high school or GED, some college, college or above); marital status (never married, married, widowed/divorced/separated); family income (<$20,000, $20,000–$34,999, $35,000–$69,999, ≥$70,000); and veteran status (i.e., ever served on active duty in the U.S. armed forces, reserves or national guard) (yes or no).

Additional covariates included in a post hoc sensitivity analysis were lifetime war-related trauma (yes, no); number of traumatic events in life (0, 1, 2, 3, 4+); before age 18, a parent/other adult living in home attempted or committed suicide (yes, no); sexual abuse before age 18 (yes, no); and sexual abuse as an adult (yes, no). These covariates were not included in the main analysis for predicting lifetime suicide attempts to avoid the potential redundancy or multicollinearity with PTSD or PTSD domains.

Analytic plan

In a preliminary step, probit regression, as well as logistic regression, was used to identify potential risk factors and covariates for suicide attempts, including broadly and narrowly defined PTSD diagnoses separately as risk factors. The same model specification was applied to the full sample as well as to the Criterion-A sample that ever had a traumatic event.

The final analysis used the Criterion-A sample to evaluate the proposed exploratory bifactor hybrid model in explaining the correlations among the 20 PTSD symptoms, which were considered factor indicators of the 8 PTSD latent factors, including 1 general and 7 specific factors. The exploratory bifactor hybrid model was based on ESEM, an approach to structural equation modeling that integrates exploratory factor analysis (EFA) with the CFA measurement model part such that every factor indicator is loaded on every factor, avoiding the requirement of specifying zero cross-loadings in CFA [48, 49]. We employed an orthogonal target rotation [50] to specifically match the factor structure of specific factors to the simple structure of the 7-factor CFA hybrid model. The orthogonality assumption ensures that the factors are uncorrelated. Although the target rotation similarly specifies certain factor loadings to be 0 in advance, the corresponding elements of the rotated factor pattern matrix are only made as close to the specified zeros as possible. This is in contrast to forcing specific factor loadings to be 0 by CFA. In that respect, the target rotation is preferable to CFA, because misspecified zeros can be easily detected when the discrepancies are large [50]. Our bifactor model extends the hybrid model by introducing a general factor, which is in addition to and uncorrelated with the specific factors [51].

The exploratory bifactor hybrid model was estimated using a robust, weighted, least-squares estimator with a diagonal weight matrix (WLSMV) and theta parameterization. Model fit indices used to assess goodness of fit to the data included comparative fit index (CFI), Tucker–Lewis index (TLI), and root mean square error approximation (RMSEA). The following cutoff values were used as an indication of good fit: CFI or TLI >0.95; RMSEA <0.06 [52, 53]. The exploratory bifactor hybrid model was compared with the 7-factor CFA hybrid model and other CFA models evaluated by Armour and colleagues [16], such as *DSM-5*, dysphoria [12, 13], dysphoric arousal [13, 14], externalizing behaviors [14], and anhedonia [13], using the Chi-square difference tests [54].

Given that the 7-factor CFA hybrid model was originally tested in a veteran sample [16], we tested measurement invariance (configural invariance versus metric/scalar invariance) between veterans and non-veterans in a multiple-group analysis framework. Configural invariance has factor loadings and thresholds free across groups, residual variances fixed at 1 in both groups, and factor means fixed at 0 in both groups. By comparison, metric/scalar invariance has factor loadings and thresholds constrained to be equal across groups, residual variances fixed at 1 in one group and free in the other group, and factor means fixed at 0 in one group and free in the other group.

The final ESEM bifactor model, presented in Fig. 1, is a full-blown mediating model in which the distal outcome (i.e., suicide attempts) is predicted by latent factors (i.e., PTSD general and PTSD-specific factors), which are predictive of PTSD symptoms; the intermediary variables (i.e., selected psychiatric disorders) are predicted by latent factors but are predictive of the distal outcome; and the distal outcome, intermediary variables, and latent factors are further predicted by the covariates. Post hoc sensitivity analyses, excluding all covariates or including additional covariates, assessed the robustness of the associations between suicide attempts and PTSD latent factors.

All analyses were conducted using Mplus 7 [55], a latent variable modeling program that takes into account the complex survey design for parameter estimation, standard errors, and model fit calculations. For all statistical tests, a two-tailed p value <0.05 was considered statistically significant.

Results

Preliminary results based on probit and logistic regression from the model that predicted suicide attempts by either the broadly or narrowly defined PTSD diagnosis and by selected covariates and mediating psychiatric disorders were provided as Supplemental Tables 1–2 online. Overall, the preliminary results justified the inclusion of covariates and mediating psychiatric disorders in our final analysis, given that all of the selected psychiatric disorders,

as well as the broadly and narrowly defined PTSD diagnoses, were found to be significant risk factors for suicide attempts. Interestingly, when a PTSD diagnosis was taken into account, veteran status was not a significant predictor for suicide attempts.

Model fit indices show that the proposed exploratory bifactor hybrid model fits the NESARC data extremely well, although the CFA models examined in this study also fit the data more than adequately. Model comparisons based on Chi-square difference tests affirm that the proposed exploratory bifactor hybrid model outperforms all the competing CFA models (Supplemental Table 3). The measurement invariance test indicates no significant difference between veterans and non-veterans in thresholds and factor loadings for the null metric/scalar invariance against the alternative configural invariance (Supplemental Table 4). Because of measurement invariance, we included veteran status as a covariate in the subsequent analyses instead of presenting a separate set of analyses for veterans only.

Tables 1, 2, 3, and 4 show the final ESEM bifactor model. Even with covariates, the model fits the data very well according to the fit indices ($\chi^2 = 764.725$; $df = 398$; CFI = 0.998; TLI = 0.996; RMSEA [95% CI] = 0.006 [0.006, 0.007]). Table 1 presents the standardized probit coefficients for the PTSD factor structure, the measurement part of the ESEM model. The standardized probit regression coefficients reflect the underlying tendency (i.e., latent variables with a standard normal distribution) toward the outcomes. All the PTSD latent factors are uncorrelated with one another, with the variance fixed at 1 and mean fixed at 0. The thresholds reflect the probabilities of endorsing symptoms, with higher thresholds indicating lower endorsement. On the whole, factor loadings are in line with our specification of target rotation. The factor loadings of the general factor (G) are significant and large across the 20 PTSD symptoms, reaffirming the general factor as a single dominant latent trait that accounts for the common variance among symptom responses. The specific factors retain their

Table 1 Exploratory structural equation model for PTSD, mediating psychiatric disorders, and suicide attempts, adjusting for selected covariates: PTSD factor structure ($N = 23{,}936$)

Symptom	Standardized threshold	Standardized factor loadings							
		G	R	A	NA	An	EB	AA	DA
1. Intrusive thoughts	0.205**	0.749**	0.545**	0.050**	0.069**	−0.127**	−0.054**	−0.050**	0.033
2. Nightmares	1.359**	0.710**	0.585**	−0.027*	−0.073**	0.031	0.020	−0.002	0.001
3. Flashbacks	1.352**	0.768**	0.527**	−0.021	−0.041**	0.002	−0.029*	0.035**	−0.019
4. Emotional cue reactivity	1.170**	0.775**	0.301**	0.242**	0.050**	−0.038*	−0.027*	0.010	0.000
5. Physiological cue reactivity	1.614**	0.773**	0.306**	0.120**	0.000	−0.030	0.001	0.087**	0.060**
6. Avoidance of thoughts	1.263**	0.753**	0.139**	0.490**	0.030**	−0.082**	−0.002	−0.030*	−0.051**
7. Avoidance of reminders	1.453**	0.804**	0.080**	0.517**	0.042**	−0.025	−0.006	−0.027*	−0.083**
8. Trauma-related amnesia	1.623**	0.658**	0.052**	0.097**	0.052*	0.071*	0.007	−0.005	−0.011
9. Negative beliefs	1.285**	0.857**	0.006	−0.052**	0.052**	0.123**	0.024	0.024	0.040*
10. Blame of self or others	0.970**	0.706**	−0.024*	0.071**	0.511**	0.017	0.001	0.169**	−0.283**
11. Negative trauma-related emotions	1.128**	0.890**	−0.013	−0.004	0.263**	0.046*	−0.037**	0.076**	−0.014
12. Loss of interest	1.658**	0.867**	−0.031**	−0.050**	−0.038*	0.151**	−0.009	−0.132**	0.250**
13. Detachment	1.811**	0.891**	−0.057**	−0.033*	0.018	0.365**	0.078**	−0.129**	0.019
14. Restricted affect	1.904**	0.899**	−0.102**	−0.080**	0.069**	0.413**	0.064**	−0.098**	−0.081**
15. Irritability/anger	2.088**	0.856**	−0.069**	−0.018	−0.051*	0.195**	0.211**	0.021	0.016
16. Self-destructive/reckless behavior	2.269**	0.794**	−0.052**	0.000	0.006	0.027	0.489**	−0.009	−0.052**
17. Hypervigilance	1.280**	0.757**	−0.024	−0.019	0.251**	−0.160**	0.010	0.412**	−0.021
18. Exaggerated startle response	1.924**	0.814**	0.072**	−0.050**	0.009	−0.108**	−0.009	0.415**	0.139**
19. Difficulty concentrating	1.614**	0.896**	−0.030**	−0.065**	−0.167**	0.006	−0.006	0.075**	0.499**
20. Sleep disturbance	1.481**	0.852**	0.095**	−0.081**	−0.134**	0.016	−0.043**	0.028*	0.439**

Covariates include age group, sex, race/ethnicity, education, marital status, family income, veteran status, lifetime *DSM-5* major depressive disorder (hierarchical), lifetime DSM-5 bipolar 1 disorder (hierarchical), any lifetime *DSM-5* anxiety disorder, *DSM-5* borderline personality disorder, *DSM-5* antisocial personality disorder, lifetime DSM-5 alcohol use disorder, lifetime *DSM-5* tobacco use disorder, and lifetime *DSM-5* drug use disorder

G general factor, *R* re-experiencing, *A* avoidance, *NA* negative affect, *An* anhedonia, *EB* externalizing behaviors, *AA* anxious arousal, *DA* dysphoric arousal. *Chi square* 764.725, *df* 398, *CFI* 0.998, *TLI* 0.996, *RMSEA [95% CI]* 0.006 [0.006, 0.007]

*$p < 0.05$; ** $p < 0.01$

Table 2 Exploratory structural equation model for PTSD, mediating psychiatric disorders, and suicide attempts, adjusting for selected covariates: regression of suicide attempts on mediating psychiatric disorders and PTSD general and PTSD-specific factors ($N = 23{,}936$)

	Suicide attempts
Lifetime *DSM-5* major depressive disorder	0.249
Lifetime *DSM-5* bipolar 1 disorder	−0.134
Any lifetime *DSM-5* anxiety disorder	−0.095
DSM-5 borderline personality disorder	−0.068
DSM-5 antisocial personality disorder	0.156
Lifetime *DSM-5* alcohol use disorder	0.243
Lifetime *DSM-5* tobacco use disorder	0.243
Lifetime *DSM-5* drug use disorder	0.342
PTSD latent factors	
G = general factor	0.208
R = re-experiencing	0.032
A = avoidance	0.076
NA = negative affect	−0.396
An = anhedonia	0.817
EB = externalizing behaviors	−0.271
AA = anxious arousal	0.340
DA = dysphoric arousal	−0.385

Covariates include age group, sex, race/ethnicity, education, marital status, family income, veteran status, lifetime *DSM-5* major depressive disorder (hierarchical), lifetime *DSM-5* bipolar 1 disorder (hierarchical), any lifetime *DSM-5* anxiety disorder, *DSM-5* borderline personality disorder, *DSM-5* antisocial personality disorder, lifetime *DSM-5* alcohol use disorder, lifetime *DSM-5* tobacco use disorder, and lifetime *DSM-5* drug use disorder

intended meanings that the factor loadings are significantly different from zeros for symptoms 1–5 (intrusive thoughts, nightmares, flashbacks, emotional cue reactivity, physiological cue reactivity) on the re-experiencing (R) factor, for symptoms 6 and 7 (avoidance of thoughts, avoidance of reminders) on the avoidance (A) factor, for symptoms 8–11 (trauma-related amnesia, negative beliefs, blame of self or others, negative trauma-related emotions) on the negative affect (NA) factor, for symptoms 12–14 (loss of interest, detachment, restricted affect) on the anhedonia (An) factor, for symptoms 15 and 16 (irritability/anger, self-destructive/reckless behavior) on the externalizing behaviors (EB) factor, for symptoms 17 and 18 (hypervigilance, exaggerated startle response) on the anxious arousal (AA) factor, and for symptoms 19 and 20 (difficulty concentrating, sleep disturbance) on the dysphoric arousal (DA) factor. The factor loadings on the negative affect (NA) factor, however, are close to 0 for symptoms 8 and 9 (trauma-related amnesia, negative beliefs). Although some of the specified zeros may be significantly different from zeros, the differences tend to be small, aside from a few cross-loadings. Notably, symptom 12 (loss of interest) is cross-loaded on both the anhedonia (An) and dysphoric arousal (DA) factors; symptom 15 (irritability/anger) is cross-loaded on both the anhedonia (An) and externalizing behaviors (EB) factors; and symptom 17 (hypervigilance) is cross-loaded on the negative affect (NA) and anxious arousal (AA) factors.

The standardized probit coefficients for the structure part of the ESEM model are presented in Tables 2 and 3. Table 2 shows the effects of PTSD latent factors and intermediary variables (i.e., other psychiatric disorders) on suicide attempts. None of these predictors significantly predicts suicide attempts. Table 3 shows the effects of PTSD latent factors on intermediary variables. Among these PTSD latent factors, only the general factor (G) shows significant, positive associations with all intermediary variables. For specific PTSD factors, the associations with intermediary variables vary. The re-experiencing (R) factor is significantly associated with MDD, anxiety disorders, ASPD, AUD, and tobacco use disorder. The avoidance (A) and dysphoric arousal (DA) factors are significantly associated with all but ASPD. The negative affect (NA) factor is significantly associated with all but bipolar 1 disorder. The anhedonia (An) factor is significantly associated with all but AUD, tobacco use disorder, and any drug use disorder. The externalizing behaviors (EB) factor is significantly associated with all but MDD. The anxious arousal (AA) factor is positively associated with bipolar 1 disorder, anxiety disorder, borderline personality disorder, and ASPD.

Table 4 summarizes the total, direct, and indirect effects of the PTSD latent factors. The indirect effects are decomposed according to the paths of mediation. As has been noted, none of the PTSD latent factors has a significant, direct effect on suicide attempts. Further, the total indirect effect on suicide attempts is not significant, either. Nevertheless, the total effect on suicide attempts is significant for the general (G), anhedonia (An), externalizing behaviors (EB), and anxious arousal (AA) factors.

Discussion

To our knowledge, this is the first study to propose using the exploratory bifactor hybrid model to characterize the factor structure of *DSM-5* PTSD in the general population based on a large, nationally representative sample of U.S. adults who have ever experienced a traumatic or stressful life event. It has provided empirical evidence to support this model by showing a superior fit to the data. The factor structure of PTSD is measurement invariant across veterans and non-veterans and is validated by significant associations of PTSD dimensionality with selected psychiatric disorders and suicide attempts.

The findings confirm that PTSD is a risk factor for suicide attempts. Among people who have experienced a traumatic event, those who score higher on the general factor

Table 3 Exploratory structural equation model for PTSD, mediating psychiatric disorders, and suicide attempts, adjusting for selected covariates: regression of mediating psychiatric disorders on PTSD general and PTSD-specific factors ($N = 23{,}936$)

PTSD latent factor	Lifetime *DSM-5* major depressive disorder	Lifetime *DSM-5* bipolar 1 disorder	Any lifetime *DSM-5* anxiety disorder	*DSM-5* borderline personality disorder	*DSM-5* antisocial personality disorder	Lifetime *DSM-5* alcohol use disorder	Lifetime *DSM-5* tobacco use disorder	Lifetime *DSM-5* drug use disorder
G = general factor	0.367**	0.432**	0.438**	0.533**	0.342**	0.229**	0.210**	0.291**
R = re-experiencing	0.101**	0.060	0.084**	0.020	0.059*	0.042*	0.053**	−0.008
A = avoidance	0.094**	0.171**	0.178**	0.122**	0.022	0.067**	0.055*	0.077**
NA = negative affect	0.362**	0.001	0.209**	0.243**	0.266**	0.378**	0.389**	0.449**
An = anhedonia	0.539**	0.466**	0.560**	0.653**	0.209**	−0.136	−0.129	−0.126
EB = externalizing behaviors	−0.039	0.549**	0.181**	0.471**	0.531**	0.690**	0.601**	0.688**
AA = anxious arousal	−0.035	0.285**	0.171**	0.249**	0.089*	−0.051	−0.042	−0.054
DA = dysphoric arousal	0.417**	0.164*	0.407**	0.240**	0.051	0.299**	0.260**	0.328**

Covariates include age group, sex, race/ethnicity, education, marital status, family income, veteran status, lifetime *DSM-5* major depressive disorder (hierarchical), lifetime *DSM-5* bipolar 1 disorder (hierarchical), any lifetime *DSM-5* anxiety disorder, *DSM-5* borderline personality disorder, *DSM-5* antisocial personality disorder, lifetime *DSM-5* alcohol use disorder, lifetime *DSM-5* tobacco use disorder, and lifetime *DSM-5* drug use disorder

*$p < 0.05$, **$p < 0.01$

Table 4 Exploratory structural equation model for PTSD, mediating psychiatric disorders, and suicide attempts, adjusting for selected covariates: total, direct, and indirect effects of PTSD general and PTSD-specific factors on suicide attempts ($N = 23{,}936$)

	PTSD general and PTSD-specific factors							
	G	R	A	NA	An	EB	AA	DA
Total effect on suicide attempts	0.423**	0.069	0.110	0.040	0.716*	0.229*	0.233*	−0.102
Direct effect on suicide attempts	0.208	0.032	0.076	−0.396	0.817	−0.271	0.340	−0.385
Total indirect effect on suicide attempts via	0.215	0.037	0.035	0.436	−0.101	0.500	−0.107	0.283
Lifetime *DSM-5* major depressive disorder	0.091	0.025	0.023	0.090	0.134	−0.010	−0.009	0.104
Lifetime *DSM-5* bipolar 1 disorder	−0.058	−0.008	−0.023	0.000	−0.063	−0.074	−0.038	−0.022
Any lifetime *DSM-5* anxiety disorder	−0.042	−0.008	−0.017	−0.020	−0.053	−0.017	−0.016	−0.039
DSM-5 borderline personality disorder	−0.036	−0.001	−0.008	−0.016	−0.044	−0.032	−0.017	−0.016
DSM-5 antisocial personality disorder	0.053	0.009	0.003	0.041	0.033	0.083	0.014	0.008
Lifetime *DSM-5* alcohol use disorder	0.056	0.010	0.016	0.092	−0.033	0.168	−0.012	0.073
Lifetime *DSM-5* tobacco use disorder	0.051	0.013	0.013	0.095	−0.031	0.146	−0.010	0.063
Lifetime *DSM-5* drug use disorder	0.100	−0.003	0.026	0.154	−0.043	0.236	−0.018	0.112

Covariates include age group, sex, race/ethnicity, education, marital status, family income, veteran status, lifetime *DSM-5* major depressive disorder (hierarchical), lifetime *DSM-5* bipolar 1 disorder (hierarchical), any lifetime *DSM-5* anxiety disorder, *DSM-5* borderline personality disorder, *DSM-5* antisocial personality disorder, lifetime *DSM-5* alcohol use disorder, lifetime *DSM-5* tobacco use disorder, and lifetime *DSM-5* drug use disorder

G general factor, *R* re-experiencing, *A* avoidance, *NA* negative affect, *An* anhedonia, *EB* externalizing behaviors, *AA* anxious arousal, *DA* dysphoric arousal

*$p < 0.05$; **$p < 0.01$

of PTSD are at significantly higher risk for attempting suicide, primarily because of their higher risk for mediating psychiatric disorders; however, those who score high on the specific factors may only have disparate degrees of risk. Because our bifactor model includes a general factor that taps all PTSD symptoms, the seven specific factors account for only the remaining symptom correlations and may not be directly comparable to the seven factors from the CFA hybrid model. For example, in addition to two symptoms (difficulty concentrating and sleep disturbance), our dysphoric arousal factor also taps loss of interest; all these symptoms reflect dysphoria in the dysphoria model [12]. Negative beliefs symptoms are loaded more on our anhedonia than negative affect factor, although both factors originate from the negative alterations in cognitions and mood factor in the 4-factor *DSM-5* model. In contrast to the CFA hybrid model, where negative affect, anhedonia, and externalizing behaviors have been shown to be positively and avoidance has been shown to be negatively related to suicidal ideation [17], our ESEM bifactor model reveals that anxious arousal, as well as anhedonia and externalizing behaviors, has a significant total effect on suicide attempts. Among these specific PTSD factors, anhedonia has the largest total effect on suicide attempts; the large total effect is disproportionally driven by the direct effect; and the magnitude is considerably larger than that of the general factor. Given that anhedonia was found to be strongly related to current depression, reduced mental functioning, and poor quality of life [17], anhedonia may indeed play a role in increased risk for suicide attempts.

Our use of the bifactor modeling is relatively novel in the PTSD literature, but it has been increasingly used in psychiatric research [56–61]. Although EFA has attracted sharp criticism in the field of PTSD research where CFA has been predominately used to study the factor structure of PTSD [62], our ESEM bifactor model cannot be indiscriminately criticized as data fishing, since it was built upon the recently proposed 7-factor hybrid model [22], which is unquestionably theory based and empirically tested. Conversely, researchers in the personality assessment community note the problem of the seemingly endless CFA studies in handling structure ambiguity for psychological measures that often result in item response data that are consistent with both unidimensional and multidimensional latent structures and thus advocate bifactor models with rotations as an alternative to the more commonly observed unidimensional, correlated-traits, or second-order representations of the latent structure [38]. Of note, the ESEM bifactor modeling has been used to study personality traits [63] and to assess the common unidimensionality assumption of item response theory (IRT) for quality-of-life item banks [64]. Reviewing 40 PTSD studies that used a *DSM*-based measure to assess PTSD severity, a meta-analytic CFA study [65] called for more research into the high-order and bifactor versions of the PTSD models, given the importance of such comparisons to the understanding of the relations among symptom groupings of this psychological construct. Accordingly, our proposed ESEM bifactor hybrid model for PTSD is valid and timely, especially against a backdrop of rising rates of PTSD [66] and suicide [67].

This study has several limitations. First, even though suicidality typology proposed by Conner and colleagues [34] involved different suicidal pathways including the presence of ideation, making plans for suicide, and suicide attempts, we only examined suicide attempts in this study because data on planning for suicide were not available from NESARC-III and suicidal ideation was not asked of all respondents but a small subset of respondents in the context of their low and high moods during a period in their lives. Second, the measure of suicide attempt in this study was based on the standalone question from the medical conditions section, supplemented by additional questions from the low/high moods sections. The additional cases of suicide attempts were ascertained as a result of the inconsistency that about 13% of individuals who reported suicide attempts in response to the two questions from the low/high mood sections reported no such incident in the medical condition section. The multiple questions from NESARC-III on suicidality, however, did not assess contextual factors and other characteristics of suicide attempts, thereby obscuring several important features of outcome (e.g., lethality, modality, possibility of intervention by others or poor planning, intent to die, likelihood of being rescued). Despite the absence of many confounding factors, the analysis of self-reported suicide attempts is an important area for research. Third, diagnoses of psychiatric disorders were based on structured interviews by lay interviewers. Although these diagnoses were informed by *DSM-5*, the retrospective self-reports were not real clinical assessments and were subject to interpretation or recall bias. Fourth, the cross-sectional NESARC data and the use of lifetime measures in our study precluded any causal inferences, even though directionality was specified in our model. Finally, post hoc sensitivity analyses suggested that the association between PTSD latent factors and suicide attempts depended on the covariates included in the models. When no covariates were included, the total effects on suicide attempts were significant for all the specific factors except anhedonia, externalizing behaviors, and anxious arousal. These are contrary to our presented findings and are more consistent with a previous NESARC Wave 2 study which found that among *DSM-IV* PTSD symptoms clusters, only re-experience and avoidance were significantly associated with suicide attempts [68]. By contrast, when additional covariates were included, none

of the PTSD-specific factors had significant total effects on suicide attempts. Only the PTSD general factor was robust against the change of covariates and consistently remained significant.

In conclusion, findings from this national study have validated the recently proposed 7-factor hybrid model in the U.S. general population and have provided strong support for the use of the ESEM bifactor model to characterize the factor structure of PTSD. The bifactor model preserves the multidimensional clinical features of the PTSD where parcels of symptom items tap similar domains, and it further identifies one single, unidimensional general factor that is more appealing to practitioners and psychometricians. The explained common variance (ECV), the ratio of the common variance explained by the general factor divided by the total common variance [69], is about 76%. The identification of one dominant general factor of PTSD supports PTSD as an independent psychiatric disorder and helps define PTSD severity in clinical practice and for etiologic research. Even though *DSM-5* does not provide specific guidelines for PTSD severity, the number of positive symptoms may offer a useful measure of severity for clinicians to monitor treatment progress. The IRT-derived estimates of PTSD severity in particular are important for future studies. Accurate measurements of PTSD severity have implications for treatment efforts and the prevention of suicide behavior, particularly given that longitudinal measurements of symptom severity are the essential component of measurement-based care, which is effective and has been advocated to enhance treatment [70]. Alternatively, the identification of specific factors of PTSD may reflect the multidimensional phenotypes of PTSD but may also inform future revisions of *DSM-5* symptom items. For example, the original seven hybrid factors include four factors (avoidance, externalizing behaviors, anxious arousal, and dysphoric arousal) that tap only two symptom items. These factors may reflect overlapping in similar items that are subject to elimination but may also reflect over-extraction of factors. Further studies using bifactor IRT analysis are required to calibrate symptom items for PTSD. Although several hierarchical versions of PTSD models have been proposed in the literature [15], more studies are needed to examine the second-order general factor that directly accounts for the high interfactor correlations among the specific factors in the hierarchical version of the hybrid model, compared with the first-order general factor that directly accounts for the high correlations among the symptom items in our bifactor model. Finally, replications of the present findings in other general population studies will further enhance our understanding of PTSD dimensionality in developing other psychiatric disorders and increasing suicide attempts.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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