Depression, anxiety, and suicidality in individuals with chronic traumatic brain injury before and during the COVID-19 pandemic: A NIDILRR TBI Model Systems Study

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Abstract

Objective: To examine the prevalence, severity, and correlates of depression, anxiety, and suicidal ideation in people with traumatic brain injury (TBI) assessed before and during the COVID-19 pandemic.

Design: Retrospective cohort study using data collected through the TBI Model Systems (TBIMS) network at 1, 2, 5, 10, 15, 20, 25, or 30 years post-TBI.

Setting: United States-based TBIMS rehabilitation centers with telephone assessment of community residing participants.

Participants: Adults (72.4% male, mean age 47.2 years) who enrolled in the TBI Model Systems National Database and completed mental health questionnaires pre-pandemic (1/1/2017-2/29/2020; n=5000) or during pandemic (4/1/2022-6/30/2021; n=2009)

Interventions: Not applicable.

Main Outcome Measure: Patient Health Questionnaire-9 (PHQ-9), Generalized Anxiety Disorder-7 questionnaires.

Results: Separate linear and logistic regressions were constructed with demographic, psychosocial, injury-related, and functional characteristics, along with a binary indicator of COVID pandemic period (pre-pandemic vs. during pandemic), as predictors of mental health outcomes. No meaningful differences in depression, anxiety, or suicidal ideation were observed before versus during the COVID-19 pandemic. Correlations between predictors and mental health outcomes were similar before and during the pandemic.

Conclusions: Contrary to our predictions, the prevalence, severity, and correlates of mental health conditions were similar before and during the COVID-19 pandemic. Results may reflect generalized resilience and are consistent with the most recent findings from the general population that indicate only small, transient increases in psychological distress associated with

the pandemic. While unworsened, depression, anxiety, and suicidal ideation remain prevalent and merit focused treatment and research efforts.

Keywords: chronic brain injuries; depression; anxiety; mental health outcomes; COVID-19; Pandemic

Abbreviations: Traumatic Brain Injury (TBI); Traumatic Brain Injury Model Systems (TBIMS); Glasgow Coma Scale score (GCS); General Anxiety Disorder-7 (GAD-7); Patient Health Questionnaire-9 (PHQ-9); suicidal ideation (SI); General Education Development (GED); Disability Rating Scale (DRS); Coronavirus Disease of 2019 (COVID-19)

The COVID-19 pandemic-associated mitigation strategies created massive societal disruption in 2020. Access to routine health services, jobs and volunteering opportunities, leisure and socialization, and cultural and religious practices was limited. In addition to the pandemic, 2020 sparked a racial justice movement in the United States with protests that may have further affected individuals' mental and physical health. A survey of American adults[1] found that 40% of individuals reported at least one adverse mental or behavioral health condition during the pandemic, including depression, anxiety, posttraumatic stress, or substance abuse.

The pandemic and related events may have differentially impacted persons living with disabilities secondary to traumatic brain injury (TBI). At baseline, people with TBI already experience higher rates of psychological distress than others. The overall prevalence of depression is 38% in people with TBI, 3.41 times greater than in non-TBI controls.[2] Clinically significant anxiety is present in 37% of people with TBI.[3] Prevalence of suicidal ideation ranges from 7-10%, and past-year suicide attempts occur in 0.8-1.7% of cases.[4] Preliminary research is mixed on how the pandemic has impacted the mental health of people living with TBI. In May and June 2020, Morrow et al.[5] surveyed 47 participants in the chronic phase of moderate-severe TBI and compared responses to non-injured peers. One-third said their brain injury made coping with the pandemic more difficult identifying social isolation as a key barrier to coping with it. However, the study was small, and no comparison could be made to pre-pandemic baselines for their population. In another study of 134 patients with physical disabilities related to neurological disorders,[6] fewer negative psychological effects were found. These individuals seemed to manifest resilience in the face of pandemic-related social isolation. The authors questioned if this unexpected result had a dubiously reassuring origin—that people with physical disabilities were "already in lockdown."

The objective of the current study was to determine the changes in anxiety, depression, and suicidality in individuals with chronic TBI during the COVID pandemic compared to before the pandemic. A secondary aim is to explore interactive predictors during the COVID pandemic such as disability severity, rural residence, minority race status, and history of substance abuse upon the mental health status of anxiety, depression, and suicidal ideation in individuals with chronic TBI. The TBI Model Systems (TBIMS) National Database[7] is well-suited to address these aims because participants are followed longitudinally at least every five years post-TBI. Standardized measures of depression, anxiety, and suicidal ideation are completed at each time point, facilitating the examination of rates and severities of these conditions before and during the pandemic. Based on preliminary studies[1, 5, 6] of the general U.S. population indicating elevated rates of mental health problems during the COVID pandemic period, these authors hypothesized that self-reported depression, anxiety, and suicidal ideation would be elevated among people with TBI when assessed during the COVID-19 pandemic period relative to the preceding years. We further hypothesized that greater disability, rural residence, history of substance abuse, and minoritized race would be more strongly associated with anxiety, depression, and suicidal ideation during the COVID-19 pandemic than before.

Methods

Participants

Participants were a subset of enrollees in the TBIMS National Database, a multicenter, longitudinal cohort of individuals who receive inpatient rehabilitation for TBI.[7] Inclusion criteria for the TBIMS are age at injury $\geq$ 16 years; moderate-severe TBI [defined as posttraumatic amnesia >24 hours, trauma-related intracranial neuroimaging abnormalities, loss of

consciousness >30 minutes, or Glasgow Coma Scale score (GCS) in the emergency department <13]; and received acute care hospitalization within 72 hours followed by inpatient rehabilitation in designated TBIMS facilities. For the present analyses, we restricted the sample to those eligible for follow up (post-injury year 1, 2, 5, 10, 15, 20, 25, or 30) between 1/01/2017 and 06/30/2021, with Patient Health Questionnaire-9 (PHQ-9) and General Anxiety Disorder-7 (GAD-7) collected during the follow-up. Only their first session was retained for participants who completed multiple follow-up sessions during this period. For comparisons, we divided our sample into two independent cross-sectional groups, "Pre-pandemic" and "during pandemic," for comparisons. Pre-pandemic was defined as data collected from January 1, 2017, to February 29, 2020. During pandemic was defined as data collected between April 1, 2020, and June 30, 2021. Data collected in March 2020 were excluded as this was a transition period of the onset of the pandemic. Human subjects research approval was received from each center's Institutional Review Boards.

Measures

The primary outcomes were depression and anxiety (PHQ-9 and GAD-7, respectively) at each assessment epoch (post-injury years 1, 2, 5, 10, 15, 20, 25, and 30). The PHQ-9 is a nine-item self-report measure scored from "0=not at all" to "3=nearly every day," with a total score of 0 to 27[8]. The PHQ-9 is a reliable and valid indicator of depression severity and probable major depression in people with TBI. For this study, the PHQ-9 was scored in three ways: a total score (0-27), a cut-off of 10 or higher for moderate-severe depression, and suicidal ideation (SI) item score greater than 0 indicating thoughts of being better off dead or of hurting oneself within the past two weeks.

The GAD-7[9] asks participants to rate seven questions using the stem "Over the past two weeks, how often have you been bothered by feeling nervous, anxious or on edge?" and scored on an ordinal scale with four categories: "0=not at all," "1=several days," "2=more than half the days (>7)," and "3=nearly every day." Total possible scores range from 0 to 21. Both the PHQ-9 and GAD-7 include a final question about symptom-related impairment, i.e., how difficult these problems [endorsed symptoms] have made it for them to do their work, take care of things at home, or get along with other people? Responses are on a 0-3 scale not difficult at all to extremely difficult

Several demographic, psychosocial, injury-related, and functional characteristics were considered as predictive variables for depression and anxiety, including participants' age at follow up, sex, race/ethnicity, education level, cause of injury, disability, employment status, marital status, household income, urbanicity, and problematic substance use. Sex was used as a binary variable. Race/ethnicity was categorized as American Indian/Alaska Native, Asian, Black, Hispanic, White, and other. Education level was classified as less than a high school diploma, high school diploma, or General Education Development (GED), and greater than a high school diploma. Cause of injury was grouped as vehicular, violence, falls, and other. Disability was measured with the Disability Rating Scale (DRS), with possible scores ranging from 0 to 29. Employment status was examined as employed, student, unemployed, and other. Marital status was categorized as single/never married, married, divorced, separated, and widowed. The region of residence was grouped as rural, urban, or suburban. Problematic substance use in the past month (dichotomized as yes or no) was defined as heavy alcohol consumption (i.e., > 14 drinks/month for males and > 7 drinks/month for females), use of illicit drugs, or binge drinking.[10,11]

Data Analysis

Preliminary analyses were conducted in SPSS Version 28[12] and R Version 4.0.4. Chi-squared tests for categorical variables and independent samples t-tests for continuous variables were used to compare sample characteristics between participants retained in analyses and those excluded and compare sample characteristics between participants by pandemic period. Pearson correlations, point-biserial correlations, and phi coefficients were used to evaluate associations between demographic, psychosocial, injury-related, and functional characteristics with depression and anxiety symptoms in the full sample and separately by pandemic period.

In order to evaluate the hypothesis that the pandemic period would be independently associated with greater depression and anxiety symptoms, separate linear and logistic regression models were constructed with demographic, psychosocial, injury-related, and functional characteristics, along with a binary indicator of the pandemic period (pre-pandemic vs. during pandemic), as predictors of four outcomes: 1) total depression symptoms (linear regression), 2) above cut-off > 10 for moderate-severe depression (logistic regression), 3) suicidal ideation > never (logistic regression), and 4) total anxiety symptoms (linear regression). There were no missing data on any outcome variables or the pandemic period predictor by design. Missing data on predictors ranged from 0% to 8.2%, though only two covariates (i.e., household income, disability rating) had more than 2% missing data; covariate missingness was uncorrelated with values on mental health outcomes or with other covariate values (r's $< \pm .05$). For regression models, complete case analysis (n = 5,805; 82.8%) was used over maximum likelihood approaches, which would not have applied well to demographic or injury-related variable imputation; participants with complete data did not systematically differ from those with incomplete data on any model variables (r's $< \pm .05$).

Given our large sample size and ability to detect very small associations at α <.01, we emphasized effect size rather than statistical significance. Effect sizes were evaluated using phi (φ; binary variables) and Cramer's V (categorical variables) for the chi-squared tests, Pearson correlations (*r*, continuous variables), and Cohen's *d* for t-tests. In regression analyses, effect sizes were evaluated using semi-partial correlations and odds ratios for linear and logistic regression models. We conducted a posthoc analysis of the symptom-related functional impairment questions from the PHQ-9 and GAD-7.

Results

Sample

A sample of 9,388 TBIMS participants was assessed between 10/01/2017 and 6/30/2021. Of these, 237 were excluded due to follow-up occurring during March 2020, and 2,142 were excluded due to missing PHQ-9 or GAD-7 data, leaving a final sample of 7,009 participants. Reasons for missing PHQ-9 or GAD-7 data were ineligibility for the administration of these measures due to reporting by an unknown or proxy source (n = 1733), missing data (n = 405), being lost to follow-up (n = 3), and withdrawal from the study (n = 1). Characteristics of the total sample and those excluded are displayed in Table 1. The demographic characteristics of those eligible but not included resembled those of the analytic sample. A greater proportion of retained participants were older, white, had higher educational attainment, were employed, and reported a higher household income than participants who were excluded, but these differences were small in magnitude. Disability ratings were much lower among those included versus excluded from the analytic sample, likely because participants must complete the PHQ-9 and GAD-7 themselves rather than by proxy interview.

[insert Table 1 about here]

Correlations Overall and by Pandemic Period

The participants' demographic, psychosocial, injury-related, and functional characteristics were similar across the pandemic period (Table 2). The only meaningful difference between participants during the two periods was follow-up timing, with a greater proportion of earlier follow-ups (e.g., Year 2, Year 5) among pre-pandemic participants than during pandemic participants. This difference was likely due to our selection strategy, which retained only the first occurrence of a participant's follow-up data collection.

[insert Table 2 about here]

There was no evidence of meaningful differences in depression symptom severity, the prevalence of moderate-severe depression, endorsement of suicidal ideation, or anxiety symptom severity by the pandemic period. Furthermore, average depression and anxiety symptom scores throughout the full assessment period (10/01/2017 to 06/30/2021) were relatively stable (Figure 1).

[insert Figure 1 about here]

Tables 3 and 4 show correlations between the predictors and mental health outcomes for the full sample and separated by the pandemic period. Being in late adulthood, being employed, being married, or having a higher household income were associated with less depression. Greater disability was associated with higher depression symptom severity, a medium-sized effect. A similar pattern of associations was found when moderate-severe depression was the outcome. Small associations were observed between a greater likelihood of endorsing suicidal ideation and lower household income, and greater disability. Regarding anxiety scores, older age, being employed, being married, having a higher household income, and not having a history of problematic substance use were associated with lower symptom severity, and the magnitude of

these relationships was small. There was a medium-sized relationship between disability and anxiety symptom severity in which greater disability was associated with higher anxiety symptom severity.

[insert Table 3 and 4 about here]

There was no evidence that the pandemic period influenced the relationships between these predictors and mental health outcomes—correlations were similar in magnitude during each assessment period (Table 4). Further, among participants assessed during the pandemic, there were no meaningful associations between rural residence, history of substance abuse, or minoritized race/ethnicity and any mental health outcomes.

[insert Table 5 here]

Regressions - Predictors of Mental Health Symptom Severity

In order to examine the unique predictive ability of the pandemic period on mental health outcomes, separate regression analyses were conducted for each outcome (Tables 5a and 5b). Given no evidence for moderation during the pandemic period in bivariate analyses, only the main effects were examined. In the depression symptoms model, the unique effect emerged as a medium-sized positive association between disability and depression symptom severity. When predicting the likelihood of moderate-severe depression symptoms, being in late adulthood compared to early adulthood offered reduced odds, while greater disability and a substance use history were associated with a small increase in moderate-to-severe depression. After all other predictors were controlled, late relative to early adulthood protected against endorsing suicidal ideation; at the same time, greater disability and a history of problematic substance use demonstrated independent associations with greater odds of suicidal ideation. Small, independent relationships emerged between being in late adulthood relative to early adulthood or having less

disability and reporting lower anxiety symptom severity. COVID pandemic period was not associated with any of the mental health outcomes assessed (Table 6).

[Insert Table 6 about here]

Discussion

The current study revealed no significant differences in depression, anxiety, or suicidality between individuals with TBI eligible for the study, assessed before and during the COVID-19 pandemic. Predictors of these mental health symptoms also remained consistent between the two periods. Furthermore, there was no significant difference in functional impairment related to depression and anxiety before and during the pandemic. This pattern of results is similar to that which has been observed in individuals with Multiple Sclerosis and spinal cord injury,[13–15,16] but may appear to contrast with the findings in the general population,[17–20] in whom *higher* levels of depression, anxiety, and suicidality were described. Still, a few important distinctions need to be considered.

About 1700 individuals with PHQ-9 or GAD-7 data from a proxy source were eliminated-- a sizeable number of individuals whose disability may have precluded them from response. Our findings may not reflect the experience of all individuals with TBI and are restricted to those who were at the minimum able to respond to PHQ-9 or GAD-7.

The timing of the study period needs to be closely considered. In the general population, symptoms of anxiety and depression increased in March 2020 but soon returned to pre-pandemic levels.[21] In our study, we eliminated data from March 2020 because of a lack of clarity regarding the specific timing of the collected data. Additionally, the PHQ-9 and GAD-7 have the subject refer to the past two weeks. Depending on the precise timing of the declaration of COVID-19 as a global pandemic, these data could not be assigned accurately to the relevant epochs.

While the findings suggest that the COVID-19 pandemic did not have a detectable harmful impact on the mental health of those with TBI, our findings are consistent with levels of psychological distress in this population reported in other studies.[3, 4, 22] The prevalence of suicidal ideation in the general population is 4%[23], but in our cohorts, the prevalence stayed between 20-30% (Figure 2). While disability rating had a medium correlation with depression and anxiety, the strength of the association was relatively stable through COVID. Others[6] have similarly found that greater disability due to neurological diseases may not be associated with changes in mental health during COVID and speculated that some of these individuals were already restricted and socially isolated. Our findings echo this sentiment.

Implications: This study highlights the ongoing high rates of anxiety, depression, and suicidal ideation for individuals with TBI. Future studies should consider the experience of individuals whose disability precludes participation in surveys.

Limitations: A few limitations should be considered. Analyses were limited to those variables collected for the TBIMS dataset, and some variables that may contribute to mental health during the pandemic were not available for study (e.g., measures of resilience; healthcare utilization; family support; and use of religion and spirituality for coping). Of note, the importance of social determinants of health is increasingly appreciated in the study of neurologic disabilities[25], and additional variables (e.g., neighborhood socioeconomic status, access to community resources) capturing these potential effects should be included in future work. No control group was available, so we could not draw direct comparisons between trends in the TBI and general populations. Finally, the TBIMS enrolls only individuals who receive acute inpatient TBI rehabilitation. Thus, it is unknown if these findings generalize to individuals with TBI

without access to specialized care, such as those from minoritized backgrounds or with limited financial resources.

Conclusions

Symptoms of depression, anxiety, and suicidality have shown little change overall during the COVID-19 pandemic in included TBIMS enrollees. At the aggregate level, these results may be regarded positively. Contrary to expectations, we did not find changes in depression, anxiety and suicidality in this population during this time period.

Figure Legend.

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Fig 1a
Depression Symptoms (PHQ-9 Total Scores)

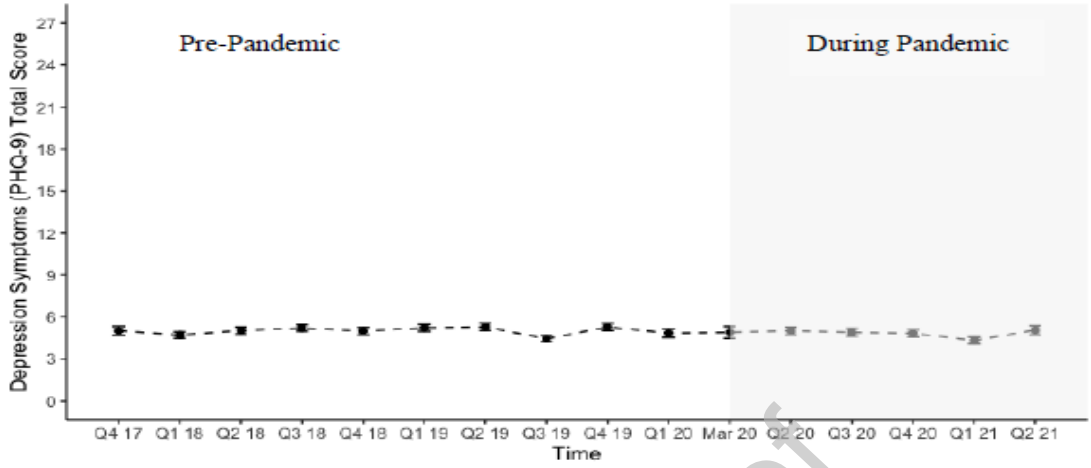
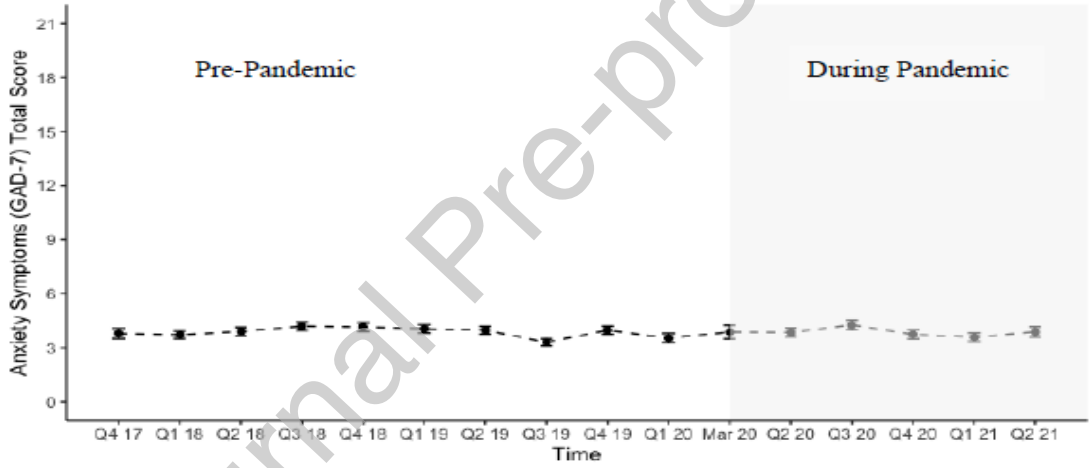


Fig 1b
Anxiety Symptoms (GAD-7 Total Scores)



Note. The shaded area represents data collected during the COVID-19 pandemic. Data collected during March 2020, while presented here, were excluded from analyses.

Figure 1

Depression and anxiety symptoms from October 2017-June 2021. Quarterly total PHQ-9 scores (Fig 1a) and quarterly total GAD-7 scores (Fig 1b) are relatively stable during the study period. The shaded area corresponds with data collected during the COVID-19 pandemic. Data collected during March 2020, while presented here, were excluded from analyses.

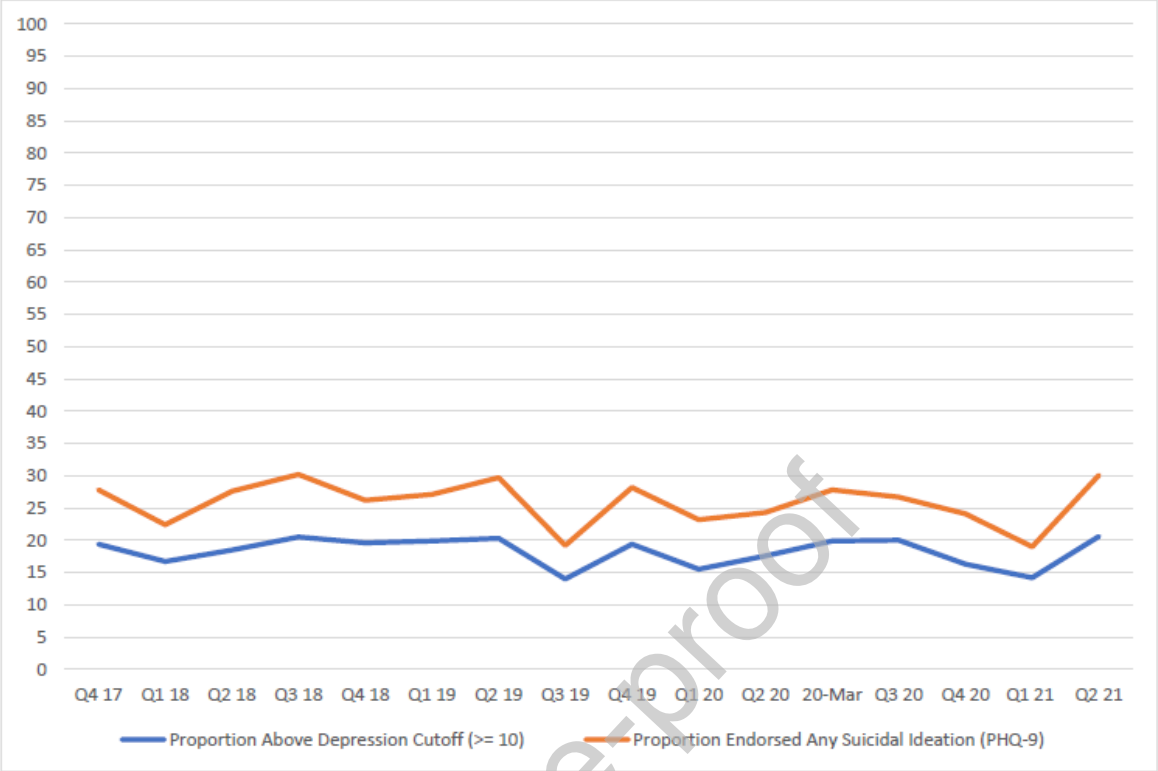


Figure 2

Proportion of Participants Above Depression Symptom Threshold (PHQ-9 ≥ 10) and Endorsement of Any Suicidal Ideation Across Data Collection Quarters

Table 1

Comparisons of Included and Excluded Participants

	Included	Excluded	Effect Size
	n = 7009	n = 2379	
Demographic Characteristics			
Sex, male (%)	5075 (72.4)	1796 (75.7)	.03
Age at follow-up (%)	47.2 (16.7)	50.7 (19.5)	.10
Early adult (16 – 34 years)	1904 (27.2)	602 (25.4)	
Early middle (35 – 44 years)	1504 (21.5)	437 (18.4)	
Late middle (45 – 64 years)	2377 (34.0)	704 (29.7)	
Late adulthood (> 64 years)	1215 (17.4)	628 (26.5)	
Race and Ethnicity (%)			.11
American Indian/Alaska Native	30 (0.4)	17 (0.7)	
Asian	186 (2.7)	84 (3.5)	
Black	1154 (16.5)	466 (19.6)	
Hispanic	690 (9.9)	375 (15.8)	
"Other" racial/ethnic group	78 (1.1)	37 (1.6)	
White	4866 (69.5)	1393 (58.7)	
Education (%)			.15
Less than high school (%)	827 (11.8)	516 (22.9)	
High school or GED (%)	2149 (30.7)	763 (33.8)	
Greater than high school (%)	4021 (57.5)	978 (43.3)	
Employment status (%)			.19
Employed	3048 (43.6)	508 (23.1)	
Student	150 (2.1)	31 (1.4)	
Other (i.e., homemaker, retired)	2910 (41.6)	1365 (62.0)	
Unemployed	890 (12.7)	296 (13.5)	
Marital status (%)			.07
Single, never married	2619 (37.5)	947 (41.7)	
Married	2564 (36.7)	713 (31.4)	
Divorced	1266 (18.1)	386 (17.0)	
Separated	250 (3.6)	69 (3.0)	
Widowed	294 (4.2)	156 (6.9)	
Household income (%)			.15
<$25k	2114 (32.9)	862 (49.2)	
$25k - <$50k	1536 (23.9)	389 (22.2)	
$50k - <$100k	1580 (24.6)	326 (18.6)	
$100k - <$150k	678 (10.5)	97 (5.5)	
$150k - <$200k	252 (3.9)	33 (1.9)	
>$200k	274 (4.3)	46 (2.6)	
Urbanicity (%)			.06
Rural	1971 (28.6)	522 (23.5)	
Urban	2701 (39.2)	998 (44.9)	

Suburban	2226 (32.3)	701 (31.6)	
Injury-related Characteristics			
Follow-up period (%)			.12
Year 1	1641 (23.4)	747 (31.4)	
Year 2	514 (7.3)	261 (11.0)	
Year 5	1384 (19.7)	470 (19.8)	
Year 10	1479 (21.1)	401 (16.9)	
Year 15	1169 (16.7)	296 (12.4)	
Year 20	616 (8.8)	146 (6.1)	
Year 25	137 (2.0)	42 (1.8)	
Year 30	69 (1.0)	16 (0.7)	
Cause of injury (%)			.09
Motor vehicle	3853 (55.0)	1061 (44.9)	
Fall	1681 (24.0)	731 (30.9)	
Violence	656 (9.4)	284 (12.0)	
Other cause	812 (11.6)	287 (12.1)	
Disability rating, m (sd)	2.1 (2.1)	5.4 (4.4)	-1.19
Problematic substance use, yes (%)	2065 (29.7)	377 (19.5)	-.09
Mental Health Symptoms			
Depression symptoms, m (sd)	5.0 (5.5)	5.3 (5.6)	-.06
Above (10) depression cutoff, (%)	1272 (18.2)	43 (21.2)	.01
Any suicidal thoughts, (%)	518 (7.4)	33 (12.5)	.04
Anxiety symptoms, m (sd)	3.9 (5.1)	4.2 (5.0)	-.06
COVID Timeframe			
During COVID-19 pandemic, (%)	2009 (28.7)	548 (25.6)	-.03

Note. Excluded participants had incomplete PHQ-9 or GAD-7 or completed follow-up during March 2020. Effect sizes are phi or Cramer's V for categorical variables and Cohen's d for continuous variables.

Table 2

Sample Descriptive Statistics

	Pre-COVID n = 5000	**During COVID** n = 2009	**Effect Size**
Demographic Characteristics			
Sex, male (%)	3623 (72.5)	1452 (72.3)	-.00
Age at follow-up, m (sd)	46.9 (16.8)	48.1 (16.4)	.07
Early adult (16 – 34 years)	1863 (28.3)	577 (22.6)	
Early middle (35 – 44 years)	1281 (19.5)	607 (23.8)	
Late middle (45 – 64 years)	2165 (32.9)	847 (33.2)	
Late adulthood (>64 years)	1274 (19.4)	522 (20.4)	
Race and Ethnicity (%)			.02
American Indian/Alaska Native	21 (0.4)	9 (0.4)	
Asian	128 (2.6)	58 (2.9)	
Black	803 (16.1)	351 (17.5)	
Hispanic	504 (10.1)	186 (9.3)	
"Other" racial/ethnic group	56 (1.1)	22 (1.1)	
White	3486 (69.7)	1380 (68.8)	
Education (%)			.01
Less than high school (%)	595 (11.9)	232 (11.6)	
High school or GED (%)	1520 (30.5)	629 (31.4)	
Greater than high school (%)	2876 (57.6)	1145 (57.1)	
Employment status (%)			.03
Employed	2181 (43.7)	867 (43.2)	
Student	115 (2.3)	35 (1.7)	
Other (i.e., homemaker, retired)	2091 (41.9)	819 (40.8)	
Unemployed	605 (12.1)	285 (14.2)	
Marital status (%)			.02
Single, never married	1892 (37.9)	727 (36.3)	
Married	1814 (36.4)	750 (37.4)	
Divorced	902 (18.1)	364 (18.2)	
Separated	170 (3.4)	80 (4.0)	
Widowed	211 (4.2)	83 (4.1)	
Household income (%)			.04
<$25k	1548 (33.5)	566 (31.2)	
$25k - <$50k	1120 (24.2)	416 (22.9)	
$50k - <$100k	1111 (24.0)	469 (25.9)	
$100k - <$150k	480 (10.4)	198 (10.9)	
$150k - <$200k	166 (3.6)	86 (4.7)	
>$200k	195 (4.2)	79 (4.4)	
Urbanicity (%)			.00
Rural	1404 (28.6)	567 (28.6)	
Urban	1928 (39.2)	773 (39.0)	

Suburban	1584 (32.2)	642 (32.4)	
Injury-related Characteristics			
Follow-up period (%)			.21
Year 1	1152 (23.0)	489 (24.3)	
Year 2	484 (9.7)	30 (1.5)	
Year 5	1123 (22.5)	261 (13.0)	
Year 10	1012 (20.2)	467 (23.2)	
Year 15	736 (14.7)	433 (21.6)	
Year 20	370 (7.4)	246 (12.2)	
Year 25	87 (1.7)	50 (2.5)	
Year 30	36 (0.7)	33 (1.6)	
Cause of injury (%)			.04
Motor vehicle	2698 (54.0)	1155 (57.5)	
Fall	1251 (25.1)	430 (21.4)	
Violence	459 (9.2)	197 (9.8)	
Other cause	586 (11.7)	226 (11.3)	
Disability rating, m (sd)	2.0 (2.1)	2.1 (2.1)	-.07
Problematic substance use, yes (%)	1516 (30.6)	549 (27.6)	-.03
Mental Health Symptoms			
Depression symptoms, m (sd)	5.0 (5.6)	4.8 (5.4)	.03
Above (10) depression cutoff, (%)	919 (18.4)	355 (17.7)	-.01
Any suicidal thoughts, (%)	382 (7.6)	136 (6.8)	-.02
Anxiety symptoms, m (sd)	3.9 (5.1)	3.9 (5.0)	.00

Table 3

Demographic, Injury-Related, and Psychosocial Correlates with Mental Health Outcomes, Full Sample (n = 7,009)

	PHQ-9 Total	**PHQ Cutoff**	**Any SI**	**GAD-7 Total**
Sex (Female vs. Male)	-.07	-.03	.01	-.08
Age (vs. all other)				
Early adult (16 – 34 years)	.04	.03	.03	.09
Early middle (35 – 44 years)	.02	.02	.03	.05
Late middle (45 – 64 years)	.03	.02	.01	.00
Late adulthood (>64 years)	-.11	-.08	-.07	-.16
Race and Ethnicity (vs. all other)				
American Indian/Alaska Native	.04	.03	.03	.02
Asian	-.01	-.01	.02	-.02
Black	.07	.06	.04	.07
Hispanic	.03	.02	.01	.04
"Other" racial group	.00	-.00	.01	.01
White	-.07	-.07	-.05	-.08
Education (vs. all other)				
Less than high school	.06	.05	.04	.07
High school or GED	.06	.05	.03	.05
Greater than high school	-.09	-.08	-.05	-.09
Employment (vs. all other)				
Employed	-.18	-.14	-.08	-.13
Student	.01	.00	.00	.01
Other (i.e., homemaker, retired)	.10	.08	.03	.05
Unemployed	.12	.10	.07	.13
Marital Status (vs. all other)				
Single, never married	.06	.04	.04	.08
Married	-.12	-.10	-.07	-.12
Divorced	.06	.05	.04	.04
Separated	.06	.06	.03	.07
Widowed	-.02	-.02	-.01	-.04
Household Income	-.22	-.18	-.10	-.21
Urbanicity				
Rural	-.01	.00	.01	-.01
Urban	.02	.01	-.01	.03
Suburban	-.01	-.01	.00	-.02
Follow-Up Period	-.04	-.03	-.03	-.04
Cause of Injury (vs. all other)				
Motor vehicle	.03	.02	.02	.05
Fall	-.05	-.04	-.03	-.07

Violence	.04	.04	.01	.04
Other cause	-.01	-.01	.00	-.01
Disability Rating	.38	.30	.17	.31
Problematic Substance Use at follow-up	.08	.06	.07	.11

Note. PHQ Cutoff is ≥ 10; Any SI indicates endorsed any suicidal ideation (PHQ item > never);

Table 4

Demographic, Injury-Related, and Psychosocial Correlates with Mental Health Outcomes By COVID Era

	Pre-COVID (n = 5000)				During COVID (n = 2009)			
	PHQ-9 Total	**PHQ Cutoff**	**Any SI**	**GAD-7 Total**	**PHQ-9 Total**	**PHQ Cutoff**	**Any SI**	**GAD-7 Total**
Sex (Female vs. Male)	-.07	-.03	.01	-.08	-.05	-.03	.02	-.07
Age (vs. all other)	-.10	-.07	-.06	-.17	-.09	-.06	-.06	-.15
Early adult (16 – 34 years)	.04	.03	.03	.09	.05	.02	.03	.10
Early middle (35 – 44 years)	.04	.03	.04	.07	-.01	.0	.01	.02
Late middle (45 – 64 years)	.02	.02	.00	-.01	.05	.03	.01	.02
Late adulthood (>64 years)	-.12	-.09	-.08	-.16	-.11	-.07	-.06	-.15
Race and Ethnicity (vs. all other)								
American Indian/Alaska Native	.05	.03	.04	.03	.02	.03	.01	.01
Asian	-.02	-.02	.02	-.02	.00	.01	.00	-.02
Black	.07	.07	.05	.08	.06	.05	.02	.06
Hispanic	.04	.03	.01	.04	.01	.01	.00	.04
"Other" racial group	.01	.00	.01	.03	-.01	-.02	-.01	-.02
White	-.08	-.07	-.06	-.09	-.05	-.05	-.02	-.06
Education (vs. all other)								
Less than high school	.08	.06	.05	.08	.02	.03	.01	.04
High school or GED	.05	.04	.04	.05	.07	.05	-.02	.06
Greater than high school	-.10	-.08	-.07	-.10	-.07	-.07	.01	-.08
Employment (vs. all other)								
Employed	-.19	-.15	-.09	-.14	-.15	-.12	-.05	-.10
Student	.01	.01	.01	.02	-.01	-.00	-.01	-.01
Other (i.e., homemaker, retired)	.11	.08	.04	.05	.07	.07	.02	.03
Unemployed	.12	.10	.08	.13	.12	.07	.04	.03
Marital Status (vs. all other)								
Single, never married	.05	.04	.03	.08	.08	.05	.04	.10
Married	-.12	-.10	-.08	-.12	-.13	-.11	-.07	-.14

Divorced	.07	.05	.04	.04	.05	.05	.03	.04
Separated	.06	.05	.03	.05	.08	.09	.03	.09
Widowed	-.01	-.01	-.00	-.02	-.06	-.06	-.03	-.07
Household Income	-.23	-.18	-.11	-.21	-.20	-.16	-.06	-.18
Urbanicity								
Rural	-.00	.00	.02	-.02	-.01	.00	-.03	-.01
Urban	.01	-.01	-.03	.02	.05	.04	.05	.05
Suburban	-.00	.01	.01	-.01	-.04	-.05	-.02	-.04
Follow-Up Period	-.03	-.03	-.03	-.02	-.06	-.04	-.03	-.07
Cause of Injury (vs. all other)								
Motor vehicle	.02	.02	.02	.05	.04	.02	.01	.05
Fall	-.05	-.04	-.03	-.07	-.06	-.04	-.02	-.08
Violence	.06	.05	.02	.05	.01	.00	-.02	.03
Other cause	-.02	-.02	-.01	-.02	.01	.01	.02	-.01
Disability Rating	.39	.32	.17	.32	.36	.27	.16	.28
Problematic Substance Use at follow-up	.10	.07	.08	.13	.04	.03	.03	.06

Note. PHQ Cutoff is ≥ 10; Any SI indicates any suicidal ideation (PHQ item > never).

Table 5

Mental health outcomes multiple regression models (n = 5,805)

Table 5a Depression severity outcomes multiple regression models

	PHQ-9 Symptom Severity			**Above Depression Cutoff**			**Any Suicidal Ideation**		
	B	*SE*	r_{sp}	*B*	*SE*	*OR*	*B*	*SE*	*OR*
Sex (ref. male)	0.79	0.15	.06	0.22	0.08	1.25	-0.12	0.13	0.89
Age (ref. early adult)									
Early middle (35 – 44 years)	0.11	0.20	.01	0.10	0.11	1.11	0.23	0.16	1.26
Late middle (45 – 64 years)	-0.20	0.20	-.01	0.01	0.11	1.01	-0.09	0.16	0.91
Late adulthood (>64 years)	-1.79	0.27	-.08	-0.62	0.16	0.54	-1.09	0.26	0.34
Race and Ethnicity (ref. White)									
American Indian/Alaska Native	2.01	0.96	.02	0.64	0.45	1.90	1.04	0.53	2.84
Asian	-0.13	0.42	-.00	-0.03	0.26	0.97	0.19	0.36	1.20
Black	0.18	0.19	.01	0.16	0.10	1.18	0.27	0.14	1.31
Hispanic	-0.18	0.24	-.01	-0.01	0.13	0.99	-0.01	0.19	0.99
"Other" racial/ethnic group	0.27	0.61	.01	-0.04	0.36	0.96	0.31	0.45	1.36
Education (ref. less than high school)									
High school or GED	0.28	0.23	.01	0.10	0.12	1.10	-0.02	0.16	0.98
Greater than high school	0.41	0.23	.02	0.22	0.13	1.24	0.04	0.17	1.04
Employment status (ref. unemployed)									
Employed	-0.92	0.22	-.05	-0.26	0.12	0.77	-0.38	0.17	0.69
Student	-0.59	0.49	-.01	-0.13	0.27	0.88	-0.35	0.40	0.71
Other (i.e., homemaker, retired)	-0.65	0.23	-.03	-0.20	0.11	0.82	-0.21	0.15	0.81
Marital status (ref. married)									
Single, never married	-0.08	0.18	-.01	0.02	0.11	1.02	-0.05	0.16	0.95
Divorced	0.52	0.20	.03	0.22	0.11	1.25	0.20	0.16	1.22

Separated	0.60	0.37	.02	0.29	0.19	1.34	0.09	0.27	1.09
Widowed	-0.38	0.36	-.01	-0.15	0.22	0.86	0.20	0.32	1.22
Household income	-0.41	0.06	-.08	-0.23	0.04	0.80	-0.15	0.06	0.86
Urbanicity (ref. rural)									
Urban	0.20	0.17	.01	-0.01	0.10	0.99	0.01	0.14	1.01
Suburban	0.14	0.17	.01	0.07	0.10	1.07	0.12	0.14	1.13
Follow-up period	-0.16	0.04	-.05	-0.08	0.02	0.93	-0.08	0.03	0.92
Cause of injury (ref. motor vehicle)									
Fall	-0.31	0.21	-.02	-0.17	0.10	0.84	-0.13	0.15	0.88
Violence	-0.11	0.24	-.01	-0.05	0.13	0.96	-0.23	0.18	0.79
Other cause	-0.31	0.21	-.02	-0.14	0.12	0.87	-0.08	0.18	0.92
Disability rating	0.93	0.04	.31	0.33	0.02	1.39	0.25	0.03	1.28
Problematic substance use	1.00	0.15	.08	0.41	0.08	1.50	0.53	0.11	1.71
COVID era	-0.29	0.14	-.02	-0.11	0.08	0.90	-0.22	0.12	0.81
		$R^2_{adjusted}$ = .20		*Nagelkerke pseudo* R^2 = .19			*Nagelkerke pseudo* R^2 = .11		

Note. r_{sp} = semi-partial correlation. OR = odds ratio.

Table 5b Anxiety symptom severity outcome multiple regression model

	GAD-7 Symptom Severity		
	B	*SE*	r_{sp}
Sex (ref. male)	1.04	0.14	.09
Age (ref. early adult)			
Early middle (35 – 44 years)	-0.13	0.19	-.01
Late middle (45 – 64 years)	-0.76	0.19	-.05
Late adulthood (>64 years)	-2.33	0.25	-.11
Race and Ethnicity (ref. White)			
American Indian/Alaska Native	0.19	0.91	.00
Asian	-0.30	0.40	-.01
Black	0.31	0.18	.02
Hispanic	-0.17	0.22	-.01
"Other" racial/ethnic group	0.51	0.57	.01
Education (ref. less than high school)			
High school or GED	-0.16	0.22	-.01

Greater than high school	-0.11	0.21	-.01
Employment status (ref. unemployed)			
Employed	-0.94	0.21	-.05
Student	-0.95	0.46	-.03
Other (i.e., homemaker, retired)	-0.77	0.21	-.04
Marital status (ref. married)			
Single, never married	-0.19	0.17	-.01
Divorced	0.21	0.19	.01
Separated	0.60	0.34	.02
Widowed	-0.49	0.34	-.02
Household income	-0.36	0.06	-.08
Urbanicity (ref. rural)			
Urban	0.33	0.16	.03
Suburban	0.17	0.16	.01
Follow-up period	-0.11	0.04	-.04
Cause of injury (ref. motor vehicle)			
Fall	-0.32	0.16	-.02
Violence	-0.17	0.22	-.01
Other cause	-0.46	0.20	-.03
Disability rating	0.69	0.03	.25
Problematic substance use	1.09	0.14	.10
COVID era	-0.07	0.14	-.01
	$R^2_{adjusted}$ = .17		

Note. r_{sp} = semi-partial correlation.

Table 6. Functional impairment due to depression and anxiety

	Pre-COVID	During COVID
Depression Symptoms		
PHQ Impairment (All Participants)		
Not at all difficult	62.2	61.1
Somewhat difficult	28.0	28.9
Very difficult	6.7	6.8
Extremely difficult	3.0	3.1
PHQ Impairment (only participants who endorse any PHQ symptoms)		
Not at all difficult	49.8	47.9
Somewhat difficult	37.2	38.7
Very difficult	8.9	9.1
Extremely difficult	4.0	4.2
Anxiety Symptoms		
GAD Impairment (All Participants)		
Not at all difficult	66.0	63.3
Somewhat difficult	25.4	27.8
Very difficult	5.6	5.8
Extremely difficult	3.0	3.0
GAD Impairment (only participants who endorse any GAD symptoms)		
Not at all difficult	46.6	45.7
Somewhat difficult	39.9	41.2
Very difficult	8.8	8.6
Extremely difficult	4.8	4.5

People who skipped the item because they reported no symptoms were recoded to the "not difficult at all" response