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Publication Date

2021-04-01

DOI

10.1016/j.jad.2021.01.086

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Author manuscript

J Affect Disord. Author manuscript; available in PMC 2022 April 01.

Published in final edited form as:

J Affect Disord. 2021 April 01; 284: 75–84. doi:10.1016/j.jad.2021.01.086.

Understanding Trajectories of Underlying Dimensions of Posttraumatic Psychopathology

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Abstract

Background: Research suggests four modal trajectories of psychological symptoms after traumatic injury: *Resilient, Chronic, Delayed Onset, Recovery*. However, most studies focus on symptoms of psychiatric disorders (e.g., posttraumatic stress disorder, depression), which are limited by heterogeneity and symptom overlap. We examined trajectories of cross-cutting posttraumatic symptom dimensions following traumatic injury and predictors of trajectory membership.

Methods: In this longitudinal study of 427 predominantly Hispanic/Latino traumatic injury survivors, posttraumatic psychopathology symptoms were assessed during hospitalization and approximately one and five months post-trauma. Using latent class growth analysis, we estimated trajectories of several posttraumatic symptom dimensions: re-experiencing, avoidance, anxious arousal, numbing, dysphoric arousal, loss, and threat. We then examined sociodemographic and trauma-related characteristics (measured during hospitalization) as predictors of trajectory membership for each dimension.

Results: Four trajectories (*Resilient, Chronic, Delayed Onset, Recovery*) emerged for all dimensions except loss and threat, which manifested three trajectories (*Resilient, Chronic, Delayed Onset*). Across dimensions, membership in the *Chronic* (vs. *Resilient*) trajectory was consistently predicted by unemployment (7 of 7 dimensions), followed by older age (3/7), female sex (3/7), and assaultive trauma (2/7). For several dimensions, unemployment also distinguished

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Conflicts of Interest

All authors declare that they have no conflicts of interest.

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between participants who presented with similar symptom levels days after trauma, but then diverged over time.

Limitations: Measures of posttraumatic symptom dimension constructs differed across assessments.

Conclusions: This study provides evidence of distinct trajectories across transdiagnostic symptom dimensions after traumatic injury. Employment status emerged as the most important predictor of trajectory membership. Research is needed to better understand the etiologies and consequences of these posttraumatic symptom dimension trajectories.

Keywords

trauma; posttraumatic psychopathology; symptom dimension; trajectory

Introduction

Each year in the United States, approximately 30 million individuals present to emergency departments for traumatic injuries resulting from incidents including motor vehicle accidents, assaults, and gunshot wounds, with nearly 3 million hospitalized (Center for Disease Control and Prevention, 2018). For these patients, the ramifications of traumatic injury rarely end once the physical wounds heal. Psychological distress is common after these experiences, and it manifests in various ways that often persist long after the injury (deRoon-Cassini et al., 2019). Posttraumatic stress disorder (PTSD) is the quintessential trauma-related mental disorder; other common adverse psychological responses to traumatic injury include depression and anxiety (deRoon-Cassini et al., 2019; deRoon-Cassini et al., 2010; Shih et al., 2010; Zatzick et al., 2007). The emotional sequelae of traumatic injury have important consequences for patients' health and functioning, as persistent psychological distress is associated with worse general health, greater disability, and lower quality of life (deRoon-Cassini et al., 2019; Haagsma et al., 2012; Holbrook et al., 1998; O'Donnell et al., 2005).

Given the significant mental health impact of traumatic injury and its consequences for long-term functioning, the American College of Surgeons Committee on Trauma (2018) has recommended mental health risk screening among injury survivors. The task of assessing psychopathology risk after trauma is complicated by the substantial variability in who develops posttraumatic psychopathology and how it manifests over time. A large body of work has identified distinct trajectories of emotional distress after trauma, including traumatic injury. Although most individuals are resilient after trauma and experience minimal impact on their emotional health, others exhibit chronic elevations in symptoms of PTSD, depression, and/or anxiety, gradual recovery of symptoms, or delayed onset of symptoms (Bonanno et al., 2012; Bryant et al., 2015; deRoon-Cassini et al., 2010; Galatzer-Levy et al., 2018; Lowe et al., 2020; Osenbach et al., 2014; Ravn et al., 2019). Given the heterogeneity in emotional responses to trauma, being able to predict who is likely to develop lasting symptoms of psychopathology—especially early after traumatic injury—is critical for allocating finite resources in a targeted manner.

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To date, research aimed at understanding risk for posttraumatic psychopathology after traumatic injury has focused on symptoms of distinct psychiatric diagnostic entities, such as PTSD or depression, an approach with limitations. For one, diagnostic categories are clinically heterogeneous (Clark et al., 1995; Hyman, 2010). A PTSD diagnosis, for example, can reflect 636,120 symptom combinations (Galatzer-Levy & Bryant, 2013). Different symptom presentations may result from distinct biological processes, but these various mechanisms are not considered when all manifestations are included under a single diagnostic umbrella (Casey et al., 2013). Furthermore, many posttraumatic psychiatric diagnoses have overlapping symptoms; for example, loss of interest and sleep disturbance are symptoms of PTSD and depression. Comorbid diagnoses are thus the norm rather than the exception (Breslau, 2009; deRoon-Cassini et al., 2010; Kessler et al., 1995), calling into question the validity of distinct diagnostic entities (Clark et al., 1995; Hyman, 2010). This conundrum has prompted many researchers to advocate for dimensional approaches to defining psychopathology (Casey et al., 2013; Clark et al., 1995; Cuthbert & Insel, 2013).

Growing research in posttraumatic psychopathology suggests that discrete and more homogeneous dimensions, which align more closely with underlying biological mechanisms, underlie several traditional psychiatric diagnoses (Armour et al., 2016; Casey et al., 2013; Forbes et al., 2010; McLean et al., 2019). Focusing on these transdiagnostic dimensions is consistent with the National Institute of Mental Health (NIMH) Research Domain Criteria (RDoC) framework for studying dimensions of functioning that cut across mental disorder diagnoses and can be linked to disrupted neurobiological processes (Cuthbert, 2014; Cuthbert & Insel, 2013). Examining the latent structure of PTSD, symptom dimensions of re-experiencing, avoidance, numbing, anxious arousal, and dysphoric arousal have been identified after trauma (Armour et al., 2016; Elhai et al., 2011). This five-factor dysphoric arousal model emerged as the best-fitting model in a review of over 100 studies examining the underlying structure of PTSD (Armour et al., 2016). Dimensions of loss (e.g., dysphoria) and threat (e.g., anxiety) have also been proposed in RDoC as key dimensions of psychopathology, and they are relevant to manifestations of posttraumatic psychopathology, including symptoms of depressive and anxiety disorders (Cuthbert & Insel, 2013).

Examining underlying symptom dimensions circumvents issues of symptom overlap between psychiatric diagnoses. Furthermore, these dimensions have unique correlates in trauma-exposed individuals. Numbing, for example, has been uniquely linked to problematic substance use and poor mental health (Sumner et al., 2014; Tsai et al., 2015), and dysphoric arousal to interpersonal conflict (Sumner et al., 2014). However, as trajectory analyses in traumatic injury patients have only focused on symptoms of psychiatric diagnoses, research has yet to consider predictors of trajectories across different symptom dimensions. Given the more homogeneous nature of posttraumatic symptom dimensions and their potentially distinct etiologies and consequences, predicting trajectories of these different dimensions may yield important insights for the pathophysiology and treatment of posttraumatic distress.

In this investigation, we harnessed data from a predominantly male, Hispanic/Latino sample of traumatic injury survivors presenting to a Level 1 trauma center. The longitudinal design of the parent study examining salivary biomarkers of posttraumatic psychopathology

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allowed us to examine how trajectories of underlying dimensions of posttraumatic psychopathology manifested after traumatic injury. Using information on posttraumatic psychopathology symptoms assessed during hospitalization and approximately one and five months after injury, we investigated trajectories of the following cross-cutting symptom dimensions: re-experiencing, avoidance, numbing, dysphoric arousal, anxious arousal, loss, and threat. Based on research on emotional distress trajectories after traumatic injury, we hypothesized that we would identify resilient, chronic, delayed onset, and recovery trajectories (Bonanno & Mancini, 2012; Galatzer-Levy et al., 2018). Examining trajectories of these posttraumatic symptom dimensions in a predominantly Hispanic/Latino sample is particularly notable given some evidence of ethnic disparities in manifestations of posttraumatic psychopathology, with Hispanic/Latino individuals reporting distinctive patterns of greater distress (Galea et al., 2004; Marshall et al., 2009).

As our second aim, we examined predictors of trajectories of underlying dimensions of posttraumatic psychopathology. We considered several sociodemographic and trauma-related characteristics that have been associated with trajectories based on symptoms of psychiatric disorders, including female sex, minority race/ethnicity, indicators of low socioeconomic status, and assaultive trauma (Brewin et al., 2000; Bryant et al., 2015; Lowe et al., 2020). In addition to comparing the resilient and chronic trajectories, we focused on patients who appeared similar in terms of their initial distress but then diverged over time (e.g., Lowe et al., 2020). Specifically, we sought to identify factors that distinguished the chronic and recovery trajectories, and the delayed onset and resilient trajectories.

Methods

Participants and Procedure

Participants were English or Spanish-speaking adult trauma patients treated between January 2014 and June 2018 at the Los Angeles County/University of Southern California Medical Center (LAC-USC), an urban Level 1 trauma center. Eligible participants were identified by the trauma care team and confirmed by research staff. Written informed consent was obtained using procedures approved by LAC-USC's Institutional Review Board. Participants were excluded if they had a grievous injury, required multiple restorative surgeries, and/or were medically unstable; had facial injuries or oral lacerations that could contaminate saliva with blood (saliva samples were collected concurrently); evidenced cognitive impairments or psychiatric problems; were in police custody or institutionalized; or were unwilling to return for follow-ups.

The main aim of the parent study was to identify salivary biomarker predictors of posttraumatic psychopathology after traumatic injury. Given a pragmatic study design that mapped onto the dynamic trauma care setting and a largely vulnerable patient population, the study employed readily assessable measures of risk factors. Assessments were conducted during hospitalization [median: 2 days post-admission, interquartile range (IQR):1–3 days; T0] and approximately one month (median: 38 days, IQR:32–53 days; T1) and five months (median: 143 days, IQR:127–203 days; T2) after injury. T0 was completed in-hospital, and participants returned to LAC-USC for T1 and T2. Questionnaires were administered by trained and calibrated staff at T0 and T1 to assess posttraumatic psychopathology symptoms,

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and diagnostic interviews were administered at T2 to measure symptoms and diagnoses of posttraumatic psychopathology. Sociodemographic and trauma-related characteristics were queried at T0. Of the 695 participants who completed T0, 386 (56%) completed T1, 368 (53%) completed T2, and 327 (47%) completed all assessments. The analytic sample comprised 427 participants who completed at least 2 assessments (61%).

Measures

Posttraumatic Symptom Dimensions.—Several measures were collected at the three assessments. At T0 and T1, staff administered the PTSD Checklist, Specific (PCL-S) version (Weathers et al., 1993) and Brief Symptom Inventory (BSI) depression and anxiety subscales (Derogatis & Melisaratos, 1983). The PCL-S assesses the 17 *DSM-IV* diagnostic criteria for PTSD; participants indicated the extent to which they were bothered by these symptoms in response to the trauma resulting in hospitalization. The PCL is a reliable and valid measure of PTSD symptoms, with good correspondence with the Clinician-Administered PTSD Scale (CAPS) diagnostic interview (Blanchard et al., 1996; Ruggiero et al., 2003). The BSI depression and anxiety subscales each comprise six symptoms; participants rated the extent to which they were bothered by symptoms. These BSI subscales have been shown to have good psychometric properties (Derogatis & Melisaratos, 1983). At T0 and T1, the PCL-S and BSI measures queried symptoms since the traumatic injury and in the past week, respectively. At T2, staff administered the CAPS (Blake et al., 1995) and Inventory of Depressive Symptomatology (IDS-30) (Rush et al., 1986; Rush et al., 1996). The CAPS is the gold-standard diagnostic interview for PTSD, with excellent psychometric properties (Weathers et al., 2001). The CAPS assesses the 17 *DSM-IV* diagnostic criteria for PTSD. Participants indicated the extent to which they were bothered by symptoms in the past month with respect to the index trauma. The IDS-30 assesses the *DSM-IV* diagnostic criteria for a major depressive episode, along with some anxiety symptoms; participants reported on symptoms in the past two weeks. This measure has been found to have good reliability and validity (Rush et al., 1996; Trivedi et al., 2004).

Using items from these measures, we defined several posttraumatic symptom dimensions. As in some prior studies of trajectories of emotional distress after trauma (e.g., deRoon-Cassini et al., 2010; Meli et al., 2020; Nash et al., 2014), the same measures were not administered at all assessments due to the parent study design. However, when different measures were used across assessments, they captured the same construct that constituted a symptom dimension with the same number of items. This consistent coverage of constructs thereby facilitated trajectory analyses. Accordingly, we used corresponding items from measures at T0, T1, and T2 to estimate trajectories of the following symptom dimensions: re-experiencing, avoidance, anxious arousal, numbing, dysphoric arousal, loss, and threat (see Table 1 for item mappings). At each assessment, symptom dimension scores were calculated by summing the relevant item responses. To harmonize each dimension score across assessments, a constant was subtracted at T0 and T1 to anchor the score at 0 without affecting the difference between the maximum and minimum score. The loss and threat dimension scores at T2 were rescaled in range to match the respective scores at T0 and T1, with resulting non-integer values rounded to the nearest integer (Table 1).

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Predictors of Trajectory Membership.—Sociodemographic and trauma-related characteristics were collected as part of the parent study and examined as predictors of trajectory membership. At T0, age, sex, race, ethnicity, relationship status, educational attainment, and employment status were queried. Race and ethnicity data were categorized as Hispanic/Latino, White, Black, and multiracial/other, and, given small numbers of participants in the non-Hispanic/Latino categories, dichotomized as Hispanic/Latino (yes/no) for analyses. Relationship status was coded dichotomously, indicating whether a participant was married or lived with a partner. Educational attainment was categorized as "less than high school," "high school," or "greater than high school." Employment status was classified as "full," "part-time," "none/unemployed," or "disabled/other." The index trauma resulting in injury was classified as assaultive (e.g., gunshot wound, assault) versus non-assaultive (e.g., motor vehicle accident, fall).

Statistical Analysis

Descriptive statistics for sociodemographic and trauma-related characteristics were compiled for the analytic sample and for those excluded due to only completing T0. Group differences were assessed using the Kruskal-Wallis test for age and χ^2 tests for categorical variables.

Latent Class Growth Analysis.—We conducted latent class growth analyses (LCGA) to identify discrete patterns of change from T0 to T2 within each symptom dimension. The criteria of the GRoLTS-Checklist (Van De Schoot et al., 2017) were applied when reporting analyses and results. LCGA accounts for heterogeneity in individual patterns of change by clustering participants into unobserved classes or trajectories underlying the sample. A preliminary investigation of dimension scores revealed that participants frequently exhibited nonlinear trajectories. We, therefore, employed a latent basis growth model in which the optimal shape of the change trajectory is estimated from the data (Grimm et al., 2016). Compared to a linear growth model, the latent basis model required estimation of one additional free parameter per class (the shape growth factor loading at T1; Supplementary Figure 1). Thus, the model afforded the flexibility to identify any type of change trajectory (linear or nonlinear) even with three measurement occasions while remaining parsimonious. Since observed dimension scores were highly left-skewed, we assumed a negative binomial distribution to avoid overextraction of classes (Bauer & Curran, 2003). Unobserved classes were allowed to differ in initial symptom severity (mean of the intercept growth factor), as well as in the magnitude (mean of the shape growth factor) and pattern of change. Residual variance not explained by class membership was assumed to be constant across time and latent classes. In exploratory analyses, we relaxed this restrictive assumption by estimating residual variances that were either a) class-specific and fixed across time or b) time-specific and fixed across classes. Under both scenarios of a less constrained error structure, model estimation problems arose. We explored relaxing the assumption of homogeneous individual trajectories within each class, but encountered model convergence issues.

To determine the most likely number of trajectories for each symptom dimension, we estimated a series of models for which the number of latent classes varied from one to five. The most plausible model was selected by evaluating several fit statistics and substantive criteria [e.g., the Bayesian information criterion (BIC), approximate likelihood ratio tests

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(LRTs), entropy (a measure of classification confidence ranging from 0–1)], in addition to considering theory, parsimony, and interpretability (Andruff et al., 2009; Jung & Wickrama, 2008; Lo et al., 2001). We also required that classes comprise at least 5% of the sample. Estimated mean trajectories were plotted for each candidate model (Supplementary Figure 2) and assessed for distinctiveness and interpretability. All LCGA models were estimated using Mplus 8.4 (Muthén & Muthén, 1998–2017) with 2,000 initial-stage random starts, 20 initial-stage iterations, and 20 final-stage optimizations for models with two or more classes. Although all participants provided data at T0, missing data at T1 and T2 were accommodated by using full information maximum likelihood estimation under the assumption that the data were missing at random.

Predictive Analysis.—Latent class membership was regressed on sociodemographic and trauma-related characteristics in a multinomial logistic regression analysis following the three-step method proposed by Vermunt (2010). In the LCGA, participants were modally assigned to a class based on the estimated probabilities of class membership. In the regression analysis, class membership was a nominal indicator of the latent class variable, and the measurement relationships between the latent class variable and the indicator variable were set to the logits of the classification probabilities obtained during LCGA estimation (Asparouhov & Muthén, 2014). The analysis was carried out with two alternative parameterizations depending on the comparison of interest, using either the resilient or recovery trajectory as the reference.

Results

Participant Characteristics

Table 2 presents characteristics of the analytic sample. Participants were mostly young, single, male, and Hispanic/Latino. Consistent with the LAC-USC catchment area, many participants were socioeconomically disadvantaged. Approximately one-third of the sample presented with an assaultive injury. Compared to participants who only completed the baseline assessment, participants in the analytic sample were more likely to be Hispanic/Latino (76.1% vs. 64.6%, p=.001) and reported higher educational attainment (<HS/HS/>HS: 26.5/32.1/41.5% vs. 34.0/34.7/31.3%, p=.019; Supplementary Table 1).

Trajectories of Posttraumatic Symptom Dimensions

Descriptive statistics for the posttraumatic symptom dimensions are shown in Supplementary Table 2. Statistical information for all candidate LCGA models for the different dimensions is provided in Table 3. There was considerable consistency in the LCGA results across symptom dimensions. Specifically, a four-class solution was selected as the best-fitting model for all dimensions except loss and threat, where a three-class solution was selected. For the re-experiencing, anxious arousal, and avoidance dimensions, consistent improvements in BIC and significant LRTs until the five-class model was specified suggested a four-class solution. In the case of dysphoric arousal, the BIC was lowest and nearly identical for the four- and five-class models, but the LRTs, which were no longer significant in the five-class model, supported the four-class solution. For numbing, the BIC reached its minimum with four classes, but the LRTs failed to reach significance for

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models with more than three classes. After examining the estimated mean trajectories for the three-class and four-class models for numbing (Supplementary Figure 2), we selected the four-class model because the resulting four trajectories were qualitatively distinct and theoretically meaningful. For loss, the BIC was lowest for the three-class model, but the LRTs retained significance with up to five classes. Here, we selected the three-class solution because the estimated trajectories of the four-class model lacked distinctiveness. Finally, a three-class solution for threat was indicated by the BIC, which reached its minimum with three classes, and by significant LRTs with up to three classes. We also carried out a complete-case LCGA, excluding participants with missing data at T1 or T2. Results closely matched those from the analytic sample: the BIC supported a four-class solution for re-experiencing, anxious arousal, dysphoric arousal, numbing, and avoidance and a three-class solution for loss and threat.

Figure 1 displays the estimated mean trajectories based on the selected model for each dimension (Supplementary Figure 3 shows mean estimated trajectories together with observed individual trajectories; Supplementary Table 3 presents parameter estimates for the selected models). For dimensions with a four-class solution, participants were classified into *Resilient, Chronic, Delayed Onset*, and *Recovery* trajectories; given the similarity with prior studies, we adopted the terms for the four modal trajectories of psychological symptoms observed after traumatic injury (Figure 1). The *Resilient* and *Chronic* trajectories were characterized by stably low and elevated symptoms over time, respectively. Elevated symptoms at T0 that decreased over time indicated a *Recovery* trajectory, whereas initially low symptoms that subsequently increased constituted the *Delayed Onset* trajectory. For the loss and threat dimensions, participants were classified into *Resilient, Chronic*, and *Delayed Onset* trajectories. Although a large percentage of participants fell into the *Resilient* class across dimensions (ranging from 17% for dysphoric arousal to 37% for avoidance), this class was only the most populous for avoidance. For example, 41% of participants were classified into the *Delayed Onset* trajectory for threat, 34% of participants were classified into the *Chronic* trajectory for numbing, and 33% of participants were each classified into the *Chronic* and *Delayed Onset* trajectories for dysphoric arousal. To determine how consistently participants were clustered into trajectories across the dimensions, we conducted a supplementary analysis. For each trajectory, we calculated the intraclass correlation [ICC(A,1)] across the latent class posterior probabilities for that trajectory in each symptom dimension. For the *Resilient* and *Chronic* trajectories, ICCs of 0.46 (95% CI, 0.42–0.51) and 0.54 (95% CI, 0.50–0.59), respectively, indicated moderate classification agreement. For the *Delayed onset* and *Recovery* trajectories, agreement was low (ICC=0.21, 95% CI, 0.17–0.25; ICC=0.02, 95% CI, 0.00–0.04, respectively).

Predictors of Trajectory Membership

Predictors of trajectory membership for the posttraumatic symptom dimensions are presented in Table 4. We first considered membership in the *Chronic* versus *Resilient* trajectory to identify factors that could distinguish between consistently elevated and low symptoms of emotional distress after injury. For all seven dimensions, unemployment and, often, part-time employment were associated with greater odds of being in the *Chronic* trajectory compared to full-time employment, with odds ratios (OR) ranging from 3.17 to

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9.44. Older age increased the odds of membership in the *Chronic* trajectory for avoidance, numbing, and loss (OR range:1.03–1.05), whereas female sex was related to greater odds of membership in the *Chronic* trajectory for re-experiencing, anxious arousal, and threat (OR range:2.72–4.29). Furthermore, participants who experienced assaultive trauma exhibited greater odds of being in the *Chronic* trajectory for avoidance and anxious arousal (OR range:2.55–3.20). Additionally, being married or cohabitating was linked to lower odds of membership in the *Chronic* trajectory for anxious arousal (OR:0.40).

Next, we examined whether we could distinguish between patients who initially appeared similar in terms of emotional distress but then diverged over time. Specifically, we considered predictors of being in the 1) *Chronic* versus *Recovery* trajectory and 2) *Delayed Onset* versus *Resilient* trajectory. Unemployment was associated with greater odds of being in the *Chronic* (versus *Recovery*) trajectory compared to full-time employment for three of the five dimensions that permitted this comparison: re-experiencing, numbing, and anxious arousal (OR range:3.19–5.75). Participants employed part-time (versus full-time) also showed greater odds of being in the *Chronic* trajectory for re-experiencing. For re-experiencing only, participants with a high school education exhibited lower odds of being in the *Chronic* trajectory compared to those with less than a high school education (OR=0.29). Unemployment also predicted membership in the *Delayed Onset* versus *Resilient* trajectory for re-experiencing and avoidance (OR range=2.90–3.45). Interestingly, being married or cohabitating was linked to higher odds of membership in the *Delayed Onset* trajectory for re-experiencing, and having greater than a high school education was associated with greater odds of being in the *Delayed Onset* trajectory for dysphoric arousal.

Discussion

In this study, we demonstrated significant heterogeneity in psychological responses after traumatic injury in a predominantly male, Hispanic/Latino sample and identified distinct trajectories of posttraumatic psychopathology. Rather than examining trajectories of symptoms of psychiatric diagnoses that are common after trauma (e.g., PTSD, depression) as in previous studies, we are the first to investigate trajectories of dimensions of posttraumatic psychopathology. By considering trajectories of re-experiencing, avoidance, anxious arousal, numbing, dysphoric arousal, loss, and threat symptoms, this study examined the diversity in how transdiagnostic symptom dimensions manifest over the first five months after traumatic injury. Furthermore, we identified sociodemographic and trauma-related predictors of membership in distinct trajectories across different dimensions.

Participants were classified into four trajectories—*Resilient, Chronic, Delayed Onset*, and *Recovery*—in five of the seven dimensions. Only in the loss and threat dimensions did we observe a best-fitting model with three trajectories (*Resilient, Chronic, Delayed Onset*). Not only did we see consistency in the patterns of trajectories across dimensions, but our findings align with other studies of trajectories of psychiatric diagnoses after traumatic injury, including PTSD, depression, and anxiety, which have often supported a similar four-class model (e.g., deRoon-Cassini et al., 2010; Galatzer-Levy et al., 2018; Lowe et al., 2020). However, unlike many of these studies, we did not find resilience was the modal response to traumatic injury. Others have notably questioned whether resilience is always

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commonplace after trauma (e.g., Infurna & Luthar, 2018; Steenkamp et al., 2012). Although a large percentage of participants fell into the *Resilient* class across dimensions, this class was only the most common for avoidance. For other dimensions, the *Chronic* (numbing, anxious arousal) and *Delayed Onset* (loss, threat) classes comprised the most participants; for dysphoric arousal, the *Chronic* and *Delayed onset* classes were both the largest. Only for re-experiencing was the *Recovery* trajectory the largest class. Additional research is needed to confirm whether trajectories with more dispersed membership are obtained when focusing on symptom dimensions, rather than diagnoses, after traumatic injury.

Whereas most studies have focused on trajectories of separate diagnoses such as PTSD or depression, we examined symptom dimensions that cut across traditional diagnostic categories. Focusing on cross-cutting symptom dimensions avoids issues of diagnostic comorbidity (Clark et al., 1995; Hyman, 2010), aligns with the NIMH RDoC framework for mental disorders (Cuthbert, 2014; Cuthbert & Insel, 2013), and these more homogeneous dimensions may be more closely tied to underlying biology (Casey et al., 2013; McLean et al., 2019). Even though a similar pattern of trajectories was observed across the symptom dimensions, we found that proportions of individuals in the trajectories varied for the dimensions; this could potentially reflect differences in their mechanisms (e.g., biological underpinnings) and risk and protective factors. Future research is needed to directly address these questions. Furthermore, the cross-dimension comparison results for a given trajectory demonstrated that participants did not cluster consistently across the different symptom dimensions; this was particularly the case for the *Delayed Onset* and *Recovery* trajectories and somewhat less so for the *Chronic and Resilient* trajectories. If individuals fell in the *Delayed Onset* trajectory for re-experiencing, they did not necessarily fall in that trajectory for the other dimensions. An important extension of the current study is to examine how symptom dimension trajectories cluster within individuals and identify predictors of these patterns.

In predictive models of trajectory membership, employment status at the time of traumatic injury emerged as an important candidate to include in risk prediction models for developing chronic manifestations of posttraumatic symptom dimensions, followed by sex, age, assaultive trauma, education, and relationship status. The *Chronic* versus *Resilient* trajectory comparison could help identify participant characteristics associated with long-lasting symptoms of posttraumatic psychopathology that could be used in screening and prevention efforts in the acute aftermath of trauma. Whereas employment status consistently predicted *Chronic* versus *Resilient* trajectory membership across different dimensions, other predictors (e.g., sex, age, assaultive trauma) emerged only for certain dimensions. The directions of these associations were consistent with previous studies of diagnostic trajectories after traumatic injury (Bryant et al., 2015; Lowe et al., 2020). Female sex, for example, was linked to an increased likelihood of being in the *Chronic* trajectory for re-experiencing, anxious arousal, and threat. Re-experiencing and anxious arousal have been considered to be threat-related symptom dimensions of PTSD (Forbes et al., 2010), and thus these findings may suggest that female sex could be particularly linked to a more chronic manifestation of threat-related symptoms after traumatic injury. Unemployment also emerged as a way to distinguish participants who presented with similar symptom levels days after trauma but then diverged over time, namely individuals who were 1) initially high on re-experiencing,

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numbing, and anxious arousal symptoms and then stayed high (*Chronic* trajectory) as opposed to recovered (*Recovery* trajectory) and 2) initially low on re-experiencing and avoidance symptoms and then exhibited an increase in symptoms (*Delayed onset* trajectory) as opposed to stayed low (*Resilient* trajectory). Thus, our findings suggest that employment status may be useful for identifying individuals who may require more long-term attention and care after traumatic injury. The consistency in our findings linking unemployment status to more long-term manifestations of multiple posttraumatic symptom dimensions is notable. Several trajectory studies have identified that socioeconomic disadvantage (e.g., low educational attainment) is associated with more chronic symptoms of posttraumatic psychopathology after traumatic injury (e.g., deRoon-Cassini et al., 2010; Lowe et al., 2020). Unemployment could signal a lack of access to resources that could aid in recovery after trauma (e.g., healthcare, stable living situation, support network at work). Furthermore, unemployment could reflect other pre-trauma risk factors such as preexisting psychopathology, which has been linked to emotional distress after trauma (e.g., Ozer et al., 2003). Additional research is needed to better understand the mechanisms linking employment status with more chronic manifestations of posttraumatic symptom dimensions. Further studies are also required to address whether this risk factor is particularly salient due to the sociodemographic composition of our sample (e.g., predominantly male, Hispanic/Latino) or whether it applies to individuals from different backgrounds.

Several limitations should be kept in mind when interpreting our findings. First, despite attempts to follow up with participants, there was substantial dropout, with nearly 39% of the initial sample not completing subsequent assessments. However, our attrition rate is consistent with those observed in other traumatic injury patient samples (deRoon-Cassini et al., 2010; Ravn et al., 2019). Furthermore, participants included in the analyses were generally similar to those excluded due to missing data, although those included were more likely to be Hispanic/Latino and had higher educational attainment. Second, even though we were able to measure similar posttraumatic symptom dimension constructs from T0 to T2, the measures differed across time points and symptom reference timeframes, as in previous studies of trajectories of emotional distress after trauma (e.g., deRoon-Cassini et al., 2010; Meli et al., 2020). Nevertheless, the different measures captured the same constructs and used similar response scales at each assessment, and we scaled scores so the ranges were equivalent across time. Additionally, prior trajectories research has used both the PCL and CAPS to index PTSD symptoms (Nash et al., 2014), as we did here. However, future research should employ the same measures at all assessments for maximum consistency. Third, this study was designed before the *DSM-5* revision; thus, we used *DSM-IV*-based measures of posttraumatic psychopathology. Despite substantial overlap between the *DSM-IV* and *DSM-5* criteria for disorders like PTSD and depression, research using *DSM-5*-based measures is needed. Fourth, due to the design of the parent study, we lacked information about pre-trauma functioning, including preexisting psychopathology, which plays a role in psychological responses to trauma (Lowe et al., 2020; Osenbach et al., 2014). Fifth, results were obtained in a predominantly male, Hispanic/Latino sample with relatively low socioeconomic status, and thus may not generalize to other populations. That said, our study adds granularity to previous research by Marshall et al. (2009) revealing that Hispanic/Latino individuals report distinctive patterns of PTSD symptoms after traumatic injury

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compared to non-Hispanic/Latino individuals. Future research is needed to determine whether factors like race/ethnicity impact manifestations of posttraumatic symptom dimension trajectories and patterns of trajectory membership.

Conclusions

Many survivors of traumatic injury experience psychological distress related to these experiences (deRoon-Cassini et al., 2019; Zatzick et al., 2007). Our study demonstrates that there is substantial heterogeneity in trajectories of transdiagnostic symptom dimensions during the first five months after injury. Further research is needed to examine how these posttraumatic symptom dimension trajectories relate to other aspects of functioning over time, such as disability and quality of life. In addition, biomarker research may point to distinct etiologies underlying different longitudinal symptom dimension presentations. Incorporating factors across multiple levels of analysis has the potential to inform the development of comprehensive risk prediction models that could be used to target prevention efforts aimed at offsetting psychological distress after traumatic injury.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

The authors thank the trauma surgeons and nurses at the LAC/USC Medical Center for facilitating the study and Estefania Ramires-Sanchez and Jenny Brooks for assisting with data management.

Funding Sources

This work was supported by the National Institutes of Health (VS, grant number R01DE022045; JAS, grant numbers K01HL130650, R01HL139614).

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Highlights

- Longitudinal study of traumatic injury patients from a Level 1 trauma center
- Examined transdiagnostic symptom dimensions of posttraumatic distress over time
- Latent class growth analysis identified 3 or 4 trajectories for each dimension
- Transdiagnostic symptom dimensions manifested in diverse ways after trauma
- Unemployment emerged as the most important predictor of trajectory membership

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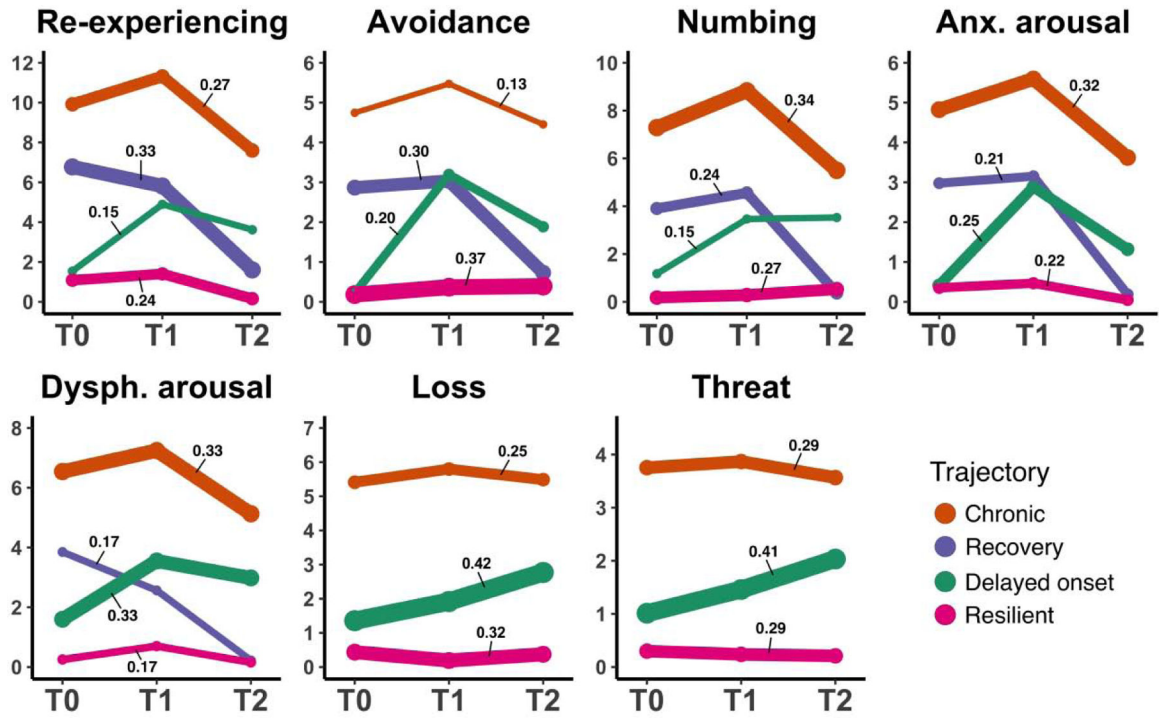

Figure 1.

Estimated latent trajectories obtained in latent class growth analyses of posttraumatic symptom dimensions. Labels, as well as line thickness, indicate the proportion of participants who were clustered into the trajectory based on their most likely class membership. Anx. = anxious; dysph. = dysphoric.

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Table 1.

Item Mappings for the Posttraumatic Symptom Dimensions, Plus Measures and Score Ranges at Each Assessment.

		T0			T1			T2			All assessments
Dimension	**Component item constructs**	**Measure**	**Item Likert range**	**Unscaled dimension score range**	**Measure**	**Item Likert range**	**Unscaled dimension score range**	**Measure**	**Item Likert range**	**Unscaled dimension score range**	**Scaled dimension score range**
Re-experiencing	Intrusions; nightmares; flashbacks; emotional reactivity; physiological reactivity	PCL-S	1–5	5–25[a]	PCL-S	1–5	5–25[a]	CAPS	0–4	0–20	0–20
Avoidance	Avoid trauma reminders; avoid thinking/ talking about trauma	PCL-S	1–5	2–10[a]	PCL-S	1–5	2–10[a]	CAPS	0–4	0–8	0–8
Anxious arousal	Hypervigilance; exaggerated startle	PCL-S	1–5	2–10[a]	PCL-S	1–5	2–10[a]	CAPS	0–4	0–8	0–8
Numbing	Trouble having positive feelings; loss of interest; feeling distant from others; trauma-related amnesia; foreshortened future	PCL-S	1–5	5–25[a]	PCL-S	1–5	5–25[a]	CAPS	0–4	0–20	0–20
Dysphoric arousal	Trouble falling or staying asleep; difficulty concentrating; irritability	PCL-S	1–5	3–15[a]	PCL-S	1–5	3–15[a]	CAPS	0–4	0–12	0–12
Loss	Feeling blue/ sad; feelings of worthlessness; thoughts of ending life; feeling hopeless about future	BSI-D	1–5	4–20[a]	BSI-D	1–5	4–20[a]	IDS-30	0–3	0–12[b]	0–16
Threat	Feeling tense; spells of terror or panic	BSI-A	1–5	2–10[a]	BSI-A	1–5	2–10[a]	IDS-30	0–3	0–6[c]	0–8

Note. The same component item constructs were measured at each assessment. T0=Time 0 (in-hospital approximately 2 days after traumatic injury); T1=Time 1 (approximately 1 month after traumatic injury); T2=Time 2 (approximately 5 months after traumatic injury); PCL-S=Posttraumatic Stress Disorder Checklist-Specific version; CAPS=Clinician Administered PTSD Scale; BSI-D=Brief Symptom Inventory-depression subscale; BSI-A=Brief Symptom Inventory-anxiety subscale; IDS=Inventory of Depressive Symptomatology.

[a] Scaled dimension scores were anchored at 0 by subtracting a constant.

[b] Rescaling formula: $score_{scaled} = 16*score_{unscaled}/12$, rounded to the nearest integer value.

[c] Rescaling formula: $score_{scaled} = 8*score_{unscaled}/6$, rounded to the nearest integer value.

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Table 2.

Sociodemographic Characteristics and Assaultive Trauma (N = 427).

Characteristic	Median (IQR) or N (%)
Age (years)	31.00 (24.00, 40.50)
Sex	
Female	95 (22.2)
Male	332 (77.8)
Race/ethnicity	
Hispanic/Latino	325 (76.1)
White	43 (10.1)
Black	32 (7.5)
Multiracial/other	27 (6.3)
Married/cohabitating	
Yes	131 (30.7)
No	296 (69.3)
Education	
<HS	113 (26.5)
HS	137 (32.1)
>HS	177 (41.5)
Employment	
Full-time	179 (41.9)
Part-time	96 (22.5)
None/unemployed	137 (32.1)
Disabled/other	15 (3.5)
Assaultive trauma	
Yes	138 (32.3)
No	289 (67.7)

Note. HS = high school; IQR = interquartile range.

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Table 3.

Fit Statistics for LCGA Models of Posttraumatic Symptom Dimensions.

					p-values		
Classes	**Parameters**	**Class sizes**	**AIC**	**BIC**	**VLMR**	**LMR**	**Entropy**
Re-experiencing							
1[a]	4	425	6,322.2	6,338.4	–	–	–
2	8	290/135	6,053.1	6,085.5	<.001	<.001	0.78
3	12	102/201/122	6,003.4	6,052.0	.001	.002	0.65
4	**16**	**141/115/104/65**	**5,968.1**	**6,033.0**	**.027**	**.031**	**0.68**
5[b]	20	67/113/132/102/11	5,995.4	6,040.2	.341	.351	0.71
Anxious Arousal							
1[a]	4	418	4,583.7	4,599.9	–	–	–
2	8	217/201	4,341.9	4,374.1	<.001	<.001	0.73
3	12	151/74/193	4,292.0	4,340.4	.002	.002	0.70
4[c]	**16**	**91/134/88/105**	**4,237.1**	**4,301.6**	**<.001**	**<.001**	**0.68**
5[c,d]	20	84/79/76/134/45	4,224.1	4,304.8	.087	.092	0.67
Dysphoric Arousal							
1	4	418	5,183.0	5,199.1	–	–	–
2	8	287/131	4,977.2	5,009.5	.002	.002	0.74
3	12	153/71/194	4,924.1	4,972.5	.004	.004	0.68
4	**16**	**140/136/73/69**	**4,872.2**	**4,936.7**	**.026**	**.030**	**0.70**
5	20	49/79/89/65/136	4,855.5	4,936.2	.158	.168	0.69
Numbing							
1[a]	4	423	5,627.6	5,643.8	–	–	–
2	8	143/280	5,381.4	5,413.8	<.001	<.001	0.79
3	12	69/224/130	5,333.7	5,382.3	.028	.031	0.73
4	**16**	**101/115/64/143**	**5,306.4**	**5,371.1**	**.408**	**.418**	**0.69**
5[e]	20	38/70/80/115/120	5,302.8	5,383.7	.559	.569	0.65
Avoidance							
1[a]	4	424	4,250.6	4,266.8	–	–	–
2	8	185/239	4,105.9	4,138.3	<.001	<.001	0.67
3	12	166/209/49	4,075.9	4,124.5	.009	.010	0.66
4	**16**	**128/55/156/85**	**4,014.0**	**4,078.8**	**.001**	**.001**	**0.70**
5[c]	20	150/41/52/83/98	4,000.7	4,081.7	.431	.438	0.67
Loss							
1	4	425	4,860.3	4,876.5	–	–	–
2	8	214/211	4,648.4	4,680.8	<.001	<.001	0.71
3	**12**	**107/180/138**	**4,602.0**	**4,650.6**	**<.001**	**<.001**	**0.66**
4	16	125/62/107/131	4,588.3	4,653.1	.032	.037	0.64

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					p-values		
Classes	**Parameters**	**Class sizes**	**AIC**	**BIC**	**VLMR**	**LMR**	**Entropy**
5	20	102/112/35/88/88	4,580.6	4,661.7	.012	.014	0.63
Threat							
1	4	425	4,313.6	4,329.8	–	–	–
2	8	207/218	4,110.6	4,143.0	<.001	<.001	0.70
3	**12**	**176/125/124**	**4,082.3**	**4,130.9**	**.007**	**.009**	**0.61**
4[e]	16	81/158/30/156	4,069.2	4,134.1	.373	.383	0.64
5[c,f]	20	72/29/151/36/137	4,055.6	4,136.6	.788	.790	0.65

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; VLMR = Vuong-Lo-Mendell-Rubin likelihood ratio test; LMR = Lo-Mendell-Rubin adjusted likelihood ratio test. Lines highlighted in bold indicate the model that was selected to represent the latent trajectory structure for the symptom dimension.

[a]The shape growth factor mean was estimated to be 0 and the basis coefficient at time $t1$ needed to be fixed to avoid singularity of the information matrix.

[b]The shape growth factor mean for the fifth class was fixed to avoid singularity of the information matrix.

[c]The residual variance needed to be set to 0 to avoid singularity of the information matrix.

[d]The shape growth factor mean for the second class was fixed to avoid singularity of the information matrix.

[e]The shape growth factor mean for the fourth class was fixed to avoid singularity of the information matrix.

[f]Non-positive definite first-order derivative product matrix involving the shape growth factor mean for the fifth class.

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Table 4.

Results of a Multinomial Logistic Regression Analysis Predicting Latent Trajectory Membership for Each of the Posttraumatic Symptom Dimensions.

	Re-experiencing		Avoidance		Numbing		Anxious Arousal		Dysphoric Arousal		Loss		Threat	
Predictor	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Chronic vs. Resilient trajectory														
Age (years)	1.01	(0.98, 1.04)	1.04*	(1.00, 1.08)	1.03*	(1.00, 1.06)	1.02	(0.98, 1.05)	1.02	(0.99, 1.06)	1.05**	(1.02, 1.09)	1.03	(1.00, 1.06)
Sex: female vs. male	4.29**	(1.73, 10.63)	2.79	(0.94, 8.32)	1.39	(0.65, 2.97)	3.90*	(1.07, 14.18)	2.27	(0.96, 5.36)	2.22	(0.96, 5.10)	2.72*	(1.23, 6.02)
Hispanic/ Latino: yes vs. no	1.12	(0.46, 2.69)	2.21	(0.70, 6.95)	1.40	(0.66, 2.98)	1.17	(0.49, 2.82)	0.78	(0.30, 2.03)	1.08	(0.48, 2.42)	0.85	(0.37, 1.97)
Married/ cohab.: yes vs. no	1.75	(0.74, 4.15)	0.94	(0.33, 2.64)	0.54	(0.26, 1.14)	0.40*	(0.17, 0.93)	0.67	(0.31, 1.45)	0.95	(0.47, 1.94)	0.82	(0.38, 1.75)
Education: HS vs. <HS	0.56	(0.22, 1.45)	1.06	(0.34, 3.37)	1.23	(0.51, 2.99)	1.90	(0.62, 5.81)	1.00	(0.41, 2.41)	0.90	(0.40, 2.02)	0.64	(0.26, 1.60)
Education: >HS vs. <HS	0.94	(0.38, 2.32)	0.75	(0.23, 2.45)	1.35	(0.58, 3.17)	0.77	(0.29, 2.08)	1.25	(0.49, 3.19)	0.86	(0.37, 1.97)	0.46	(0.20, 1.09)
Employment: part- vs. full-time	4.17**	(1.61, 10.82)	6.57**	(1.79, 24.11)	3.18**	(1.37, 7.39)	1.93	(0.67, 5.57)	2.00	(0.81, 4.93)	3.65**	(1.53, 8.74)	2.48*	(1.08, 5.69)
Employment: none vs. full-time	5.66***	(2.22, 14.42)	9.44**	(2.50, 35.58)	5.14***	(2.34, 11.30)	3.17*	(1.20, 8.37)	3.32*	(1.33, 8.29)	4.77***	(2.09, 10.91)	3.52**	(1.48, 8.35)
Assaultive trauma: yes vs. no	1.86	(0.86, 4.02)	3.20*	(1.08, 9.50)	1.25	(0.61, 2.59)	2.55*	(1.09, 5.93)	1.04	(0.48, 2.30)	1.23	(0.61, 2.48)	1.01	(0.49, 2.09)
Delayed Onset vs. Resilient trajectory														
Age (years)	0.98	(0.93, 1.03)	1.01	(0.97, 1.05)	1.00	(0.96, 1.05)	1.03	(0.98, 1.07)	1.00	(0.96, 1.04)	1.03	(0.99, 1.07)	1.02	(0.98, 1.06)
Sex: female vs. male	2.01	(0.57, 7.05)	1.66	(0.57, 4.80)	2.35	(0.70, 7.90)	3.00	(0.62, 14.47)	0.89	(0.29, 2.75)	1.78	(0.70, 4.50)	1.11	(0.41, 3.04)
Hispanic/ Latino: yes vs. no	1.27	(0.29, 5.62)	1.13	(0.45, 2.82)	0.65	(0.22, 1.87)	0.84	(0.32, 2.21)	0.58	(0.20, 1.70)	0.95	(0.42, 2.12)	0.59	(0.21, 1.67)
Married/ cohab.: yes vs. no	4.47**	(1.47, 13.64)	2.02	(0.87, 4.68)	1.70	(0.60, 4.76)	0.54	(0.21, 1.39)	1.40	(0.61, 3.23)	0.78	(0.38, 1.62)	1.57	(0.67, 3.69)
Education: HS vs. <HS	0.49	(0.13, 1.77)	0.94	(0.35, 2.49)	1.71	(0.38, 7.71)	2.86	(0.82, 10.06)	3.23	(1.00, 10.44)	1.37	(0.57, 3.32)	1.20	(0.42, 3.46)
Education: >HS vs. <HS	1.13	(0.38, 3.38)	0.73	(0.27, 1.95)	1.24	(0.29, 5.41)	1.13	(0.37, 3.42)	4.28*	(1.29, 14.23)	1.58	(0.68, 3.68)	0.53	(0.19, 1.49)
Employment: part- vs. full-time	1.69	(0.44, 6.48)	1.63	(0.56, 4.78)	0.76	(0.19, 3.02)	0.50	(0.12, 2.03)	1.02	(0.37, 2.80)	1.16	(0.49, 2.73)	1.04	(0.39, 2.73)
Employment: none vs. full-time	3.45*	(1.02, 11.66)	2.90*	(1.05, 8.00)	1.39	(0.41, 4.75)	1.11	(0.37, 3.33)	1.24	(0.42, 3.64)	1.19	(0.54, 2.62)	2.23	(0.80, 6.23)
Assaultive trauma: yes vs. no	2.05	(0.75, 5.62)	1.65	(0.67, 4.09)	0.86	(0.24, 3.08)	1.01	(0.36, 2.85)	1.69	(0.73, 3.91)	1.02	(0.50, 2.09)	0.71	(0.30, 1.71)

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	Re-experiencing		Avoidance		Numbing		Anxious Arousal		Dysphoric Arousal		Loss		Threat	
Predictor	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Chronic vs. Recovery trajectory														
Age (years)	1.02	[0.98, 1.05]	1.03	[0.99, 1.07]	1.04	[1.00, 1.10]	1.02	[0.98, 1.06]	1.04	[0.99, 1.09]	–	–	–	–
Sex: female vs. male	1.83	[0.76, 4.38]	1.65	[0.52, 5.23]	9.46	[0.95, 93.71]	1.86	[0.49, 6.99]	2.87	[0.85, 9.69]	–	–	–	–
Hispanic/ Latino: yes vs. no	2.17	[0.90, 5.25]	2.25	[0.66, 7.63]	1.19	[0.48, 2.98]	1.11	[0.36, 3.40]	1.61	[0.62, 4.18]	–	–	–	–
Married/ cohab.: yes vs. no	1.74	[0.55, 5.46]	0.96	[0.30, 3.00]	0.89	[0.31, 2.60]	0.68	[0.20, 2.33]	0.70	[0.24, 2.02]	–	–	–	–
Education: HS vs. <HS	0.29*	[0.09, 0.98]	1.14	[0.31, 4.21]	1.83	[0.49, 6.80]	3.40	[0.69, 16.78]	1.04	[0.35, 3.13]	–	–	–	–
Education: >HS vs. <HS	0.59	[0.19, 1.86]	0.68	[0.18, 2.64]	0.94	[0.29, 3.09]	1.88	[0.51, 6.90]	1.21	[0.41, 3.61]	–	–	–	–
Employment: part- vs. full-time	3.53*	[1.28, 9.71]	2.73	[0.65, 11.40]	1.18	[0.39, 3.56]	1.95	[0.63, 6.06]	0.94	[0.32, 2.73]	–	–	–	–
Employment: none vs. full-time	3.66*	[1.20, 11.14]	2.56	[0.62, 10.67]	3.19*	[1.22, 8.34]	5.75*	[1.79, 18.47]	1.66	[0.54, 5.07]	–	–	–	–
Assaultive trauma: yes vs. no	2.37	[0.92, 6.10]	2.04	[0.62, 6.71]	0.77	[0.30, 1.94]	3.17	[0.81, 12.32]	0.95	[0.33, 2.73]	–	–	–	–

Note. Results for “employment: disabled/other vs. full-time” are not reported because the small number of participants in the “disable/other” category rendered estimates unreliable. Cohab = cohabitating; CI = confidence interval; HS = high school; OR = odds ratio.

* $p<.05$,

** $p<.01$,

*** $p<.001$