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Posttraumatic Stress Disorder Symptom Trajectories Within the First Year Following Emergency Department Admissions: Pooled Results from the International Consortium to Predict PTSD

Sarah R. Lowe[1], **Andrew Ratanatharathorn**[2], **Betty S. Lai**[3], **Willem van der Mei**[4], **Anna C. Barbano**[5], **Richard A. Bryant**[6,7], **Douglas L. Delahanty**[8], **Yutaka J. Matsuoka**[9], **Miranda Olff**[10,11], **Ulrich Schnyder**[12], **Eugene Laska**[13], **Karestan C. Koenen**[14], **Arieh Y. Shalev**[15], **Ronald C. Kessler**[16] **ICPP***

[1]Yale University, School of Public Health [2]Department of Epidemiology, Columbia University Mailman School of Public Health, New York, New York [3]Lynch School of Education and Human Development, Boston College, Chestnut Hill, USA [4]Data Scientist, New York County Defender Services [5]Department of Psychology, University of Toledo [6]School of Psychology, University of New South Wales, Sydney, NSW 2052, Australia [7]Brain Dynamics Centre, Westmead Institute of Medical Research, University of Sydney, Westmead, Australia [8]Kent State University, Department of Psychological Sciences, Kent, OH, USA [9]Division of Health Care Research, Center for Public Health Sciences, National Cancer Center Japan, Tokyo, Japan [10]Department of Psychiatry, Amsterdam UMC, University of Amsterdam, Amsterdam, The Netherlands [11]ARQ National Psychotrauma Centre, Diemen, The Netherlands [12]University of Zurich, Zurich, Switzerland; [13]Steven and Alexandra Cohen Veterans Center for the Study of Posttraumatic Stress and Traumatic Brain Injury, Department of Psychiatry, New York University School of Medicine [14]Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, Massachusetts [15]Department of Psychiatry, New York University School of Medicine, New York, New York [16]Department of Health Care Policy, Harvard Medical School, Boston, Massachusetts

Abstract

Background.—Research exploring the longitudinal course of posttraumatic stress disorder (PTSD) symptoms has documented four modal trajectories (low, remitting, high, and delayed), with proportions varying across studies. Heterogeneity could be due to differences in trauma types and patient demographic characteristics.

Methods.—This analysis pooled data from six longitudinal studies of adult survivors of civilian-related injuries admitted to general hospital emergency departments (EDs) in six countries (pooled *N* = 3,083). Each study included at least three assessments of the Clinician-Administered PTSD Scale in the first post-trauma year. Latent class growth analysis determined the proportion of

*ICPP members: Soraya Seedat, Stellenbosch University; Terri deRoon-Cassini, Medical College of Wisconsin; Sara Freedman, Bar IlanUniversity; Joanne Mouthaan, Leiden University; Marit Sijbrandij, VU University; Mirjam van Zuiden, Academic Medical Center; Daisuke Nishi, University of Tokyo School of Medicine; Alexander McFarlane, Center for Traumatic Studies, University of Adelaide, Derrick Silove, University of New South Wales School of Psychiatry; Meaghan O'Donnell, University of Melbourne;Wei Qi, New York University; Martin Gevonden, Vrije Universiteit

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participants exhibiting various PTSD symptom trajectories within and across the datasets. Multinomial logistic regression analyses examined demographic characteristics, type of event leading to the injury, and trauma history as predictors of trajectories differentiated by their initial severity and course.

Results.—Five trajectories were found across the datasets: *Low* (64.5%), *Remitting* (16.9%), *Moderate* (6.7%), *High* (6.5%), and *Delayed* (5.5%). Female gender, non-white race, prior interpersonal trauma, and assaultive injuries were associated with increased risk for initial PTSD reactions. Female gender and assaultive injuries were associated with risk for membership in the *Delayed* (vs. *Low*) trajectory, and lower education, prior interpersonal trauma, and assaultive injuries with risk for membership in the *High* (vs. *Remitting*) trajectory.

Conclusions.—The results suggest that over 30% of civilian-related injury survivors admitted to EDs experience moderate-to-high levels of PTSD symptoms within the first post-trauma year, with those reporting assaultive violence at increased risk of both immediate and longer-term symptoms.

Keywords

Posttraumatic stress; traumatic injuries; latent class growth analysis; resilience

Introduction

The majority of people will be exposed to one or more potentially traumatic events (PTE) in their lifetime (Kessler *et al.*, 2017, Kessler *et al.*, 1995, Nickerson *et al.*, 2012). It is now well known that there is substantial heterogeneity in psychological responses to such events. This variability is reflected in the lifetime prevalence of posttraumatic stress disorder (PTSD), which has been consistently estimated at less than 10 percent across studies worldwide (for a review, see (Lowe *et al.*, 2015).

From a longitudinal perspective, it has been theorized that there exists a range of patterns of PTSD symptom progression, including persisting low symptoms, initially high symptoms that either quickly or gradually remit, delayed-onset symptoms, and chronically moderate or high symptoms (Bonanno and Diminich, 2013, Norris *et al.*, 2009). The existence of such subpopulations aligns with the results of longitudinal studies that used person-centered statistical methods, such as latent class growth analysis (LCGA), to search for classes of growth and decline in PTSD symptoms (Andruff *et al.*, 2009, Jung and Wickrama, 2008, Van de Schoot, 2015). In the past decade, there has been a proliferation of such studies in the aftermath of traumatic events, including sexual assault, military deployment, and traumatic injury (Berntsen *et al.*, 2012, Bonanno *et al.*, 2012, Galatzer-Levy *et al.*, 2013, Norris *et al.*, 2009, Steenkamp *et al.*, 2012).

A recent review of 67 studies of mental health (not exclusively PTSD symptoms) in the aftermath of PTEs provided evidence for four prototypical trajectories in relatively consistent proportions (Galatzer-Levy *et al.*, 2018). The modal trajectory in this review was characterized by consistently low post-trauma symptoms, which the authors termed *Resilience*, with an average of 65.7% of participants exhibiting this pattern across studies. The other three trajectories were characterized by initially high symptoms that remitted over time (*Recovery*; 20.8%), consistently high symptoms (*Chronic*; 10.6%), and initially low symptoms that increased over time (*Delayed Onset*; 8.9%). Despite this consistency, the authors observed marked heterogeneity in the proportion of participants in each of the prototypical trajectories across studies.

Several factors could underlie the heterogeneity in trajectories across studies. First, as noted by Galatzer-Levy and colleagues (2018), sample characteristics likely influence the proportion of participants in each trajectory. One important characteristic appears to be the type of PTE to which participants were exposed, such that a consistently low trajectory is more common following less severe PTEs (e.g., Fink *et al.*, 2017). A second source of heterogeneity could be timing of assessment, with the length of follow-up across trajectory studies ranging from months to several years post-trauma. Few studies have concluded within the first year following trauma exposure (for exceptions, see, e.g., (Berntsen *et al.*, 2012, deRoon-Cassini *et al.*, 2010, Dickstein *et al.*, 2010, Steenkamp *et al.*, 2012), which is arguably the time during which survivors might most readily have access to mental health services and interventions are most optimal, thereby reducing long-term costs associated with chronic symptoms. Finally, a range of assessment instruments has been utilized and, although this source of heterogeneity remains empirically unexplored, it remains possible that it could influence patterns of results. Few studies have used the gold-standard assessment of PTSD symptoms, the Clinician-Administered PTSD Scale (CAPS; (Blake *et al.*, 1995); for exceptions, see (Boasso *et al.*, 2015, Nash *et al.*, 2015).

Addressing these three key sources of heterogeneity – type of PTE, timing of assessment, and assessment instrument – could yield more definitive information about the proportion of survivors likely to exhibit the four prototypical trajectories in the first post-trauma year. One context in which such information would be useful would be emergency departments (EDs), wherein survivors of traumatic injuries frequently present for immediate care. For example, in the United States in 2016, nearly 39 million injury survivors were treated in EDs, representing over 20 percent of primary diagnoses (Rui *et al.*, 2016). Insight into what percentage of potentially traumatic injury survivors might be in need of services at different times during the first trauma year would help allocate scarce resources to prevent and treat of PTSD symptoms.

Addressing the heterogeneity in trajectory studies could also provide clinically useful information into the factors that predict trajectory membership. In an ED context, knowledge of such factors could inform targeted outreach efforts. Several factors have been identified that decrease the likelihood of a consistently low symptom trajectory, including demographic characteristics (e.g., female gender, low socioeconomic status), greater event severity, and prior trauma exposure (Bonanno *et al.*, 2012, Bryant *et al.*, 2015, Lowe *et al.*, 2014, Pietrzak *et al.*, 2013).

However, the literature has generally not explored predictors of trajectory membership with explicit attention to the two key elements that differentiate trajectories, that is, their starting points (i.e., intercepts) and how they change over time (i.e., slopes). Predicting intercept and slope terms is the goal of conventional latent growth curve models; however, these models are not appropriate for contexts in which subpopulations of growth are hypothesized, such as mental health in the aftermath of trauma (Jung and Wickrama, 2008). Strategically developing models predicting trajectory membership could provide similar information in the aftermath of trauma. For example, identifying predictors of trajectories that start with high, versus low, PTSD symptoms could shed light upon which survivors are likely to need immediate care after discharge. In contrast, analyses that focus on changes in symptoms over time – for example, membership in a consistently high trajectory versus a symptom recovery trajectory, or membership in a delayed-onset trajectory versus a consistently low trajectory – would help identify characteristics of survivors who might be in need of longer-term services.

The current study aimed to advance the literature on PTSD symptom trajectories by pooling data from six studies that each included survivors of civilian-related injuries severe enough to warrant ED admission, and that each had at least three post-trauma assessments of PTSD within the first year of trauma exposure using the CAPS. We first documented the proportion of participants in each trajectory both within and across the six datasets, and then developed predictive models to elucidate the factors associated with both initial PTSD reactions and the course of PTSD symptoms over time, including demographic characteristics, type of event leading to the injury, and history of trauma exposure. By documenting the prevalence and predictors of PTSD symptom trajectories in the pooled sample, we sought to provide more generalizable information about the short-term mental health needs of potentially traumatic injury survivors reporting to EDs. To our knowledge, this is the first study to analyze PTSD symptom trajectories using pooled data.

Method

Data from this study came from the International Consortium to Predict PTSD (ICPP), a collaboration to pool longitudinal studies of hospital admissions for civilian trauma-related incidents around the world. Articles published between 1997 and 2015 were screened for eligibility, including assessment of all 17 DSM-IV PTSD symptoms at two or more time points, starting early after trauma exposure. Lead authors of identified studies were invited to join the consortium and provide itemized data. Additional information on identification of studies and efforts to pool data can be found elsewhere (Qi *et al.*, 2018). The current analysis included studies with least three assessments of PTSD symptoms using the Clinician-Administered PTSD Scale (CAPS; (Blake *et al.*, 1995) within the first post-trauma year. Six studies met these criteria: the Multisite Acute Stress Disorder study (Multisite ASD; (Bryant *et al.*, 2008), Jerusalem Trauma Outreach and Prevent Study (JTOPS; (Shalev *et al.*, 2012), Tachikawa Cohort of Motor Vehicle Accidents (TCOM; (Matsuoka *et al.*, 2009), Ohio Motor Vehicle Accident study (Ohio-MVA; (Delahanty *et al.*, 2003), Zurich Intensive Care Unit study (Zurich ICU; (Hepp *et al.*, 2008), and the Amsterdam Cortisol study (Mouthaan *et al.*, 2014), each representing a different country (Australia, Israel, Japan, United States, Switzerland, and the Netherlands, respectively). Investigators of the six studies obtained informed consent from participants using procedures approved by their local institutional review boards. The pooled sample consisted of 3,083 participants.

Measures

PTSD symptoms.—PTSD symptoms were measured in each study with the CAPS (Blake *et al.*, 1995), which is considered the "gold standard" assessment tool for PTSD. Participants reported on symptoms specifically in reference to the civilian-related injury leading to their hospital admission. The CAPS uses structured interviews to assess DSM-IV PTSD Criteria B (intrusive symptoms, e.g., unwanted memories and unpleasant dreams about the event), C (avoidance and numbing symptoms, e.g., avoidance of thoughts and feelings related to the event, feelings of detachment or estrangement from others) and D (hyperarousal symptoms, e.g., difficulty falling or staying asleep, difficulty concentrating). Each symptom is rated on frequency and intensity from 0 to 4, and symptom severity scores are calculated as the sum of all frequency and intensity ratings, ranging from 0 to 136 (Weathers *et al.*, 1999). The CAPS has been found to have good psychometric properties across a range of clinical and research settings (Weathers et al., 2001), including high inter-rater reliability, test-retest reliability, and internal consistency (Blake *et al.*, 1995, Hovens *et al.*, 1994).

Predictors.—Two categories of predictors were included in the analysis. First, demographics that were assessed across all six studies were included: age quartiles (reference = <27 years of age), gender (reference = male), race (reference = white), level of education (reference = secondary education or more), and marital status (reference = married/living with a partner at baseline). Second, we included dummy variables indicating the type of incident leading to the injury, including motor vehicle accidents (MVA), other accidents, and assaults. MVA was used as the reference category as it was the most common precipitating incident in the pooled sample. We also included a variable for prior trauma severity including a history of non-interpersonal trauma or interpersonal trauma (reference = no prior trauma). In addition to these categories of predictors, we also controlled for the data source using dummy variables, with the source contributing the most participants to the pooled sample (Multisite ASD) as the reference group. For variables missing responses (race, education, marital status, prior trauma), an indicator for missingness was included.

Data Analysis

Data analysis consisted of four steps. First, descriptive analyses were conducted in R version 3.5 (Team, 2013). Means and standard deviations of the CAPS for each time point, and frequencies of covariates were computed. One-way analysis of variance tests were conducted to examine whether CAPS severity varied significantly across studies at each time point. Chi-square tests were conducted to assess for significant variation across studies on all covariates.

Second, latent class growth analyses (LCGA) were conducted in Mplus 8.0 (Muthén and Muthén, 1998) for each dataset. Based on prior research (Galatzer-Levy *et al.*, 2018), we decided *a priori* to utilize the four-class solution from each dataset. However, models with classes ranging from 1 to 6 were conducted for descriptive purposes, and various statistical criteria (e.g., Bayesian information criteria, entropy, average posterior probabilities, Lo-Mendel-Rubin likelihood ratio test) were recorded, as per recommended guidelines (e.g., Jung & Wickrama, 2007; Andruff *et al.*, 2009; Berlin *et al.*, 2014). All models included both linear and quadratic growth terms. Given that five of the six datasets only had three data points for PTSS, the variance of intercept and growth terms for all models were constrained to facilitate convergence (Andruff *et al.*, 2009; Berlin *et al.,* 2014). Data points were anchored at the number of months since ED admission for each wave of the given study; assessments at <1 month were anchored at 0.5 months. Trajectories from the four-class model for each dataset were labeled based on intercept and slope terms with the following terms: (1) *Low*, (2) *Moderate-Low*, (3) *Moderate*, (4) *Remitting*, (5) *Fast Remitting*, (6) *High*, and (7) *Delayed.* The six datasets were then pooled, with trajectory membership included as a categorical variable, and the frequencies of predictor variables were computed.

Third, a series of predictive models was conducted using R version 3.5 (Team, 2013). Univariate differences in frequency of risk predictors between participants across studies and trajectories were assessed using likelihood-ratio χ^2 tests. Multivariable binary logistic regression models including all predictors simultaneously were then fit to estimate factors affecting initial PTSD reactions and course. Initial PTSD reactions were assessed from models predicting a *Low* trajectory versus any other trajectory, and a *Low* trajectory versus a *High* trajectory. Factors affecting PTSD course were assessed from models of a *Low* trajectory versus a *Delayed* trajectory, and a *High* trajectory versus a *Remitting* trajectory. Model fit was evaluated using Efron's R^2, the Brier Score, and the Area Under the Receiver of the Receiver Operating Characteristic (AUC).

Fourth, a series of supplementary analyses was conducted. Multivariable logistic regressions were repeated leaving one study out at a time to assess whether individual studies influenced the relationships between predictors and trajectories. Subsequently, two multivariable multinomial logistic regressions compared predictors' effects on initial PTSD reactions and course. First, a model predicting the *Delayed* and *High* trajectories versus the *Low* trajectory was fit to compare predictors of consistently high symptoms versus symptoms that onset later. A second model was fit predicting *Low* and *Remitting* trajectories versus the *High* trajectory comparing the predictors of consistently low symptoms with those that remitted over time. For both models, two multivariable multinomial logistic regressions were fit for each predictor to test the consistency of effect across outcomes. Predictors were first constrained to be equal across both outcomes and in the second regression predictors could vary by outcome. A likelihood ratio test was then used to compare model fits and indicate whether predictors' effects varied by outcome.

Results

Descriptive Statistics

Table 1 shows descriptive statistics for predictor variables. Significant variation was found across age quartiles ($\chi_2^{15} = 122.89$, $p < .001$), gender ($\chi_2^{5} = 105.10$, $p < .001$), education ($\chi_2^{10} = 233.68$, $p < .001$), and marital status ($\chi_2^{10} = 188.05$, $p < .001$). Rates of prior non-interpersonal (27.7–43.7%) and interpersonal trauma (24.7–59.5%) ranged across studies with prior trauma not assessed in the Zurich ICU study ($\chi_2^{15} = 1,104.56$, $p < .001$). White participants made up a majority of five studies except for TCOM where 100% of the participants were non-white ($\chi_2^{10} = 1,707.19$, $p < .001$). Significant differences in index trauma type were reported across studies as two studies (TCOM and Ohio-MVA) recruited motor vehicle accidents (χ_2^{15} = 122.89, $p < .001$). Significant differences in mean CAPS severity across studies were found for three time points: <1 month ($F_1 = 4.49$, $p = .034$), 1 month ($F_3 = 340.39$, $p < .001$), and 6 months ($F_4 = 27.27$ p < .001).

Latent Class Growth Analysis

Statistical information on all of the LCGA models examined for each dataset are provided in Supplemental Tables 1–6. The number and percentage in each trajectory across studies from the four-class solution are presented in Table 2. A *Low* trajectory and *High* trajectory were common to all six studies. *Moderate-low* and *Fast Remitting* trajectories were only found in one study each. Participants in these trajectories were combined with those in the *Moderate* and *Remitting* categories, respectively, resulting in five unique trajectories. Supplemental Table 7 provides growth terms and descriptive data for participants with most likely membership in each trajectory from each dataset. Observed means for each dataset and the pooled sample are plotted in Figure 1.

Table 3 shows the descriptive data for participants in each of the five trajectories for the pooled dataset. Significant differences were found across age quartiles (χ_2^{12} = 61.46, $p < .001$), gender (χ_2^{4} = 112.29, $p < .001$), race (χ_2^{8} = 64.09, $p <.001$), education (χ_2^{8} = 74.02, $p < .001$), marital status (χ_2^{8} = 54.73, $p <.001$), prior interpersonal trauma (χ_2^{12} = 156.09, $p < .001$), and index trauma (χ_2^{8} = 124.83, $p < .001$).

Predicting Trajectory Membership

Table 4 summarizes the results of the initial PTSD reactions and course prediction models.

Initial PTSD reaction models.—Logistic regression predicting Any Other trajectory versus the *Low* trajectory found that third quartile of age (OR = 1.49, 95% CI: 1.17–1.91), female gender (OR = 2.00, 95% CI: 1.69–2.36), non-white race (OR = 1.6, 95% CI: 1.12–2.30), prior interpersonal trauma (OR = 1.65, 95% CI: 1.29–2.12), and experiencing an assault as the index trauma (OR = 2.31, 95% CI: 1.65–3.25) increased the risk for being in Any Other trajectory, while experiencing a non-MVA accident decreased risk (OR = 0.65, 95% CI: 0.52–0.81). Descriptive statistics for the All Other trajectories versus *Low* trajectory are available in Supplemental Table 8.

For the PTSD onset model of *High* versus *Low* trajectories a similar pattern was found with second (OR = 1.65, 95% CI: 1.03–2.65) and third quartile of age (OR = 2.38, 95% CI: 1.46 −3.87), female gender (OR = 2.63, 95% CI: 1.90–3.65), non-white race (OR = 2.66, 95% CI: 1.38–5.12), having less than a secondary education (OR = 2.83, 95% CI: 1.93–4.15), prior interpersonal trauma (OR = 3.20, 95% CI: 1.83–5.61), and experiencing an assault as the index trauma (OR = 4.74, 95% CI: 2.86–7.85) increasing the risk for being in the *High* trajectory.

PTSD course models.—Female gender increased risk for being in the *Delayed* versus the *Low* trajectory (OR = 1.56, 95% CI: 1.07–2.27), as did experiencing an assault (OR = 2.67, 95% CI: 1.32–5.40), while experiencing a non-MVA accident decreased risk (OR = 0.49, 95% CI: 0.31–0.79). Prior trauma experience was overall statistically significant (*p* = .002), although no specific trauma type was individually predictive. Descriptive statistics for the *Low* versus *Delayed* trajectories are available in Supplemental Table 9.

In the *High* versus *Remitting* model, having less than a secondary education (1.89, 95% CI: 1.16–3.09), prior interpersonal trauma (OR=2.57, 95% CI: 1.34–4.93), and experiencing an assault (OR=2.09, 95% CI: 1.17–3.71) increased risk for being in the *High* trajectory. Descriptive statistics for the High versus Remitting analysis are available in Supplemental Table 10.

Supplementary Analyses

Across all models, study dummy variables were significant indicating differences existed in the prevalence of the outcome trajectories. Logistic regressions without each study were concordant with the pooled results (see Supplemental Figures 1–3).

Results from the multinomial regression found all predictors were significantly stronger predictors of initial PTSD onset compared to course of PTSD symptoms (p<.001; see Supplemental Tables 11 and 12).

Discussion

The current study included data from six studies of hospital admissions for civilian-related injuries, evaluating initial PTSD reactions and the course of PTSD symptoms over the first post-trauma year. Based on previous research, we first examined four-class trajectory models for the six studies. Consistently low and consistently high symptom trajectories were found across all studies, whereas other trajectories (e.g., recovery, moderate, delayed) were not. When we pooled data from the six studies, initial PTSD reaction models showed that female gender, non-white race, prior interpersonal trauma, and assaultive injuries were robust risk factors for initial PTSD reactions. In PTSD course models, female gender and assaultive injuries increased the risk of membership in the *Delayed* versus *Low* trajectory group. Among those with initially high symptoms, lower education, prior interpersonal trauma, and assaultive injuries increased risk of membership in the *High* versus *Remitting* trajectory group.

Our examination of prototypical patterns of trajectories revealed that consistently low and consistently high PTSD symptoms are robust post-trauma trajectories. These findings align with a large body of literature documenting the presence of these trajectories among people who have been exposed to potentially traumatic events (Galatzer-Levy *et al.*, 2018). Results suggest that practitioners working with injury survivors can expect that a majority of survivors will report consistently low symptoms over the first year, while a minority of survivors will report consistently high symptoms over the first year.

On the other hand, other trajectories, including a *Remitting* trajectory, were not apparent across studies. This is in contrast to findings from the recent review of PTSD trajectories by Galatzer-Levy and colleagues (2018), which found *Recovery* to be the second most commonly observed trajectory across 54 studies. Galatzer-Levy and colleagues noted that substantive differences in populations (e.g., police force workers versus civilians) were associated with heterogeneity in their estimates. However, for the current study it is less likely, although not impossible, that substantive population differences are the reason we observed heterogeneity in estimates. This is because a major strength of this study is the inclusion of data from similar populations (i.e., those presenting at hospitals for civilian related injuries). Instead, it seems more likely that inconsistent findings in this study may be due to contextual factors such as comorbid symptoms, developmental stage, social network characteristics, physical health, or coping styles (Bonanno *et al.*, 2015, Fan *et al.*, 2015, Galatzer-Levy *et al.*, 2018, Lai *et al.*, 2013).

One notable caveat when interpreting the pooled results is that one of the studies (JTOPS) had markedly different proportions of participants with most likely membership in each trajectory than the other five studies. For example, the percentage of participants in the *Low* trajectory for JTOPS was 40%, compared to 68–80% across the other studies. This is likely due to JTOPS having distinctive inclusion criteria – namely, that eligible participants were required to meet DSM-IV PTSD Criterion A and have acute stress symptoms upon enrollment. This discrepancy illuminates how systematic differences in sampling even within the same trauma context can influence the nature and proportion of PTSS trajectories. The pooled proportion for the *Low* trajectory is therefore likely an underestimate for the population of adult survivors of civilian-related injuries admitted to EDs, whereas the pooled proportions for the trajectories in JTOPS characterized by temporary or chronic symptom elevations (*Remitting*, *Fast remitting*, and *High*) are likely overestimates.

When we evaluated risk factors for initial PTSD reactions, the risk factors we identified (i.e., female gender, non-white race, prior interpersonal trauma, and assault) were consistent with prior research (Bryant *et al.*, 2015, Fink *et al.*, 2017, Sripada *et al.*, 2017). These findings suggest that these risk factors should be included in prediction tools to identify survivors at risk for initially high levels of PTSD symptoms as part of routine post-injury psychiatric evaluations.

PTSD course models provided initial evidence that female gender and assaultive injury differentiated between those who were more likely to report delayed symptoms, versus consistently low symptoms. This again provides suggestions for survivors that should be targeted for follow-up. It is unclear why these particular risk factors are important. It is possible female gender may represent other factors, such as women's greater use of alcohol to cope with PTSD symptoms and gender-related psychobiological stress responses (Olff *et al.*, 2007), that confer risk for delayed reactions. These findings may also represent gender differences in exposure to intervening trauma. For example, female participants might have been more likely to experience interpersonal violence over the course of the studies, thereby heightening their risk for delayed PTSD symptoms (Benjet *et al.*, 2016; McLaughlin *et al.*, 2013). In a similar vein, injuries due to assaultive violence might have been more likely than those due to motor vehicle or other accidents to yield secondary stressors, such as difficulties in social relationships, legal problems, and economic strain, thereby increasing risk for delayed PTSD (Lowe *et al.*, 2017). These are issues that warrant further study.

Finally, several risk factors distinguished between with consistently high versus recovering symptoms. In particular, lower education, prior interpersonal trauma, and assault were predictors of chronic responses. These findings are consistent with prior findings identifying low education and prior interpersonal trauma as risk factors for more symptomatic trajectories (Muzik *et al.*, 2016, Pietrzak *et al.*, 2014). Perhaps most notable were the findings related to assault. Although this finding is consistent with prior research showing assaultive violence to be associated with increased risk for PTSD, relative to other types of trauma (McLaughlin *et al.*, 2013), only one trajectory study to our knowledge has explored whether assaultive trauma is associated with membership in chronically symptomatic trajectories (Lowe *et al.*, 2014). This study, however, did not look at PTSD symptom trajectories in the context of civilian-related injuries in EDs, but rather examined them among urban residents who each reported on symptoms in reference to their self-identified worst trauma from an inventory of potentially traumatic events.

Our findings, in contrast, suggest that, within the context of civilian-related injuries, the nature of the exposure is predictive of trajectory membership, and reflect the importance of identifying trauma-related characteristics that confer risk for distressed trajectories. More generally, the results regarding risk and protective factors are particularly important given their relevance for tiered intervention strategies. As this study focused on civilian trauma, results suggest that providers of psychological services in emergency departments should be mindful of these risk factors, especially in the presence of moderate-to-high levels of initial PTSD symptom presentation. The findings suggest that people in these groups may be particularly vulnerable to persistent symptoms and thus should be targets of outreach efforts.

Several limitations should be considered in interpreting these results. First, although pooling data was a strength of our analysis, variability across the individual studies, including in the timing of assessments and number of cases, could have influenced patterns of results. We accounted for these differences by controlling for source of the data in predictive analyses and replicating analyses excluding one dataset at a time. Second, there was systematically missing data in our predictive analyses, limiting the extent to which our results generalize to the full population of injury survivors. Third, we were only able to study predictors that were assessed across studies. Researchers should work toward developing common batteries for post-trauma research, which would facilitate pooled analyses in the future. Studies should in particular include assessments of pre-trauma psychopathology, which prior work has shown to be a robust predict of PTSD symptoms (DiGangi et al., 2013). Fourth, the studies in the pooled analyses included multiple cultural contexts. Although this increases the generalizability of the study, this approach assumes that PTSD symptom trajectories are a cross-cultural phenomenon. Fifth, this study focused on the first year after traumatic events. Although we consider this first year particularly important in planning intervention and assessment, this decision may have prevented us from capturing patterns that only emerge over a longer period of time. Finally, we included all participants in the analysis, regardless of their initial symptom severity. Although this maximized statistical power and made our findings more generalizable to the population of civilians who present to emergency departments with injuries, it is likely that some participants would not consider their injuries to be traumatic and that a different pattern of results would have emerged had we focused on only those participants who surpassed a certain threshold of baseline distress. Further analyses of these data will explore the latter possibility, providing insight into PTSD symptom trajectories among the population of initially symptomatic injury survivors.

Despite these limitations, the results provide important information about the form and course of PTSD trajectories, and the factors that are associated with both initial PTSD reactions and the course of symptoms over the first post-trauma year. The findings highlight the diversity of responses to potentially traumatic events and the need for researchers and clinicians to approach assessment and treatment with this heterogeneity in mind. Yet, important questions remain. Future research is needed that examines injury across the lifespan to understand the degree to which trajectories may differ by stage of development. In addition, studies with longer follow-up periods and various types of trauma exposure will enable us to understand whether trajectories may change across the post-trauma period or across types of trauma.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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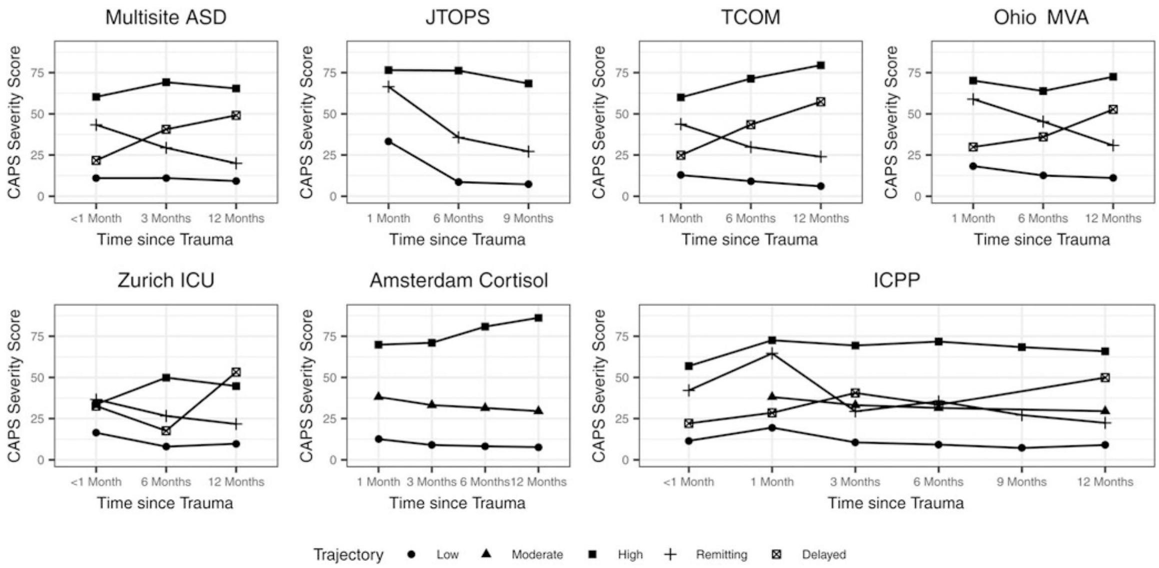

Figure 1.

Plot of estimated mean values at each time point for trajectories from the four-class latent growth analysis. In JTOPS, the Fast-remitting and Remitting categories were combined and in the Amsterdam Cortisol study the Moderate-low and Moderate categories were combined. CAPS = Clinician-Administered PTSD Scale.

Table 1.

Descriptive Data for Included Studies and the Pooled ICPP Dataset

Variable	Multisite ASD	JTOPS	TCOM	Ohio-MVA	Zurich ICU	Amsterdam Cortisol	ICPP	$\chi 2_{df}$; p-value
Age Quartile								χ^2_{15}=122.89
<27	272 (26.1%)	181 (24.6%)	59 (33.9%)	87 (30.4%)	36 (29.8%)	119 (16.4%)	754 (24.5%)	$p < .001$
27–37	231 (22.2%)	263 (35.8%)	39 (22.4%)	52 (18.2%)	24 (19.8%)	180 (24.8%)	789 (25.6%)	
38–48	283 (27.2%)	146 (19.9%)	28 (16.1%)	81 (28.3%)	29 (24%)	179 (24.7%)	746 (24.2%)	
>48	255 (24.5%)	145 (19.7%)	48 (27.6%)	66 (23.1%)	32 (26.4%)	248 (34.2%)	794 (25.8%)	
Gender								χ^2_5=105.1
Male	761 (73.1%)	379 (51.6%)	126 (72.4%)	163 (57%)	91 (75.2%)	462 (63.6%)	1982 (64.3%)	$p < .001$
Female	280 (26.9%)	356 (48.4%)	48 (27.6%)	123 (43%)	30 (24.8%)	264 (36.4%)	1101 (35.7%)	
Race								χ^2_{10}=1707.19
White	622 (59.8%)	735 (100%)	0 (0%)	262 (91.6%)	99 (81.8%)	650 (89.5%)	2368 (76.8%)	$p < .001$
Non-White	69 (6.6%)	0 (0%)	174 (100%)	23 (8%)	0 (0%)	64 (8.8%)	330 (10.7%)	
Missing	350 (33.6%)	0 (0%)	0 (0%)	1 (0.3%)	22 (18.2%)	12 (1.7%)	385 (12.5%)	
Education								χ^2_{10}=233.68
Secondary or Greater	692 (66.5%)	594 (80.8%)	139 (79.9%)	261 (91.3%)	105 (86.8%)	569 (78.4%)	2360 (76.5%)	$p < .001$
Less than Secondary	234 (22.5%)	86 (11.7%)	35 (20.1%)	24 (8.4%)	16 (13.2%)	152 (20.9%)	547 (17.7%)	
Missing	115 (11%)	55 (7.5%)	0 (0%)	1 (0.3%)	0 (0%)	5 (0.7%)	176 (5.7%)	
Marital Status								χ^2_{10}=188.05
Married/living with partner	459 (44.1%)	343 (46.7%)	77 (44.3%)	120 (42%)	52 (43%)	393 (54.1%)	1444 (46.8%)	$p < .001$
Single/not living with partner	476 (45.7%)	337 (45.9%)	97 (55.7%)	165 (57.7%)	69 (57%)	332 (45.7%)	1476 (47.9%)	
Missing	106 (10.2%)	55 (7.5%)	0 (0%)	1 (0.3%)	0 (0%)	1 (0.1%)	163 (5.3%)	
Prior Trauma								χ^2_{15}=1104.56
No prior trauma	133 (12.8%)	195 (26.5%)	38 (21.8%)	15 (5.2%)	0 (0%)	90 (12.4%)	471 (15.3%)	$p < .001$
Prior non-interpersonal trauma	288 (27.7%)	234 (31.8%)	76 (43.7%)	120 (42%)	0 (0%)	278 (38.3%)	996 (32.3%)	
Prior interpersonal trauma	619 (59.5%)	224 (30.5%)	43 (24.7%)	127 (44.4%)	0 (0%)	357 (49.2%)	1370 (44.4%)	
Missing	1 (0.1%)	82 (11.2%)	17 (9.8%)	24 (8.4%)	121 (100%)	1 (0.1%)	246 (8%)	
Trauma Type								χ^2_{10}=558.12

Variable	Multisite ASD	JTOPS	TCOM	Ohio-MVA	Zurich ICU	Amsterdam Cortisol	ICPP	$\chi 2_{df}$; p-value
MVA	674 (64.7%)	604 (82.2%)	174 (100%)	286 (100%)	75 (62%)	476 (65.6%)	2289 (74.2%)	p <.001
Other accidents	310 (29.8%)	41 (5.6%)	0 (0%)	0 (0%)	46 (38%)	218 (30%)	615 (19.9%)	
Assaults (intentional harm)	57 (5.5%)	90 (12.2%)	0 (0%)	0 (0%)	0 (0%)	32 (4.4%)	179 (5.8%)	
Mean CAPS Severity (SD)								**F_{df}, p-value**
<1 month	18.12 (16.81)				21.5 (15.14)		18.47 (16.67)	$F_1 = 4.49$, p =.034
1 month		56.77 (25.14)	19.71 (17.64)	26.02 (21.24)		22.04 (19.98)	36.74 (27.89)	$F_3 = 340.39$, p < .001
3 months	20.25 (20.88)					18.53 (17.71)	19.84 (20.18)	$F_1 = 1.55$ p = .214
6 months		29.33 (25.77)	15.64 (16.13)	20.21 (19.21)	14.79 (13.84)	17.93 (18.84)	22.47 (22.27)	$F_4 = 27.27$ p < .001
9 months		31.51 (26.73)					31.51 (26.73)	N/A
1 year	19.03 (21.91)		16.88 (20.96)	18.56 (19.64)	16.69 (15.12)	15.69 (17.23)	17.84 (20.07)	$F_4 = 2.04$ p = .086

Note. df = degrees of freedom; CAPS = Clinician-Administered PTSD Scale; SD = Standard Deviation;

Table 2.

Number of participants in each trajectory and the percentage each trajectory encompasses in each individual study and the pooled ICPP dataset.

Trajectory	Multisite ASD	JTOPS	TCOM	Ohio-MVA	Zurich ICU	Amsterdam Cortisol	ICPP
Low	750 (72%)	292 (40%)	137 (79%)	229 (80%)	88 (73%)	491 (68%)	1987 (64%)
Moderate-Low	-	-	-	-	-	153 (21%)	-
Moderate	-	-	-	-	-	54 (7%)	207 (7%)
Remitting	86 (8%)	139 (19%)	25 (14%)	23 (8%)	19 (16%)	-	521 (17%)
Fast remitting	-	229 (31%)	-	-	-	-	-
High	63 (6%)	75 (10%)	6 (3%)	18 (6%)	9 (7%)	28 (4%)	199 (6%)
Delayed	142 (14%)	-	6 (3%)	16 (6%)	5 (4%)	-	169 (5%)
N	1041 (34%)	735 (24%)	174 (6%)	286 (9%)	121 (4%)	726 (24%)	3083 (100%)

Table 3.

Number of participants and the percentage encompassed in each predictor category across trajectories and in the pooled ICPP dataset.

Variable	Low	Moderate	Remitting	High	Delayed	ICPP	χ^2_{df}; p-value
Age Quartile							χ^2_{12}=61.46
<27	501 (25.2%)	29 (14%)	145 (27.8%)	37 (18.6%)	42 (24.9%)	754 (24.5%)	p < .001
27–37	476 (24%)	60 (29%)	158 (30.3%)	59 (29.6%)	36 (21.3%)	789 (25.6%)	
38–48	451 (22.7%)	58 (28%)	114 (21.9%)	65 (32.7%)	58 (34.3%)	746 (24.2%)	
>48	559 (28.1%)	60 (29%)	104 (20%)	38 (19.1%)	33 (19.5%)	794 (25.8%)	
Gender							χ^2_{4}=112.29
Male	1400 (70.5%)	110 (53.1%)	258 (49.5%)	98 (49.2%)	116 (68.6%)	1982 (64.3%)	p < .001
Female	587 (29.5%)	97 (46.9%)	263 (50.5%)	101 (50.8%)	53 (31.4%)	1101 (35.7%)	
Race							χ^2_{8}=64.09
White	1491 (75%)	175 (84.5%)	441 (84.6%)	147 (73.9%)	114 (67.5%)	2368 (76.8%)	p < .001
Non-White	233 (11.7%)	26 (12.6%)	34 (6.5%)	21 (10.6%)	16 (9.5%)	330 (10.7%)	
Missing	263 (13.2%)	6 (2.9%)	46 (8.8%)	31 (15.6%)	39 (23.1%)	385 (12.5%)	
Education							χ^2_{8}=74.02
Secondary or Greater	1542 (77.6%)	172 (83.1%)	404 (77.5%)	118 (59.3%)	124 (73.4%)	2360 (76.5%)	p < .001
Less than Secondary	361 (18.2%)	33 (15.9%)	72 (13.8%)	55 (27.6%)	26 (15.4%)	547 (17.7%)	
Missing	84 (4.2%)	2 (1%)	45 (8.6%)	26 (13.1%)	19 (11.2%)	176 (5.7%)	
Marital Status							χ^2_{8}=54.73
Married/living with partner	953 (48%)	107 (51.7%)	222 (42.6%)	90 (45.2%)	72 (42.6%)	1444 (46.8%)	p < .001
Single/not living with partner	953 (48%)	100 (48.3%)	252 (48.4%)	88 (44.2%)	83 (49.1%)	1476 (47.9%)	
Missing	81 (4.1%)	0 (0%)	47 (9%)	21 (10.6%)	14 (8.3%)	163 (5.3%)	
Prior Trauma							χ^2_{12}=156.09
No prior trauma	297 (14.9%)	18 (8.7%)	115 (22.1%)	19 (9.5%)	22 (13%)	471 (15.3%)	p <.001
Prior non-interpersonal trauma	700 (35.2%)	70 (33.8%)	150 (28.8%)	45 (22.6%)	31 (18.3%)	996 (32.3%)	
Prior interpersonal trauma	848 (42.7%)	119 (57.5%)	182 (34.9%)	111 (55.8%)	110 (65.1%)	1370 (44.4%)	
Missing	142 (7.1%)	0 (0%)	74 (14.2%)	24 (12.1%)	6 (3.6%)	246 (8%)	
Trauma Type							χ^2_{8}=124.83

Variable	Low	Moderate	Remitting	High	Delayed	ICPP	χ^2_{df}; p-value
MVA	1449 (72.9%)	153 (73.9%)	415 (79.7%)	143 (71.9%)	129 (76.3%)	2289 (74.2%)	p <.001
Other accidents	472 (23.8%)	41 (19.8%)	54 (10.4%)	22 (11.1%)	26 (15.4%)	615 (19.9%)	
Assaults (intentional harm)	66 (3.3%)	13 (6.3%)	52 (10%)	34 (17.1%)	14 (8.3%)	179 (5.8%)	

Note. df = degrees of freedom

Table 4.

Results of Models Predicting Trajectory Membership for Initial PTSD Reaction Models and PTSD Course Models (OR [95% CI]).

Variables	Initial PTSD Reaction Models		PTSD Course Models	
	All Other (1) vs. Low (0)	**High (1) vs. Low (0)**	**Delayed (1) vs. Low (0)**	**High (1) vs. Remitting (0)**
Intercept	0.17^{***} [0.12–0.24]	0.01^{***} [0–0.02]	0.17^{***} [0.09–0.32]	0.21^{*} [0.08–0.54]
Age Quartile				
27–37	1.15 [0.91–1.45]	1.65^{*} [1.03–2.65]	1.14 [0.69–1.89]	1.63 [0.93–2.84]
38–48	1.49^{*} [1.17–1.91]	2.38^{**} [1.46–3.87]	1.67^{*} [1.04–2.69]	2.26^{*} [1.27–4.04]
>48	0.92 [0.71–1.18]	0.96 [0.56–1.66]	0.96 [0.56–1.64]	1.81 [0.96–3.39]
Difference	χ^2_3=19.71; p < .001	χ^2_3=20.71; p < .001	χ^2_3=7.28; p = .064	χ^2_3=7.7; p = .053
Gender				
Female	2^{***} [1.69–2.36]	2.63^{***} [1.9–3.65]	1.56^{*} [1.07–2.27]	1.14 [0.78–1.68]
Difference	χ^2_1=64.91; p < .001	χ^2_1=33.48; p < .001	χ^2_1=5.36; p = .021	χ^2_1=0.45; p = .504
Race				
Non-White	1.6^{*} [1.12–2.3]	2.66^{*} [1.38–5.12]	0.83 [0.4–1.72]	0.96 [0.28–3.27]
Missing	1.19 [0.88–1.61]	1.38 [0.78–2.44]	0.74 [0.46–1.19]	0.69 [0.34–1.4]
Difference	χ^2_2=7.29; p = .026	χ^2_2=9.02; p = .011	χ^2_2=1.66; p = .437	χ^2_2=1.08; p = .584
Education				
Less than Secondary	1.16 [0.93–1.43]	2.83^{***} [1.93–4.15]	0.72 [0.45–1.16]	1.89^{*} [1.16–3.09]
Missing	2.05^{*} [1.19–3.55]	4.59^{*} [1.84–11.46]	2.37 [0.95–5.92]	2.89 [0.99–8.49]
Difference	χ^2_2=7.92; p = .019	χ^2_2=34.83; p < .001	χ^2_2=5.7; p = .058	χ^2_2=9.19; p = .01
Marital Status				
Single/not living with partner	1.07 [0.89–1.28]	0.95 [0.66–1.36]	1.03 [0.71–1.51]	0.77 [0.49–1.2]
Missing	0.94 [0.52–1.71]	0.81 [0.28–2.35]	0.62 [0.21–1.87]	0.64 [0.2–2.05]
Difference	χ^2_2=0.59; p = .745	χ^2_2=0.19; p = .91	χ^2_2=0.84; p = .657	χ^2_2=1.68; p = .432
Prior Trauma				
Prior non-interpersonal	1.01 [0.78–1.3]	1.54 [0.84–2.8]	0.59 [0.32–1.07]	1.71 [0.87–3.37]
Prior interpersonal	1.65^{***} [1.29–2.12]	3.2^{***} [1.83–5.61]	1.33 [0.8–2.24]	2.57^{*} [1.34–4.93]

Variables	Initial PTSD Reaction Models		PTSD Course Models	
	All Other (1) vs. Low (0)	**High (1) vs. Low (0)**	**Delayed (1) vs. Low (0)**	**High (1) vs. Remitting (0)**
Missing	1.88* [1.17–3.03]	3.54* [1.44–8.66]	0.44 [0.05–3.54]	1.73 [0.69–4.29]
Difference	χ^2_3=35.19; p < .001	χ^2_3=26.05; p < .001	χ^2_3=14.49; p = .002	χ^2_3=8.61; p = .035
Trauma Type				
Other accidents	0.65** [0.52–0.81]	0.61 [0.37–1.02]	0.49* [0.31–0.79]	0.55 [0.28–1.08]
Assaults (intentional harm)	2.31*** [1.65–3.25]	4.74*** [2.86–7.85]	2.67* [1.32–5.4]	2.09* [1.17–3.71]
Difference	χ^2_2=42.05; p < .001	χ^2_2=44.06; p < .001	χ^2_2=18.55; p < .001	χ^2_2=10.48; p < .001
Study				
JTOPS	3.94*** [3.07–5.06]	4.03*** [2.45–6.61]	-	0.27*** [0.15–0.49]
TCOM	0.56* [0.33–0.94]	0.39 [0.13–1.16]	0.31* [0.11–0.94]	0.35 [0.08–1.55]
Ohio-MVA	0.61* [0.43–0.87]	1.22 [0.64–2.33]	0.32** [0.18–0.58]	1.12 [0.5–2.54]
Zurich ICU	0.92 [0.49–1.73]	1.77 [0.57–5.47]	0.83 [0.09–7.78]	0.98 [0.29–3.39]
Amsterdam Cortisol	1.42* [1.13–1.8]	0.92 [0.54–1.56]	-	-
Difference	χ^2_5=187.15; p < .001	χ^2_5=46.75; p < .001	χ^2_5=17.52; p = .004	χ^2_5=30.39; p < .001
N	3083	2186	2156	720
Efron's R^2	0.15	0.14	0.12	0.24
Brier	0.2	0.07	0.06	0.15
AUC	0.73	0.79	0.83	0.77

Note:

* $p < .05$

** $p < .01$

*** $p < .001$;

AUC = Area Under the Curve of the Receiver Operator Characteristic.