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Socio-demographic and trauma-related predictors of depression within eight weeks of motor vehicle collision in the AURORA study

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Abstract

Background: This is the first report on the association between trauma exposure and depression from the AURORA multisite longitudinal study of adverse post-traumatic neuropsychiatric sequelae (APNS) among participants seeking emergency department (ED) treatment in the aftermath of a traumatic life experience.

Methods: We focus on participants presenting at EDs after a motor vehicle collision (MVC), which characterizes most AURORA participants, and examine associations of participant socio-demographics and MVC characteristics with 8-week depression as mediated through peritraumatic symptoms and 2-week depression.

Results: Eight-week depression prevalence was relatively high (27.8%) and associated with several MVC characteristics (being passenger vs. driver; injuries to other people). Peritraumatic distress was associated with 2-week but not 8-week depression. Most of these associations held when controlling for peritraumatic symptoms and, to a lesser degree, depressive symptoms at 2-weeks post-trauma.

Conclusions: These observations, coupled with substantial variation in the relative strength of the mediating pathways across predictors, raises the possibility of diverse and potentially complex underlying biological and psychological processes that remain to be elucidated in more in-depth analyses of the rich and evolving AURORA database to find new targets for intervention and new tools for risk-based stratification following trauma exposure.

Keywords

INTRODUCTION

Although most individuals experiencing a trauma do not develop adverse post-traumatic neuropsychiatric sequelae (APNS), a substantial number do (Santiago et al., 2013; Koenen et al., 2017). The four most notable APNS are post-traumatic stress disorder, post-concussion syndrome, major depression, and regional or widespread pain syndrome (Kessler, 2000; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995; Roberts, Gilman, Breslau, Breslau, & Koenen, 2011; Boscarino, 2006). These are a source of enormous morbidity and mortality (Atwoli, Stein, Koenen & McLaughlin, 2015) but their effects may be preventable because opportunities exist to screen and initiate preventive interventions among the 40 million Americans who present at an emergency department (ED) each year in the immediate aftermath of trauma (Roberts et al., 2011). However, efforts to develop such interventions are hampered by APNS not being characterized adequately across molecular, neural, physiological, cognitive, behavioral, or symptom levels, leading to little information existing about the pathogenesis of discrete APNS or how to identify-intervene with people at high APNS risk after trauma exposure.

Progress will require programmatic research. The National Institute of Mental Health recently initiated a collaborative study to do this known as AURORA (Advancing Understanding of RecOvery afteR traumA). AURORA is designed to collect prospective genomic, neuroimaging, psychophysical, physiological, neurocognitive, digital phenotype, and self-reported data from an enriched sample of approximately 5,000 trauma survivors from EDs in the early aftermath of trauma and follow them for one year. As described in more detail elsewhere (McLean et al., in press), traditional APNS and their intermediate phenotypes are characterized in AURORA with both self-report scales and biomarkers from different Research Domain Criteria (RDoC) "units of analysis" (National Institute of Mental Health, n.d.) to facilitate hypothesis testing about influences of specific pre-trauma, trauma-related, and recovery-related factors on onset, course, and severity of these outcomes.

Initial AURORA analyses are focusing on the separate traditional APNS in the first 8 weeks after trauma exposure in preparation for subsequently integrating information across multivariate symptom profiles. Our first report focused on post-traumatic stress disorder (PTSD; Kessler et al., in press). The current report focuses on depression. We consider only the AURORA respondents who were involved in a motor vehicle collision (MVC), as this makes up the vast majority of initial AURORA participants. We consider associations of socio-demographic and MVC characteristics with depression as of our 8-week assessment as mediated through peritraumatic distress and dissociation and depression as of a 2-week assessment.

This focus on depression is important because even though depression is significantly elevated post-trauma (Breslau, Davis, Peterson, & Schultz, 2000; Fergusson, Horwood, Boden, & Mulder, 2014; Pozzato et al., 2020a), the emphasis of most post-trauma studies is on PTSD. Importantly, there are ongoing debates whether post-traumatic predictors of depression and PTSD are the same or different (Breslau et al., 2000; McFarlane & Papay, 1992; Tracy, Norris, & Galea, 2011), an issue we will address in future AURORA analyses

and that was examined recently by Pozzato et al. (2020a), who found high rates of co-occurrence and evidence for shared vulnerability factors in participants recruited within 28 days after an MVC and followed for one year (see also Pozzato et al., 2020b).

Previous research suggests that a number of socio-demographic variables (most notably, sex, race-ethnicity, and socioeconomic status) and diverse indicators of trauma severity predict anxiety and depression in the aftermath of trauma exposure (Lowe, Sampson, Gruebner, & Galea, 2015; Tang, Liu, Liu, Xue, & Zhang, 2014; Kazantzis et al., 2012; Hruska, Irish, Pacella, Sledjeski, & Delahanty, 2014; Pozzato et al., 2020a). An important aim of the current study is to examine whether these variables predict depression 8 weeks after an MVC. Existing studies suggest that peritraumatic distress predicts depression 30 days post-injury (Bunnell, Davidson, Anton, Crookes, & Ruggiero, 2018) and that peritraumatic dissociation has a strong cross-sectional association with depression (Duncan, Dorahy, Hanna, Bagshaw & Blampied, 2013; Bronner et al., 2009). Given these findings, another important aim of the current study is to see how much the associations between socio-demographic predictors and MVC characteristics are mediated by peritraumatic symptoms. Finally, we do not know how much the associations of socio-demographics, MVC characteristics, or peritraumatic symptoms with 8-week depression are due to more proximal associations with early depression rather than persistence of these early symptoms. A final important aim of this study is to investigate these important questions of APNS dynamics in our 2-week and 8-week surveys. Subsequent reports will investigate predictors of comorbid PTSD-depression, pure PTSD, and pure depression.

PARTICIPANTS AND METHODS

Participants

AURORA enrollment began September 2017 after approval by the Biomedical IRB at UNC Chapel Hill and subsequently by all participating institutions. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

The cases considered here are from the first data freeze of respondents who completed the 8-week assessment (described below) as of late March 2019. Enrollment occurred at 23 urban EDs across the US. Eligibility required presentation at the ED within 72 hours of exposure to a qualifying trauma (physical or sexual assault, MVC, other life-threatening traumatic events). Respondents had to be ages 18-75, able to speak-read English, oriented and able to follow protocol, and to have had a smart phone for >1 year (Supplementary Figure 1). We excluded patients with solid organ injuries (AAST Grade >1), significant hemorrhage, requiring a chest tube or operation with anesthesia, or likely to be admitted for >72 hours. However, patients admitted to the hospital from the ED not anticipated to require hospitalization > 72 hours were eligible to enroll during hospitalization. And patients discharged from the ED were eligible to return for enrollment within 72 hours of discharge if missed when they were in the ED.

Research assistants (RAs) employed at the participating EDs screened ED records of all patients immediately after intake and approached all potentially eligible patients in the ED (or by phone if already discharged). RAs informed patients about general study aims, expectations for participation, and the voluntary nature of participation, and then discussed risks and benefits before seeking written informed consent. RAs also contacted eligible hospitalized patients for recruitment. A total of 666 patients met the above criteria, provided informed consent, and completed our baseline assessment while in the ED or when hospitalized and the 2-week and 8-week assessments. More detailed information on inclusion criteria are presented elsewhere (McLean et al., in press).

Measures

Each consented participant received an interviewer-administered assessment with both self-report questions and biological sample collections described elsewhere (McLean et al., in press). Subsequent 2-week and 8-week web surveys were sent by text or e-mail for self-completion or with the help of telephone interviewers. Each participant was reimbursed $60 for the ED assessment and $40 each for the 2-week and 8-week surveys.

Socio-demographics and MVC characteristics: Information was recorded on basic socio-demographics (age, sex, race-ethnicity, marital status, education, income, employment status). MVC characteristics were then abstracted from chart reviews and assessed in interviews and a self-report questionnaire. Characteristics considered here include such things as if the participant was the driver or passenger, the nature of the collision (i.e., with a moving or stationary object), amount of vehicle damage, severity of injuries sustained by the participant and others (McLean et al., 2009). Severity of injury was recorded in the Abbreviated Injury Scale (AIS; Loftis, Price, & Gillich, 2018). Overall pain severity was assessed in the ED with a single question using a 0-10 response scale where 0 means "no pain or tenderness" and 10 means "severe pain or tenderness" (Farrar, Young, LaMoreaux, Werth, & Poole, 2001). Comparable questions were asked about severity of 20 other symptoms, including 12 from the Pennebaker Inventory of Limbic Languidness scale (PILL; Pennebaker & Watson, 1991) and 8 from the Rivermead Post-Concussion Symptoms Questionnaire (RPQ; King, Crawford, Wenden, Moss, & Wade, 1995). Each individual-level scores was standardized to a mean of 0 and variance of 1. These 20 standardized scores were then summed into an overall scale (Cronbach's α=.85).

Peritraumatic distress and dissociation: Peritraumatic distress and dissociation were assessed in the ED with 8 items from the Peritraumatic Distress Inventory (PDI; Brunet et al., 2001) and the 5-item revised Michigan Critical Events Perception Scale (MCEPS; Michaels et al., 1999). Cronbach's α was .80 for the PDI and .77 for the MCEPS. Each score was standardized to a mean of 0 and variance of 1 to facilitate interpretation.

Depression: Depression was assessed in the 2-week and 8-week surveys with the PROMIS Depression Short-Form 8b (Cella et al., 2010), an 8-item scale used to measure symptoms of depression in the recent past. We asked participants to indicate how often they experienced each symptom in the past 2 weeks (2-week survey) or past 30 days (8-week survey) using a 0-4 response scale ("none of the time," "a little," "some," "most," "all or

almost all the time"). Raw scores were summed (0-32 scale) and converted to a T-score (continuous scale) with a mean of 50 and standard deviation of 10 relative to the general United States population. Cronbach's α was .95 (2-week survey) and .97 (8-week survey). Consistent with PROMIS guidelines, a score of 60+ (i.e. 1 standard deviation above the mean in the general US population) was used as the threshold for defining moderate to severe depression (PROMIS, 2015).

Pre-trauma depression: We also asked participants to self-report depression in the 30 days prior to the accident using the same PROMIS depression scale. Continuous PROMIS scores 30 days prior to the MVC were included in all analyses to control for pre-trauma functioning.

Analysis methods

We began by examining bivariate associations of pre-trauma depression and peritraumatic symptoms with 2-week and 8-week depression. We then estimated logistic regression equations for the separate, joint, and interactive associations of the 2 peritraumatic symptom scales with 8-week depression decomposed through 2-week depression and the transition between 2-week and 8-week depression (i.e., the regression of 8-week depression on the peritraumatic symptoms scales controlling for 2-week depression) controlling for pre-trauma depression. Linear regression models were estimated for the associations of participant socio-demographic and MVC characteristics with peritraumatic distress and dissociation, followed by expanded logistic models for the associations of these predictors with 8-week depression with and without controls for peritraumatic symptoms, 2-week depression, and pre-trauma depression. These decompositions allowed us to examine gross associations of predictors with 8-week depression and mediation through peritraumatic symptoms and 2-week depression. Item missing values were imputed using simple mean imputations given the small amount of item-level missing data (see below). Logits and logits +/− 2 standard errors were exponentiated and are reported as odds-ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was consistently evaluated using .05-level two-sided tests.

RESULTS

Imputation of item missing values

Information was collected on participant age, sex, MVC characteristics, and most participant injury characteristics. The exception was that confirmation of whether the participant experienced a head injury was missing for 8.6% of participants and small numbers of participants were missing ED information on pain severity (2 participants) and severity of other somatic symptoms (1-2 items for 34 participants, all 20 items for 2 participants). Median imputation was used for missing values of race/ethnicity, marital status, education, income, and employment status, each of which was missing for only 1-5 participants. We took the fact that none of the participants with missing head injury data were evaluated for post-concussion syndrome as presumptive evidence of no head injury. Mean item-level imputation was used for the missing peritraumatic symptom severity items. Scoring algorithms for the PROMIS Depression Short-Form (8b) require only 4 or more non-missing

items (out of 8) to produce a valid T-score, resulting in a small number of respondents missing threshold depression (2-week: n=2; 8-week: n=3). For those few participants, the mode was used to impute item-level missing data.

Loss to follow-up

Supplementary Figure 1 shows that a substantial number of ED patients either refused to participate in AURORA before eligibility was determined (n=2,277) or after they were determined to be eligible (n=169). No additional information was obtained about these patients. However, an additional n=362 patients participated in the baseline ED assessment and then failed to complete either the 2-week (n=120), 8-week (n=42), or both (n=200) subsequent assessments. We were able to compare baseline and in some cases 2-week and 8-week responses of these partial respondents to those of the respondents who completed all three assessments. Full respondents were somewhat older, more likely to be female, never or previously married, and to have higher education than partial respondents (Supplementary Table 1). All of these socio-demographic variables were controlled in the analyses reported below. Full and partial respondents did not differ, though, in MVC characteristics (Supplementary Table 2). Nor did full respondents differ from the complete baseline sample either on pre-MVC depression or peritraumatic symptoms (Supplementary Table 3). Finally, full respondents did not differ from the subset of respondents who completed the 2-week but not the 8-week assessment on 2-week depression.

Prevalence of 2-week and 8-week depression in the aftermath of MVC

Depression was fairly stable between the 2-week and 8-week assessments (ϕ=.43), with prevalence (standard error) of 30.5% (1.8) and 27.2% (1.7), respectively. Conditional 8-week prevalence rates among participants above and below the 2-week threshold were 62.6% (3.4) and 11.7% (1.5), respectively.

Associations of peritraumatic symptoms with 2-week and 8-week depression

The peritraumatic distress and dissociation scales correlated .57 with each other (*r;* Pearson correlation). Both scales predicted 2-week and 8-week depression (see Table 1, MI). Pre-trauma depression was significantly associated with both distress and dissociation as well as with 2-week and 8-week depression (see Table 1). The best-fitting multivariate model for the joint associations of these peritraumatic symptoms with 8-week depression was an additive model with linear effects of both predictors. Quadratic terms were non-significant when added to the additive model (χ^2_1=0.0-1.1, p=.89-.30). The interaction term between peritraumatic distress and dissociation, which was estimated in a model that controlled for both quadratics in order to distinguish nonlinearities from interactions, given the high correlation between the two scales, was also non-significant (χ^2_1=1.1, p=.29). The odds ratios (ORs) in the additive model predicting 2-week depression were positive and significant for pre-trauma depression (2.4) and peritraumatic distress (OR=1.6) but not for peritraumatic dissociation (OR=1.2, Table 1, MII). The odds ratios (ORs) in the additive model predicting 8-week depression were not significant for both peritraumatic distress (OR=1.2) or peritraumatic dissociation (OR=1.2, Table 1, MII) but were significant for pre-trauma depression (OR = 2.3). Decomposition showed that while pre-trauma depression and 2-week depression significantly predicted 8-week depression, neither peritraumatic distress

nor peritraumatic dissociation predicted 8-week depression controlling 2-week depression (Table 1, MIII).

Associations of socio-demographics with peritraumatic symptoms

None of the socio-demographic characteristics predicted peritraumatic dissociation in univariate analyses (Table 2). Peritraumatic distress was significantly elevated among females (b=0.4; metric regression coefficient predicting scores on a standardized outcome scale), participants with the lowest family incomes (b=0.2), and those not employed (b=0.2). The multivariate model including all socio-demographics predicted distress significantly (R^2=.094; $F_{15,649}$=2.7, p<.001), suggesting that the individually significant univariate predictors can be interpreted. The multivariate model did not predict dissociation significantly (R^2=.054; $F_{15,649}$=0.7, p=.83).

Associations of MVC characteristics with peritraumatic symptoms

Peritraumatic distress and dissociation were not related to the participant's role in the MVC (i.e., passenger vs. driver), whether the vehicle collided with another vehicle, or whether others in the participant's vehicle were injured, and two indicators of participant injury (AIS-Max score, admitted vs. discharged) (Table 3). Peritraumatic distress and dissociation were both significantly elevated among participants whose vehicle sustained severe damage (b=0.7-0.4), who were in vehicles in which others sustained injuries (b=0.1), who were transported to the ED by ambulance (b=0.4-0.3), who hit their head (b=0.2-0.3), and who met the study definition of MTBI (b=0.5-0.6). In addition, peritraumatic distress and dissociation were both positively associated with self-reported severity of pain (b=0.2-0.1) and other somatic symptoms (b=0.2) in the ED compared to the prior 30 days. Multivariate models including all MVC characteristics significantly predicted both distress (R^2=.260; $F_{17,632}$=8.2, p<.001) and dissociation (R^2=.195; $F_{17,632}$=6.5, p<.001).

Associations of socio-demographic characteristics with depression

None of the socio-demographic variables was associated significantly with 8-week depression controlling for pre-trauma depression scores (Table 4).

Despite absence of gross associations with 8-week depression, several other socio-demographics were associated significantly with 2-week depression controlling for pre-trauma depression (Table 4, M3 and M4). These included elevated odds of 2-week depression among participants with some college education and significantly reduced odds among participants ages 50+ and characterized as "Other" race/ethnicity. No significant predictors of 8-week depression were found when controlling for 2-week depression.

Associations of MVC characteristics with depression

Univariate analyses found that the majority of MVC characteristics, including the nature of the collision (with a moving vehicle, a stationary object, or other), the extent of vehicle damage and a number of participant injury characteristics (AIS-Max, admitted) were unrelated to 8-week depression after controlling for pre-trauma depression and adjusting for socio-demographics (Table 5, M1 and M2). However, six MVC characteristics were significant and positive predictors of 8-week depression after socio-demographic and pre-

trauma depression controls: role in MVC (being passenger: OR = 1.9), number of passengers who sustained moderate-severe injuries in the participant's vehicle (OR=1.3); whether the participant sustained a head injury (OR = 1.6); whether the participant was diagnosed with TBI (OR=1.8); self-reported severity of pain in the ED (OR=1.4) and self-reported severity of other somatic symptoms (OR = 1.3).

Decomposition of these associations found that diverse pathways were involved. Passengers were significantly less likely than drivers to have 2-week depression but significantly more likely than drivers to have 8-week depression after controlling 2-week depression (OR = 2.9; M5 and M6). Participants who were in vehicles where other passengers sustained injuries were no more likely than others to develop 2-week depression but were significantly more likely than others to have 8-week depression controlling for 2-week depression (OR = 2.7). Number of passengers who sustained moderate-severe injuries was not related to 2-week depression but predicted depression at 8 weeks controlling for 2-week depression. Transportation to the ED by ambulance predicted higher levels of 8-week depression controlling for 2-week depression. The associations of personal injury characteristics with 8-week depression, in comparison, were all due to more proximal association with elevated odds of 2-week depression; none of them predicted 8-week depression after controlling 2-week depression.

DISCUSSION

It is interesting to contrast the results of the current report with those of an earlier report on the associations of the same predictors with PTSD (Kessler et al., in press). The earlier report found that, in line with prior epidemiological studies, PTSD prevalence in AURORA at 8 weeks is about 50%. We found in the current report, in comparison, that depression prevalence at 8 weeks is 27.2% of the sample. This depression prevalence is considerably higher than estimates in previous studies examining post-MVC psychopathology (Smith, Mackenzie-Ross, & Scragg, 2007; Ehring, Ehlers, & Glucksman, 2008), but comparable to a recent Australian report that recruited respondents using insurance information (Kenardy et al., 2018). It is noteworthy in this regard that the threshold used to define depression in the PROMIS screening scale might not be consistent with the thresholds used in previous studies. Given prior evidence that peritraumatic symptoms predict depression (Bronner et al., 2009; see Vance, Kovachy, Dong, & Bui, 2018 for a recent review), we were somewhat surprised that the associations of peritraumatic symptoms with 8-week depression in our sample were weak. This may be the consequence of the truncation of the peritraumatic symptom scales due to selection into treatment based on these scores. We are currently developing a plan to contact a sample of people who chose not to come to the ED in the immediate aftermath of an MVC to investigate both the distribution of peritraumatic symptoms and the associations of these symptoms with subsequent depression compared to the associations found here in order to evaluate that selection hypothesis.

The prospective AURORA design allowed us to disaggregate the gross associations of peritraumatic symptoms with 8-week depression. When controlling for pre-trauma depression, only peritraumatic distress but not dissociation was a significant predictor of 2-week depression. Importantly, these peritraumatic symptoms did not predict the transition

between 2-week depression and 8-week depression. This suggests that peritraumatic symptoms predict short-term (i.e., 2-week) post-traumatic emotional responses but do not predict increase in depression at 8 weeks when controlling for 2-week depression (Roberts et al., 2011). Thus, peritraumatic distress predicts 8-week depression through its association with 2-week depression but is not a specific predictor of depression at 8-weeks. We are unaware of previous research that attempted to carry out this kind of disaggregation.

We next examined associations of socio-demographics and MVC characteristics with 8-week depression mediated by both peritraumatic symptoms and 2-week depression, controlling for pre-trauma depression. None of the socio-demographic variables predicted 8-week depression. Some variables predicted 2-week depression but only education was significant with some college education predicting higher levels of 2-week depression. These generally non-significant associations with 8-week depression, and especially the failure to find a significant sex difference, are surprising given previous work and research documenting sex differences in post-traumatic responses of women compared to men (Galea et al., 2002; Miguel-Tobal et al., 2006).

The strongest predictors of 8-week depression (controlling for pre-trauma depression) were several indicators of MVC severity, including the participant's role in the MVC, injuries among others , transportation to the ED, and severity of the participant's personal injuries. As with the earlier decompositions, though, we found substantial variation in pathways across these predictors. The associations of participant injury characteristics with 8-week depression were not significant when controlling for 2-week depression, which suggests that personal injuries are related to short-term but not longer-term adjustment to MVCs other than through 2-week depression. Having been a passenger rather than the driver emerged as the strongest predictor of threshold 8-week depression controlling for 2-week depression. Injuries sustained by others in the vehicle and number of passengers with injuries also predicted 8-week depression controlling for 2-week depression. Finally, transportation to the ED by ambulance predicted 8-week depression controlling for 2-week depression. Importantly, these associations held when controlling for peritraumatic symptoms, socio-demographics as well as pre-trauma depression.

Although it is difficult to know how to interpret this apparent variation in pathways between predictors and 8-week depression, the strong association of having been a passenger and not the driver with 8-week threshold depression controlling for 2- week depression (OR=2.9) was especially striking. This might be associated with increased feelings of helplessness and lack of control among passengers compared to drivers, which would be in line with previous research emphasizing the importance of perceived control and the negative effect of perceived helplessness on the relationship between stress and depression (Culpin, Stapinski, Miles, Araya, Joinson, 2015; Kazantzis et al., 2012; Leotti, Iyengar, Ocsner, 2010). The presence of others with injuries, the number of passengers with injuries, and transportation to the ED by ambulance could reflect that severity of the accident is an important factor in long-term adjustment to the traumatic event. It is interesting though that personal injury characteristics only predicted 2-week but not 8-week depression.

It also interesting to compare these predictors with the predictors of PTSD outcome (Kessler et al., in press). Whereas various demographic variables such as gender and education, for example, predicted PTSD, none of these variables were significant predictors of depression in the current analyses. Severity of pain in the ED was the main predictor of PTSD but was not significant as a predictor of depression in the current study. The main variables that were found to impact depression risk at 8- weeks in the current study (being a passenger and not the driver, injuries to other people) were not significant predictors of PTSD. As expected, PTSD and depression were highly comorbid but even in participants that show both outcomes, predictors of PTSD and depression differed. We plan to follow up on these interesting findings to further examine differential prediction of PTSD and depression in response to trauma once recruitment is completed and more follow-up data is available. In a very interesting recent report with a similar focus to our study, Pozzato et al. (2020a) examined trajectories of depression, PTSD, and their comorbidity after MVC and found not only high rates of (asymmetrical) comorbidity but also evidence for common vulnerability factors.

The study has several limitations. Many statistical tests were conducted, increasing the risk of type I errors. In addition, given that this is an early report on a subsample, the study is under-powered to estimate complex statistical models. We will carry out more complex analyses when the full sample is collected and 3-month follow-up data are available. Because data collection started in the ED, participants who were not oriented or who had solid organ injuries were excluded (see McLean et al., in press, for more information about inclusion criteria). This decision may have introduced a bias, excluding participants with high MVC severity. In addition, the majority of the participants approached in the ED declined enrollment in the study. No additional information on these participants was collected. We therefore cannot rule out the possibility of a selection bias that may have affected our results. We are in the process of carrying out a methodological sub-study to investigate the extent to which this kind of selection bias influenced our results. Missing information about baseline functioning is another limitation. We did include a measure of peritraumatic distress that was administered in the ED as well as information on pre-trauma depression (8-weeks before the accident) and controlled for scores on these measures in all analyses. In this paper, we did not examine the role of pre-injury mental and physical health factors, but this will be an important goal in our future work. We also did not collect information about intervening traumatic events which may have affected our findings. Finally, these analyses did not include assessments of blame or fault or important individual difference variables like self-efficacy or helplessness but considering individual difference variables will be an important aim for our future work.

Within the context of these limitations, 8-week depression prevalence was relatively high (27.8%) and associated with pre-MVC depression and several MVC characteristics that remained significant after controlling for peritraumatic symptoms and, to a lesser degree, depressive symptoms at 2-weeks post-trauma. These observations, coupled with substantial variation in the relative strength of the mediating pathways across predictors, raises the possibility of diverse and potentially complex underlying biological and psychological processes that remain to be elucidated in more in-depth analyses of the rich and evolving

AURORA database to find new targets for intervention and new tools for risk-based stratification following trauma exposure.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Conflicts of interest:

Dr. Peacock is supported by research grants from Abbott, Boehringer Ingelheim, Braincheck, CSL Behring, Daiichi-Sankyo, Immunarray, Janssen, Ortho Clinical Diagnostics, Portola, Relypsa, Roche. He has served as a consultant for Abbott, Astra-Zeneca, Bayer, Beckman, Boehrhinger-Ingelheim, Ischemia Care, Dx, Immunarray, Instrument Labs, Janssen, Nabriva, Ortho Clinical Diagnostics, Relypsa, Roche, Quidel, Salix, Siemens. He has also provided expert testimony for Johnson and Johnson. He owns stock or has ownership interest in AseptiScope Inc, Brainbox Inc, Comprehensive Research Associates LLC, Emergencies in Medicine LLC, Ischemia DX LLC. Over the past three years, Dr. Pizzagalli has received consulting fees from Akili Interactive Labs, BlackThorn Therapeutics, Boehringer Ingelheim, Posit Science, and Takeda Pharmaceuticals, as well as an honorarium from Alkermes for activities unrelated to the current project. Dr. Germine is on the scientific advisory board of the nonprofit Sage Bionetworks, for which she receives a small honorarium. She is also a consultant with 23andme, Inc. Dr. Jones reports no direct conflicts related to this paper, and no ongoing conflicts. He has been an investigator on studies funded by Hologic Inc, Janssen, and AstraZeneca, for which his department has received research funding.= Dr. Ressler has served on advisory boards for Takeda, Resilience Therapeutics, Janssen and Verily/ Google. His research has been sponsored by Alkermes and Brainsway and he has worked as a consultant for Alkermes. In the past 3 years, Dr. Kessler was a consultant for Datastat, Inc, Sage Pharmaceuticals, and Takeda. The remaining authors declare no conflicts of interest.

References

Atwoli L, Stein DJ, Koenen KC, & McLaughlin KA (2015). Epidemiology of posttraumatic stress disorder: prevalence, correlates and consequences. Current Opinion in Psychiatry, 28(4), 307. doi:10.1097/YCO.0000000000000167 [PubMed: 26001922]

Boscarino JA (2006). Posttraumatic stress disorder and mortality among US Army veterans 30 years after military service. Annals of Epidemiology, 16(4), 248–256. doi:10.1016/ j.annepidem.2005.03.009 [PubMed: 16099672]

Breslau N, Davis GC, Peterson EL, & Schultz LR (2000). A second look at comorbidity in victims of trauma: the posttraumatic stress disorder–major depression connection. Biological Psychiatry, 48(9), 902–909. doi:10.1016/s0006-3223(00)00933-1 [PubMed: 11074228]

Bronner MB, Kayser A-M, Knoester H, Bos AP, Last BF, & Grootenhuis MA (2009). A pilot study on peritraumatic dissociation and coping styles as risk factors for posttraumatic stress, anxiety and depression in parents after their child's unexpected admission to a Pediatric Intensive Care Unit. Child and Adolescent Psychiatry and Mental Health, 3. doi:10.1186/1753-2000-3-33 [PubMed: 19175910]

Brunet A, Weiss DS, Metzler TJ, Best SR, Neylan TC, Rogers C, … Marmar CR (2001). The Peritraumatic Distress Inventory: a proposed measure of PTSD criterion A2. American Journal of Psychiatry, 158(9), 1480–1485. doi:10.1176/appi.ajp.158.9.1480 [PubMed: 11532735]

Bunnell BE, Davidson TM, Anton MT, Crookes BA & Ruggiero KJ (2018). Peritraumatic distress predicts depression in traumatically injured patients admitted to a Level I trauma center. General Hospital Psychiatry, 54, 57–59. doi:10.1016/j.genhosppsych.2018.02.009 [PubMed: 29482917]

Cella D, Riley W, Stone A, Rothrock N, Reeve B, Yount S, … Cook K (2010). Initial adult health item banks and first wave testing of the patient-reported outcomes measurement information system (PROMIS™) network: 2005–2008. Journal of Clinical Epidemiology, 63(11), 1179. doi:10.1016/j.jclinepi.2010.04.011 [PubMed: 20685078]

Culpin I, Stapinski L, Miles ÖB, Araya R, & Joinson C (2015). Exposure to socioeconomic adversity in early life and risk of depression at 18 years: the mediating role of locus of control. Journal of Affective Disorders, 183, 269–278. doi:10.1016/j.jad.2015.05.030 [PubMed: 26047304]

Duncan E, Dorahy MJ, Hanna D, Bagshaw S, & Blampied N (2013). Psychological responses after a major, fatal earthquake: The effect of peritraumatic dissociation and posttraumatic stress symptoms on anxiety and depression. Journal of Trauma & Dissociation, 14(5), 501–518. doi:10.1080/15299732.2013.769479 [PubMed: 24060033]

Ehring T, Ehlers A, & Glucksman E (2008). Do cognitive models help in predicting the severity of posttraumatic stress disorder, phobia, and depression after motor vehicle accidents? A prospective longitudinal study. Journal of Consulting and Clinical Psychology, 76(2), 219. doi:10.1037/0022-006X.76.2.219 [PubMed: 18377119]

Farrar JT, Young JP Jr, LaMoreaux L, Werth JL, & Poole RM (2001). Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain, 94(2), 149–158. doi:10.1016/s0304-3959(01)00349-9 [PubMed: 11690728]

Fergusson DM, Horwood LJ, Boden JM, & Mulder RT (2014). Impact of a major disaster on the mental health of a well-studied cohort. JAMA Psychiatry, 71(9), 1025–1031. doi:10.1001/jamapsychiatry.2014.652 [PubMed: 25028897]

Galea S, Ahern J, Resnick H, Kilpatrick D, Bucuvalas M, Gold J, & Vlahov D (2002). Psychological sequelae of the September 11 terrorist attacks in New York City. New England Journal of Medicine, 346, 982–987. doi:10.1056/NEJMsa013404 [PubMed: 11919308]

Hruska B, Irish LA, Pacella ML, Sledjeski EM, & Delahanty DL (2014). PTSD symptom severity and psychiatric comorbidity in recent motor vehicle accident victims: A latent class analysis. Journal of Anxiety Disorders, 28(7), 644–649. doi:10.1016/j.janxdis.2014.06.009 [PubMed: 25124501]

Kazantzis N, Kennedy-Moffat J, Flett RA, Petrik AM, Long NR, & Castell B (2012). Predictors of chronic trauma-related symptoms in a community sample of New Zealand motor vehicle accident survivors. Culture, Medicine and Psychiatry, 36(3), 442–464. doi:10.1007/s11013-012-9265-z [PubMed: 22528056]

Kenardy J, Edmed SL, Shourie S, Warren J, Crothers A, Brown EA, … Heron-Delaney M (2018). Changing patterns in the prevalence of posttraumatic stress disorder, major depressive episode and generalized anxiety disorder over 24 months following a road traffic crash: results from the UQ SuPPORT study. Journal of Affective Disorders, 236, 172–179. doi:10.1016/j.jad.2018.04.090 [PubMed: 29738952]

Kessler RC (2000). Posttraumatic stress disorder: the burden to the individual and to society. Journal of Clinical Psychiatry, 61 Suppl 5, 4–14.

Kessler RC, Ressler KJ, House SL, Beaudoin FL, An X, Stevens JS … McLean SA (in press). Socio-demographic and trauma-related predictors of PTSD within eight weeks of a motor vehicle collision in the AURORA study. Molecular Psychiatry.

Kessler RC, Sonnega A, Bromet E, Hughes M, & Nelson CB (1995). Posttraumatic stress disorder in the National Comorbidity Survey. Archives of General Psychiatry, 52(12), 1048–1060. doi:10.1001/archpsyc.1995.03950240066012 [PubMed: 7492257]

King NS, Crawford S, Wenden FJ, Moss NEG, & Wade DT (1995). The Rivermead Post Concussion Symptoms Questionnaire: a measure of symptoms commonly experienced after head injury and its reliability. Journal of Neurology, 242(9), 587–592. doi:10.1007/BF00868811 [PubMed: 8551320]

Koenen KC, Ratanatharathorn A, Ng L, McLaughlin KA, Bromet EJ, Stein DJ, … Atwoli L (2017). Posttraumatic stress disorder in the World Mental Health Surveys. Psychological Medicine, 47(13), 2260–2274. doi:10.1017/S0033291717000708 [PubMed: 28385165]

Leotti LA, Iyengar SS, & Ochsner KN (2010). Born to choose: the origins and value of the need for control. Trends in Cognitive Sciences, 14(10), 457–463. doi:10.1016/j.tics.2010.08.001 [PubMed: 20817592]

Loftis KL, Price J, & Gillich PJ (2018). Evolution of the Abbreviated Injury Scale: 1990–2015. Traffic Injury Prevention, 19(sup2), S109–S113. doi:10.1080/15389588.2018.1512747 [PubMed: 30543458]

Lowe SR, Sampson L, Gruebner O, & Galea S (2015). Psychological resilience after Hurricane Sandy: the influence of individual-and community-level factors on mental health after a large-scale natural disaster. PLoS One, 10(5), e0125761. doi:10.1371/journal.pone.0125761 [PubMed: 25962178]

McFarlane AC, & Papay P (1992). Multiple diagnoses in posttraumatic stress disorder in the victims of a natural disaster. Journal of Nervous and Mental Disease, 180(8), 498–504. doi:10.1097/00005053-199208000-00004 [PubMed: 1500931]

McLean SA, Kirsch NL, Tan-Schriner CU, Sen A, Frederiksen S, Harris RE, … Maio RF (2009). Health status, not head injury, predicts concussion symptoms after minor injury. American Journal of Emergency Medicine, 27(2), 182–190. doi:10.1016/j.ajem.2008.01.054 [PubMed: 19371526]

McLean SA, Ressler KJ, Koenen KC, Neylan TC, Germine LT, Jovanovic T, … Kessler RC (in press). The AURORA Study: a longitudinal, multimodal library of brain biology and function after traumatic stress exposure. Molecular Psychiatry. doi:10.1038/s41380-019-0581-3

Michaels AJ, Michaels CE, Moon CH, Smith JS, Zimmerman MA, Taheri PA, & Peterson C (1999). Posttraumatic stress disorder after injury: impact on general health outcome and early risk assessment. Journal of Trauma, 47(3), 460–467. doi:10.1097/00005373-199909000-00005 [PubMed: 10498298]

Miguel-Tobal JJ, Cano-Vindel A, Gonzalez-Ordi H, Iruarrizaga I, Rudenstine S, Vlahov D, & Galea S (2006). PTSD and depression after the Madrid March 11 train bombings. Journal of Traumatic Stress, 19(1), 69–80. doi:10.1002/jts.20091 [PubMed: 16568454]

National Institute of Mental Health. (n.d.). RDoC Research Domain Criteria Initiative. Retrieved from https://www.nimh.nih.gov/research/research-funded-by-nimh/rdoc/constructs/index.shtml

Patient-Reported Outcomes Measurement Information System (PROMIS) Health Organization and PROMIS Cooperative Group. (2015). PROMIS Depression Scoring Manual. Health Measures: PROMIS Scoring Manuals. Retrieved from http://www.healthmeasures.net/index.php?option=com_content&view=article&id=180&Itemid=994

Pennebaker JW, & Watson D (1991). The psychology of somatic symptoms. In Kirmayer LJ & Robins JM (Eds.), Progress in Psychiatry, No. 31. Current Concepts of Somatization: Research and Clinical Perspectives (pp. 21). Washington DC: American Psychiatric Association.

Pozzato I, Craig A, Gopinath B, Kifley A, Tran Y, Jagnoor J, & Cameron ID (2020a). Outcomes after traffic injury: mental health comorbidity and relationship with pain interference. BMC Psychiatry, 20, 189. doi:10.1186/s12888-020-02601-4 [PubMed: 32345257]

Pozzato I, Kifley A, Craig A, Gopinath B, Tran Y, Jagnoor J, & Cameron ID (2020b). Effects of seeking compensation on the psychological health and recovery of injured patients: the role of stress vulnerability and injury-related disability. Psychological Medicine, 1–12. doi:10.1017/S003329172000166X

Roberts AL, Gilman SE, Breslau J, Breslau N, & Koenen KC (2011). Race/ethnic differences in exposure to traumatic events, development of post-traumatic stress disorder, and treatment-seeking for post-traumatic stress disorder in the United States. Psychological Medicine, 41(1), 71–83. doi:10.1017/S0033291710000401 [PubMed: 20346193]

Santiago PN, Ursano RJ, Gray CL, Pynoos RS, Spiegel D, Lewis-Fernandez R, … Fullerton CS (2013). A systematic review of PTSD prevalence and trajectories in DSM-5 defined trauma exposed populations: intentional and non-intentional traumatic events. PLoS One, 8(4), e59236. doi:10.1371/journal.pone.0059236 [PubMed: 23593134]

Smith B, Mackenzie-Ross S, & Scragg P (2007). Prevalence of poor psychological morbidity following a minor road traffic accident (RTA): the clinical implications of a prospective longitudinal study. Counselling Psychology Quarterly, 20(2), 149–155. doi:10.1080/09515070701403679

Tang B, Liu X, Liu Y, Xue C, & Zhang L (2014). A meta-analysis of risk factors for depression in adults and children after natural disasters. BMC Public Health, 14(1), 623. doi:/10.1186/1471-2458-14-623 [PubMed: 24941890]

Tracy M, Norris FH, & Galea S (2011). Differences in the determinants of posttraumatic stress disorder and depression after a mass traumatic event. Depression and Anxiety, 28(8), 666–675. doi:10.1002/da.20838 [PubMed: 21618672]

Vance MC, Kovachy B, Dong M, & Bui E (2018). Peritraumatic distress: a review and synthesis of 15 years of research. Journal of Clinical Psychology, 74(9), 1457–1484. doi:10.1002/jclp.22612 [PubMed: 29543336]

Table 1.

Associations of peritraumatic distress and dissociation with week 8 self-reported depression in the Freeze 1 AURORA MVC sample (n = 666)

	Peritraumatic distress [1]		Peritraumatic dissociation [1]		2-week self-reported depression		8-week self-reported depression	
	b	(95% CI)	b	(95% CI)	OR	(95% CI)	OR	(95% CI)
I. Univariate associations [2]								
Continuous Promis depression score 30 day before MVC	0.2*	(0.1–0.3)	0.2*	(0.1–0.3)	2.5*	(2.1–3.1)	2.4*	(2.0–3.0)
Peritraumatic distress					1.9*	(1.6–2.3)	1.5*	(1.3–1.8)
Peritraumatic dissociation					1.7*	(1.4–2.0)	1.5*	(1.3–1.8)
2-week depression spline 1							2.6*	(1.7–3.8)
2-week depression spline 2							1.9*	(1.6–2.3)
χ^2_2 for 2-week depression splines							130.7*	
II. Multivariate associations with pre-MVC depression, Distress and Dissociation								
Continuous Promis depression score 30 day before MVC					2.4*	(1.9–2.9)	2.3*	(1.9–2.8)
Peritraumatic distress					1.6*	(1.3–2.0)	1.2	(1.0–1.5)
Peritraumatic dissociation					1.2	(1.0–1.5)	1.2	(1.0–1.5)
χ^2_2 for distress and dissociation					35.4*		11.5*	
χ^2_3 overall χ^2 test for model					107.1*		85.0*	
III. Multivariate associations with pre-MVC depression, Distress and Dissociation, and 2-week depression splines								
Continuous Promis depression score 30 day before MVC							1.4*	(1.1–1.8)
Peritraumatic distress							0.9	(0.7–1.2)
Peritraumatic dissociation							1.0	(0.8–1.3)
χ^2_2 for distress and dissociation							0.3	
2-week depression spline variable 1							2.4*	(1.6–3.6)
2-week depression spline variable 2							1.8*	(1.6–2.2)
χ^2_2 for 2-week depression splines							96.5*	
χ^2_5 overall χ^2 test for model							132.9*	

Abbreviations: MVC, motor vehicle collision; b, unstandardized linear regression coefficient; CI, confidence interval; OR, odds ratio.

*
Significant at the .05 level, two-sided test.

[1]
Continuous Promis depression score 30 day before MVC, peritraumatic distress and dissociation scales were all standardized to mean 0 and variance 1, allowing the ORs to be interpreted as the relative odds of MDE associated with a one standard deviation difference in peritraumatic symptom scores.

[2]
Continuous Promis depression score 30 day before MVC, peritraumatic distress, peritraumatic dissociation are independent variables in three separate univariate models. 2-week depression spline variables 1 and 2 are included in the same univariate model.

Table 2.

Distributions and Associations of socio-demographic characteristics with self-reported peritraumatic distress and dissociation in the Freeze 1 AURORA MVC sample (n = 666)

	%	(SE)	Associations[1]				Multivariate associations[1]			
			Distress[2]		Dissociation[2]		Distress[2]		Dissociation[2]	
			b	(95% CI)	b	(95% CI)	b	(95% CI)	b	(95% CI)
Age										
50+	18.3	(1.5)	0.1	(−0.1-0.3)	−0.0	(−0.2-0.2)	0.1	(−0.2-0.3)	−0.0	(−0.3-0.2)
35-49	28.7	(1.8)	0.1	(−0.1-0.3)	−0.1	(−0.3-0.2)	0.1	(−0.1-0.3)	−0.1	(−0.4-0.1)
25-34	30.5	(1.8)	−0.1	(−0.3-0.1)	−0.1	(−0.3-0.1)	−0.0	(−0.3-0.2)	−0.1	(−0.3-0.1)
18-24	22.5	(1.6)	Ref	--	Ref	--	Ref	--	Ref	--
$F_{3,661}$			1.3		0.3		0.7		0.5	
Sex (female)	73.0	(1.7)	0.4[*]	(0.3-0.6)	0.0	(−0.1-0.2)	0.4[*]	(0.3-0.6)	0.0	(−0.1-0.2)
Race/ethnicity										
Non-Hispanic Black	56.3	(1.9)	0.0	(−0.2-0.2)	0.1	(−0.1-0.2)	−0.1	(−0.2-0.1)	0.1	(−0.1-0.3)
Non-Hispanic White	30.0	(1.8)	Ref	--	Ref	--	Ref	--	Ref	--
Hispanic	10.5	(1.2)	0.0	(−0.2-0.3)	−0.0	(−0.3-0.3)	−0.0	(−0.3-0.3)	0.0	(−0.3-0.3)
Other	3.2	(0.7)	−0.1	(−0.5-0.4)	0.1	(−0.3-0.5)	−0.1	(−0.5-0.3)	0.2	(−0.3-0.6)
$F_{3,661}$			0.1		0.3		0.2		0.6	
Marital status										
Married/cohabitating	42.5	(1.9)	Ref	--	Ref	--	Ref	--	Ref	--
Previously married[3]	14.0	(1.3)	0.1	(−0.1-0.4)	−0.1	(−0.3-0.2)	0.0	(−0.2-0.2)	−0.1	(−0.4-0.1)
Never married	43.5	(1.9)	−0.0	(−0.2-0.1)	−0.1	(−0.2-0.1)	−0.1	(−0.2-0.1)	−0.1	(−0.3-0.1)
$F_{2,662}$			1.0		0.4		0.2		1.1	
Education										
College graduate	22.1	(1.6)	Ref	--	Ref	--	Ref	--	Ref	--
Some college	44.0	(1.9)	0.1	(−0.1-0.3)	0.1	(−0.1-0.3)	0.1	(−0.1-0.3)	0.1	(−0.1-0.3)
High school graduate	24.0	(1.7)	0.1	(−0.2-0.3)	0.0	(−0.2-0.3)	0.1	(−0.1-0.3)	0.0	(−0.2-0.3)
Less than high school	9.9	(1.2)	0.2	(−0.1-0.5)	0.1	(−0.2-0.4)	0.1	(−0.2-0.4)	0.1	(−0.2-0.4)
$F_{3,661}$			1.0		0.5		0.3		0.4	

	%	(SE)	Associations [1] Distress [2] b	(95% CI)	Dissociation [2] b	(95% CI)	Multivariate associations [1] Distress [2] b	(95% CI)	Dissociation [2] b	(95% CI)
Income [4]										
More than $35K	33.6	(1.8)	Ref	--	Ref	--	Ref	--	Ref	--
$19-35K	31.5	(1.8)	0.2*	(0.0-0.4)	0.1	(−0.0-0.3)	0.2	(−0.0-0.4)	0.1	(−0.1-0.3)
Less than $19K	34.8	(1.8)	0.2	(−0.0-0.3)	−0.0	(−0.2-0.2)	0.1	(−0.1-0.3)	−0.1	(−0.3-0.1)
$F_{2,662}$			2.6		1.7		1.8		2.3	
Employed (yes vs. no)	77.0	(1.6)	−0.2*	(−0.4--0.0)	−0.1	(−0.2-0.1)	−0.2	(−0.3-0.0)	−0.1	(−0.3-0.1)
Overall $F_{15,649}$			--		--		2.7*		0.7	

Abbreviations: MVC, motor vehicle collision; SE, standard error; b, unstandardized linear regression coefficient; CI, confidence interval.

*
Significant at the .05 level, two-sided test.

[1]
All Univariate and multivariate models control for continuous Promis depression score 30 day before MVC.

[2]
Standardized to mean=0 and standard deviation=1.

[3]
Separated, divorced, or widowed.

[4]
Family income before taxes.

Table 3.

Distributions and Associations of MVC characteristics with self-reported peritraumatic distress and dissociation in the Freeze 1 AURORA MVC sample (n = 666)

| | %/Mean | (SE) | Associations[1] | | | | Multivariate associations[1] | | | |
| | | | Distress[2] | | Dissociation[2] | | Distress[2] | | Dissociation[2] | |
			b1	(95% CI)	b1	(95% CI)	b1	(95% CI)	b1	(95% CI)
Role in MVC										
Passenger	23.3	(1.6)	0.0	(−0.2-0.2)	0.1	(−0.1-0.3)	−0.0	(−0.2-0.2)	−0.0	(−0.3-0.2)
Driver with others	19.2	(1.5)	0.1	(−0.1-0.3)	0.1	(−0.1-0.3)	0.1	(−0.1-0.3)	0.0	(−0.2-0.2)
Driver alone	57.5	(1.9)	Ref	--	Ref	--	Ref	--	Ref	--
$F_{2,647}$			1.0		0.7		0.3		0.2	
Your vehicle collided with										
Other moving vehicle	68.2	(1.8)	0.2	(−0.0-0.4)	0.1	(−0.1-0.3)	0.1	(−0.1-0.3)	0.0	(−0.2-0.2)
Stationary object	17.9	(1.5)	0.1	(−0.2-0.4)	−0.0	(−0.3-0.2)	−0.0	(−0.3-0.2)	−0.2	(−0.4-0.1)
Other[3]	14.0	(1.3)	Ref	--	Ref	--	Ref	--	Ref	--
$F_{2,647}$			1.8		0.9		1.5		2.1	
Damage to your vehicle										
Severe	58.3	(1.9)	0.7*	(0.4-1.0)	0.4*	(0.1-0.7)	0.6*	(0.3-0.8)	0.3*	(0.0-0.6)
Moderate	26.4	(1.7)	0.2	(−0.1-0.5)	0.1	(−0.3-0.4)	0.2	(−0.1-0.5)	0.1	(−0.2-0.4)
Minor	8.9	(1.1)	−0.1	(−0.5-0.3)	−0.2	(−0.6-0.2)	−0.1	(−0.4-0.3)	−0.1	(−0.5-0.3)
Other[4]	6.5	(1.0)	Ref	--	Ref	--	Ref	--	Ref	--
$F_{3,646}$			19.5*		10.5*		12.6*		5.4*	
Passengers with injuries (0-4 standardized)[5]	0.0	(0.0)	0.1*	(0.0-0.2)	0.1*	(0.0-0.2)	0.0	(−0.1-0.1)	0.1	(−0.0-0.2)
Others with injuries (any vs. none)[5]	10.2	(1.2)	0.2	(−0.0-0.4)	0.2	(−0.1-0.4)	−0.0	(−0.2-0.2)	−0.0	(−0.2-0.2)
Transportation to ED										
Ambulance	58.0	(1.9)	0.4*	(0.2-0.6)	0.3*	(0.2-0.5)	0.3*	(0.1-0.5)	0.2*	(0.0-0.4)
Other immediately	14.7	(1.4)	0.1	(−0.2-0.3)	0.2	(−0.1, 0.4)	0.2	(−0.1-0.4)	0.2	(−0.0-0.4)
Other delay	27.3	(1.7)	Ref	--	Ref	--	Ref	--	Ref	--

	%/Mean	(SE)	Associations[1]				Multivariate associations[1]			
			Distress[2]		Dissociation[2]		Distress[2]		Dissociation[2]	
			b1	(95% CI)	b1	(95% CI)	b1	(95% CI)	b1	(95% CI)
$F_{2,647}$			12.6*		7.4*		6.5*		3.2*	
Personal injury										
Hit head (yes vs. no)	57.4	(1.9)	0.2*	(0.1-0.4)	0.3*	(0.2-0.5)	-0.1	(-0.3-0.1)	-0.0	(-0.2-0.2)
MTBI (yes vs. no)	27.5	(1.7)	0.5*	(0.3-0.6)	0.6*	(0.4-0.8)	0.3*	(0.1-0.5)	0.4*	(0.2-0.6)
AIS-Max[6] (2+ vs 1)	13.1	(1.3)	0.0	(-0.2-0.3)	0.2	(-0.1-0.4)	-0.1	(-0.3-0.2)	0.0	(-0.2-0.3)
Admitted (yes vs. no)	4.1	(0.8)	0.1	(-0.3-0.5)	0.3	(-0.1-0.7)	-0.0	(-0.4-0.4)	0.2	(-0.2-0.5)
Severity of pain (mean)[7]	0.0	(0.0)	0.2*	(0.1-0.2)	0.1*	(0.0-0.2)	0.1*	(0.0-0.2)	0.1	(-0.0-0.1)
Severity of other somatic symptoms (mean)[8]	0.0	(0.0)	0.2*	(0.2-0.3)	0.2*	(0.1-0.3)	0.2*	(0.1-0.2)	0.1*	(0.1-0.2)
Overall $F_{17,632}$			--		--		8.2*		6.5*	

Abbreviations: MVC, motor vehicle collision; SE, standard error; b, unstandardized linear regression coefficient; CI, confidence interval; ED, emergency department; MTBI, minor traumatic brain injury; AIS, Abbreviated Injury Scale.

*
Significant at the .05 level, two-sided test.

[1] All univariate and multivariate models control for continuous Promis depression score 30 day before MVC.

[2] Standardized to mean=0 and standard deviation=1.

[3] No collision (n=81), "other" (n=8), and "don't know" (n=8).

[4] None (n=12) and "don't know" (n=31).

[5] Moderate or severe injuries.

[6] Max score of the nine AIS regions.

[7] Self-reported 0-10 scale on pain intensity right now, standardized to mean=0 and standard deviation=1.

[8] Sum of all differences in each somatic symptom between 30-day (self-reported 0-10 scale) and right now (self-reported 0-10.

Table 4.

Univariate associations between socio-demographic characteristics and self-reported depression with and without controls for peritraumatic distress and dissociation in the Freeze 1 AURORA MVC sample (n = 666)

| | 8-week | | | | 2-week | | | | 8-week controlling 2-week | | | |
| | M1[1] | | M2[2] | | M3[1] | | M4[2] | | M5[3] | | M6[4] | |
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Age												
50+	1.0	(0.5-1.7)	0.9	(0.5-1.7)	0.6*	(0.3-1.0)	0.5*	(0.3-0.9)	1.5	(0.8-3.1)	1.5	(0.8-3.1)
35-49	1.0	(0.6-1.6)	1.0	(0.6-1.7)	0.6	(0.4-1.0)	0.6	(0.4-1.0)	1.3	(0.7-2.3)	1.3	(0.7-2.4)
25-34	1.2	(0.8-2.0)	1.3	(0.8-2.2)	0.8	(0.5-1.3)	0.9	(0.5-1.4)	1.5	(0.8-2.7)	1.5	(0.8-2.7)
18-24	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--
χ^2_3	1.5		2.2		5.3		6.9		2.4		2.3	
Sex (female)	1.2	(0.8-1.8)	1.1	(0.7-1.7)	1.4	(0.9-2.1)	1.2	(0.8-1.8)	0.9	(0.6-1.5)	0.9	(0.6-1.5)
Race/ethnicity												
Non-Hispanic Black	0.8	(0.5-1.1)	0.7	(0.5-1.1)	0.8	(0.6-1.3)	0.8	(0.5-1.2)	0.8	(0.5-1.3)	0.8	(0.5-1.3)
Non-Hispanic White	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--
Hispanic	1.3	(0.7-2.4)	1.3	(0.7-2.4)	0.9	(0.5-1.7)	0.9	(0.5-1.7)	1.3	(0.7-2.7)	1.3	(0.7-2.7)
Other	0.8	(0.2-2.4)	0.8	(0.2-2.4)	0.2*	(0.0-0.8)	0.2*	(0.0-0.8)	2.3	(0.6-9.3)	2.3	(0.6-9.3)
χ^2_3	4.1		4.6		5.0		5.3		4.7		4.7	
Marital status												
Married/cohabitating	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--
Previously married[5]	1.0	(0.6-1.8)	1.1	(0.6-1.9)	1.0	(0.6-1.8)	1.0	(0.6-1.9)	1.1	(0.6-2.2)	1.1	(0.6-2.2)
Never married	0.8	(0.5-1.2)	0.8	(0.5-1.2)	1.0	(0.7-1.5)	1.1	(0.7-1.7)	0.7	(0.4-1.1)	0.7	(0.4-1.0)
χ^2_2	1.7		1.4		0.1		0.3		4.1		4.2	
Education												
College graduate	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--
Some college	1.2	(0.7-1.9)	1.1	(0.7-1.8)	1.9*	(1.2-3.1)	1.8*	(1.1-2.9)	0.8	(0.5-1.4)	0.8	(0.5-1.4)
High school graduate	1.0	(0.6-1.7)	1.0	(0.5-1.7)	1.2	(0.7-2.1)	1.2	(0.6-2.1)	0.8	(0.4-1.5)	0.8	(0.4-1.6)
Less than high school	1.0	(0.5-1.9)	0.9	(0.4-1.8)	1.5	(0.7-3.0)	1.3	(0.7-2.7)	0.7	(0.3-1.5)	0.7	(0.3-1.5)

| | 8-week | | | | 2-week | | | | 8-week controlling 2-week | | | |
| | M1[1] | | M2[2] | | M3[1] | | M4[2] | | M5[3] | | M6[4] | |
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
$\chi^2 3$	0.9	--	0.7	--	8.0*	--	6.5	--	1.1	--	1.0	--
Income[6]												
More than $35K	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--
$19-35K	0.7	(0.5-1.2)	0.7	(0.4-1.1)	1.3	(0.9-2.1)	1.2	(0.8-1.9)	0.6*	(0.3-1.0)	0.6*	(0.3-1.0)
Less than $19K	1.1	(0.7-1.7)	1.1	(0.7-1.7)	1.1	(0.7-1.7)	1.1	(0.7-1.7)	1.0	(0.6-1.7)	1.0	(0.6-1.7)
$\chi^2 2$	3.0		4.2		1.7		0.6		5.5		5.5	
Employed (yes vs. no)	1.0	(0.7-1.6)	1.1	(0.7-1.7)	0.9	(0.6-1.4)	1.1	(0.7-1.6)	1.0	(0.6-1.6)	1.0	(0.6-1.6)

Abbreviations: MVC, motor vehicle collision; OR, odds ratio; CI, confidence interval.

*
Significant at the .05 level, two-sided test.

[1]
Without controls for peritraumatic distress/dissociation, controls for Continuous Promis depression score 30 day before MVC.

[2]
With controls for peritraumatic distress/dissociation and Continuous Promis depression score 30 day before MVC.

[3]
With controls for two-week Depression (spline variables) and Continuous Promis depression score 30 day before MVC, but not peritraumatic distress/dissociation.

[4]
With controls for two-week Depression (spline variables), Continuous Promis depression score 30 day before MVC, and peritraumatic distress/dissociation.

[5]
Separated, widowed, or divorced.

[6]
Family income before taxes.

Table 5.

Net univariate associations of MVC characteristics after controlling socio-demographics with self-reported depression with and without controls for peritraumatic distress and dissociation in the Freeze 1 AURORA MVC sample (n = 666)

| | 8-week | | | | 2-week | | | | 8-week controlling 2-week | | | |
| | M1[1] | | M2[2] | | M3[1] | | M4[2] | | M5[3] | | M6[4] | |
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Role in MVC												
Passenger	1.9*	(1.2-3.2)	1.9*	(1.2-3.1)	0.5*	(0.3-0.9)	0.5*	(0.3-0.9)	2.9*	(1.6-5.3)	2.9*	(1.6-5.3)
Driver with others	1.2	(0.7-2.0)	1.1	(0.7-1.9)	0.8	(0.5-1.3)	0.7	(0.4-1.2)	1.2	(0.7-2.3)	1.2	(0.7-2.3)
Driver alone	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--
χ^2_2	7.2		6.7*		5.8		6.5*		12.7*		12.7*	
Your vehicle collided with												
Other moving vehicle	0.9	(0.5-1.7)	0.9	(0.5-1.6)	0.9	(0.5-1.6)	0.8	(0.5-1.5)	0.9	(0.5-1.8)	0.9	(0.5-1.8)
Stationary object	0.8	(0.4-1.7)	0.8	(0.4-1.7)	1.1	(0.6-2.2)	1.1	(0.5-2.2)	0.7	(0.3-1.6)	0.7	(0.3-1.7)
Other[5]	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--
χ^2_2	0.3		0.3		0.6		1.3		0.9		0.8	
Damage to your vehicle												
Severe	0.8	(0.4-1.7)	0.6	(0.3-1.4)	1.8	(0.8-4.3)	1.4	(0.6-3.3)	0.4	(0.1-1.0)	0.4	(0.1-1.0)
Moderate	0.6	(0.2-1.3)	0.5	(0.2-1.3)	1.1	(0.5-2.7)	1.1	(0.4-2.7)	0.3*	(0.1-0.9)	0.3*	(0.1-0.9)
Minor	0.3*	(0.1-0.9)	0.4*	(0.1-1.0)	0.6	(0.2-1.7)	0.6	(0.2-1.9)	0.3	(0.1-1.0)	0.3	(0.1-1.0)
Other[6]	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--
χ^2_3	6.7		4.3		12.2*		4.0		5.2		5.0	
Passengers with injuries (0-4 standardized)[7]	1.3*	(1.0-1.5)	1.2*	(1.0-1.5)	1.0	(0.8-1.2)	0.9	(0.8-1.1)	1.3*	(1.0-1.6)	1.3*	(1.0-1.6)
Others with injuries (any vs. none)[7]	1.7	(1.0-3.1)	1.6	(0.9-2.9)	0.7	(0.4-1.3)	0.6	(0.3-1.1)	2.7*	(1.3-5.3)	2.7*	(1.4-5.4)
Transportation to ED												
Ambulance	1.5	(1.0-2.4)	1.3	(0.8-2.1)	1.0	(0.6-1.5)	0.8	(0.5-1.2)	1.7*	(1.0-2.9)	1.7*	(1.0-2.9)
Other immediately	0.8	(0.4-1.6)	0.8	(0.4-1.5)	1.0	(0.5-1.8)	0.9	(0.5-1.7)	0.8	(0.4-1.6)	0.8	(0.4-1.6)
Other delay	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--	Ref	--

| | 8-week | | | | 2-week | | | | 8-week controlling 2-week | | | |
| | M1[1] | | M2[2] | | M3[1] | | M4[2] | | M5[3] | | M6[4] | |
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
χ^2_2	6.3*		3.9		0.0		1.3		7.8*		8.0*	
Personal injury												
Hit head (yes vs. no)	1.6*	(1.1-2.4)	1.5	(1.0-2.2)	1.5	(1.0-2.1)	1.3	(0.8-1.9)	1.5	(1.0-2.5)	1.5	(1.0-2.5)
MTBI (yes vs. no)	1.8*	(1.2-2.7)	1.5	(1.0-2.3)	1.6*	(1.1-2.4)	1.2	(0.8-1.8)	1.6	(1.0-2.6)	1.6	(1.0-2.6)
AIS-Max[8] (2+ vs. 1)	1.1	(0.6-1.9)	1.0	(0.6-1.8)	1.1	(0.7-2.0)	1.1	(0.6-1.9)	1.1	(0.6-2.1)	1.1	(0.6-2.1)
Admitted (yes vs. no)	0.8	(0.3-2.1)	0.7	(0.3-1.9)	1.1	(0.5-2.9)	1.0	(0.4-2.7)	0.7	(0.2-2.1)	0.6	(0.2-2.1)
Severity of pain[9]	1.4*	(1.2-1.8)	1.4*	(1.1-1.7)	1.6*	(1.3-2.0)	1.5*	(1.2-1.9)	1.2	(0.9-1.5)	1.2	(0.9-1.6)
Severity of other somatic symptom[10]	1.3*	(1.1-1.6)	1.2	(1.0-1.5)	1.5*	(1.3-1.9)	1.4*	(1.1-1.7)	1.1	(0.9-1.3)	1.1	(0.9-1.4)

Abbreviations: MVC, motor vehicle collision; OR, odds ratio; CI, confidence interval; ED, emergency department; MTBI, minor traumatic brain injury; AIS, Abbreviated Injury Scale.

*
Significant at the .05 level, two-sided test.

[1] Without controls for peritraumatic distress/dissociation, controls for Continuous Promis depression score 30 day before MVC.

[2] With controls for peritraumatic distress/dissociation and Continuous Promis depression score 30 day before MVC.

[3] With controls for two-week Depression (spline variables) and Continuous Promis depression score 30 day before MVC, but not peritraumatic distress/dissociation.

[4] With controls for two-week Depression (spline variables), Continuous Promis depression score 30 day before MVC, and peritraumatic distress/dissociation.

[5] No collision (n=81), "other" (n=8), and "don't know (n=8).

[6] None (n=12) and "don't know" (n=31).

[7] Moderate or severe injuries.

[8] Max score of the nine AIS regions.

[9] Self-reported 0-10 scale on pain intensity right now, standardized to mean=0 and standard deviation=1.

[10] Sum of all differences in each somatic symptom between 30-day (self-reported 0-10 scale) and right now (self-reported 0-10 scale), standardized to mean=0 and standard deviation=1.