Brain Injury and Substance Use in Young Adults: The Need for Integrating Care

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ABSTRACT

OBJECTIVES: This study examined sociodemographic disparities in traumatic brain injury (TBI), and the association between TBI and substance misuse among young adults in Rhode Island.

METHODS: Among this sample of N=1,022 from the 2022 Rhode Island Young Adult Survey, multivariable logistic regressions were used to examine both study objectives.

RESULTS: Black, Asian, and Hispanic young adults had 77% (95%CI: 26%, 93%), 79% (95%CI: 32%, 94%), and 58% (95%CI: 31%, 75%) lower odds of brain injury, respectively, compared to White, non-Hispanic young adults. Those having experienced brain injury were more likely to engage in hazardous alcohol use (p = 0.003), hazardous marijuana use (p < 0.001), and illicit drug use (p = 0.003), but not OTC or prescription drug misuse.

CONCLUSIONS: There is a pressing need for integrated, large-scale, multidisciplinary programs with a well-trained workforce to address TBI and substance misuse in various medical settings for behavioral health and emergency care.

KEYWORDS: Traumatic brain injury, substance use, young adult, Rhode Island

INTRODUCTION

Traumatic brain injury (TBI) is a major public health concern with approximately a 50% lifetime prevalence globally.[1] TBI is defined as a jolt or a blow to the head which causes an acute disruption to brain function; this can manifest as a period of loss of consciousness, confusion, or posttraumatic amnesia. Long-term health consequences of mild TBI are memory loss, periods of confusion, tinnitus, and loss of consciousness.[2] Concussions are classified as a traumatic brain injury, regardless of severity.[3] Mild TBIs are also associated with an increased risk of depression and anxiety.[3,4] Severe TBIs have significant long-term health consequences such as coma, emotional problems, seizures, and death. Similarly, severe TBI is associated with an increased risk of depression, anxiety, agitation, anger, aggression, and irritability.[4] This emotional distress can increase suicide attempts, especially in young adults with TBIs.[5]

In the United States, an estimated 1.7 million people sustain a TBI annually.[6] In Rhode Island between 2016 and 2020, 14,300 individuals were discharged from the emergency department with a TBI diagnosis, 2,769 were admitted to the hospital, and 653 TBI-associated deaths occurred. Of these, 3,401 individuals aged 15–24 years old were admitted to the emergency department with a TBI diagnosis (23.8%), 163 were admitted to the hospital (5.9%), and 28 had TBI-associated fatalities (4.3%). The most common causes of TBI in Rhode Island young adults (15–24 years) during this time were being struck by an object (28.2%), falls (22.8%), and motor vehicle accidents (22.6%).[7]

Available data show that young adults 18–25 years old are at high risk for TBI, following only elderly adults (75+ years) and young children (<5 years).[2] TBIs sustained during this developmental stage can have a lasting impact. Global function, cognitive function, and motor function can decrease as a result of TBI.[8] TBI can also cause behavioral and emotional changes.[9] Young adults with TBIs often have trouble returning to work or higher education due to executive function and cognitive setbacks.[10]

Young adults are also at high risk for substance use. Physiologically, the prefrontal cortex responsible for impulse control is still developing,[11] and substance use is typically initiated in the teenage years and young adulthood.[12] Rates of substance use tend to be highest in young adulthood and are generally higher among Rhode Island young adults than across the nation. According to the 2019-2020 National Survey on Drug Use and Health, 41% of Rhode Island young adults binge drank compared to 32% of the national young adult population. Similar disparities were found with marijuana use (36% RI vs. 23% US), illicit drug use (34% RI vs. 24% US), and pain reliever misuse (5% RI vs. 4% US).[13]

The relationship between TBI and substance use is likely bidirectional. Substance use can be a risk factor for TBI in all age groups; however, young adults have an increased risk of long-term morbidity compared to older adults, as their brains are still developing.[14] Studies have shown that those suffering from TBI were likely to be found intoxicated from alcohol upon hospital admission,[15] and a history of problem alcohol use is linked to an increased risk of incurring a TBI.[16] Similarly, among those with poor mental health or substance use disorder (SUD), risk of fatal and non-fatal TBI is increased while individuals are under the influence of

substances. Substance abuse also increases risk of motor vehicle accident, which can result in TBI.[16]

Conversely, substance use may result from a TBI.[17-19] Some literature suggests that TBI patients have increased risk for developing alcohol use disorder within a year of injury.[17] Another study shows that being a young adult and suspected substance intoxication at the time of TBI were both independently associated with post-TBI substance use disorder. Furthermore, studies examining TBI outcomes show that individuals who exhibit excessive substance abuse can have lower rates of good neuropsychological outcomes such as memory recall and recognition.[15,20] TBI-related substance abuse is associated with long-term outcomes such as neurological dysfunction, permanent disability, emotional and financial state,[21] an increased risk of repeated injury,[22] and death.[23]

There is limited information on TBIs in young adults and even less research on the relationship between TBI and substance use in young adults. The purpose of this study is to: 1) examine any sociodemographic disparities in TBI, and 2) to understand the relationship between TBI and various types of substance use among young adults in Rhode Island. This study aims to expand the knowledge of young adults with traumatic brain injuries and their relationship to substance use.

METHODS

Sample

A cross-sectional analysis was conducted with data from the web-based Rhode Island Young Adult Survey (RIYAS) from May through August 2022. A full description of RIYAS methodology has been previously published.[24] The survey resulted in N = 1,022 young adults aged 18–25 years who lived in Rhode Island for at least part of the year, all of whom are included in this study. This study was approved by the Johnson & Wales University Institutional Review Board.

Measures

The primary exposure of this study is having experienced a brain injury. This was assessed by the question, *have you ever experienced a significant head injury, brain injury, or a concussion?* Response options included *Yes, in the past year, Yes, more than a year ago,* and *No.* This measure was dichotomized as those having ever experienced a brain injury or never have experienced a brain injury.

The primary outcomes in this study include hazardous alcohol use, hazardous marijuana use, over the counter (OTC) drug misuse, prescription drug misuse, and any illicit drug use. Hazardous alcohol use was assessed by the Alcohol Use Disorders Identification Test (AUDIT) score generated from 10 items.[25] This valid and reliable assessment includes eight items about drinking behaviors with various frequency responses, for example, ranging from *never* to *daily or almost daily.*[26] The final two items had response options *never*, *yes, but not in the past year*, or *yes, during the past year*. The assessment was scored according to scoring instructions. Scores of 8 or more were considered hazardous alcohol use. Interitem reliability was $\alpha = 0.82$. Hazardous marijuana use was assessed via the Cannabis Use Disorders Identification Test - Revised (CUDIT-R).[27] This valid and reliable assessment includes eight items total: seven about marijuana use behaviors with various frequency responses on a 5-point Likert scale, for example, ranging from *never* to *daily or almost daily* and the final question, *Have you ever thought about cutting down, or stopping, your use of cannabis?* had response options *never*, *yes, but not in the past 6 months*, or *yes, during the past 6 months*.[28] The assessment was scored according to scoring instructions. Scores of 8 or more indicated hazardous marijuana use. Interitem reliability was $\alpha = 0.82$. OTC drug misuse, prescription drug misuse, and any illicit drug use were all assessed by similar questions: *Have you ever used over-the-counter medication for non-medical reasons?, Have you ever used prescription drugs not prescribed to you?,* or *Have you ever used illegal/illicit drugs or club drugs?* Response options *yes, in the past month* or *yes, more than a month ago* were both considered affirmative responses for use, and all variables were dichotomized.

Several covariates that may be associated with brain injury and substance use were included in the study. Covariates included sexual and gender identity *(cisgender heterosexual males, cisgender heterosexual females, sexual and gender minorities*), race/ethnicity (*White non-Hispanic, Black, Asian, Hispanic, Multiracial or something else*), age in years, and social status. Social status was measured using the Macarthur Scale of Subjective Social Status,[29] which assessed a participant's perceived social rank relative to other members of the community on a scale of 1, meaning *worst off*, to 10, meaning *best off*.

Statistical Analysis

Descriptive statistics such as frequencies and percentages were computed for all variables among the total sample. Bivariable statistics were used to compare covariates and substance use outcomes by brain injury status (**Tables 1, 2**). Particularly, two-sample t-tests were used for continuous variables, chi-square tests for categorical variables, and Fisher's exact test was used for categorical variables when a single cell had fewer than 5 observations. A multivariable logistic regression was conducted to calculate adjusted odds of brain injury for all covariates including sexual and gender identity, race/ethnicity, and social status (**Table 3**). Multivariable logistic regressions were also conducted for each of the five substance use outcomes controlling for all covariates (**Table 4**). All statistical tests were assessed at $\alpha = 0.05$. All analyses were conducted in Stata/SE 15.0.[30]

RESULTS

Among this sample of Rhode Island young adults, 16.8% (N=172) reported having ever experienced a brain injury, with N=36 reporting the occurrence within the past year (3.5%). Those having ever experienced a brain injury were more likely to be White, non-Hispanic ($p < 0.001$), and older ($p = 0.028$). However, brain injury status did not vary by sexual and gender identity or race/ethnicity (**Table 1**). Substance use outcomes varied in prevalence with the highest engaging in hazardous marijuana use (18.5%), then hazardous alcohol use (15.7%), prescription drug misuse (12.1%), OTC drug misuse (9.2%), and illicit drug use (9.1%). Those having experienced a brain injury were more likely to engage in hazardous alcohol use ($p = 0.003$), hazardous marijuana use ($p < 0.001$), and illicit drug use ($p = 0.003$). However, brain injury status did not vary by OTC or prescription drug misuse (**Table 2**).

The multivariable model for brain injury showed that Black young adults, Asian young adults, and Hispanic young adults had 77% (95%CI: 26%, 93%), 79% (95%CI: 32%, 94%), and 58% (95%CI: 31%, 75%) lower odds of

Table 1. Characteristics of Rhode Island Young Adults by Brain Injury

	TOTAL N=1022 (%)	Never Experienced a Brain Injury N=850 (83.2%)	Ever Experienced a Brain Injury N=172 (16.8%)	P-value
Sexual and Gender Identity				0.069
Cisgender Heterosexual Males	133 (13.0)	107 (12.6)	26 (15.1)	
Cisgender Heterosexual Females	456 (44.6)	393 (46.2)	63 (36.6)	
Sexual and Gender Minorities	433 (42.4)	350 (41.2)	83 (48.3)	
Race/Ethnicity				**<0.001**
White, non-Hispanic	611 (59.8)	482 (56.7)	129 (75.0)	
Black	54 (5.3)	51 (6.0)	3 (1.7)	
Asian	59 (5.8)	56 (6.6)	3 (1.7)	
Hispanic	210 (20.6)	190 (22.4)	20 (11.6)	
Multiracial or Something Else	88 (8.6)	71 (8.4)	17 (9.9)	
Social Status [mean (SE)]	4.99 (0.05)	5.00 (0.06)	4.98 (0.13)	0.860
Age [mean (SE)]	21.32 (0.07)	21.25 (0.07)	21.63 (0.15)	**0.028**

Note: P-values were computed using two-sample t-tests for continuous variables, chi-square tests for categorical variables, and Fisher's Exact tests for categorical variables with cell sizes < 5

Table 2. Substance Use Outcomes of Rhode Island Young Adults by Brain Injury

Substance Use Outcomes	TOTAL N=1022 (%)	Never Experienced a Brain Injury N=850 (83.2%)	Ever Experienced a Brain Injury N=172 (16.8%)	P-value
Hazardous Alcohol Use	160 (15.7)	120 (14.1)	40 (23.3)	**0.003**
Hazardous Marijuana Use	189 (18.5)	136 (16.0)	53 (30.8)	**<0.001**
OTC Drug Misuse	94 (9.2)	75 (8.8)	19 (11.1)	0.358
Prescription Drug Misuse	124 (12.1)	98 (11.5)	26 (15.1)	0.189
Illicit Drug Use	93 (9.1)	67 (7.9)	26 (15.1)	**0.003**

Note: P-values were computed using two-sample t-tests for continuous variables, chi-square tests for categorical variables, and Fisher's Exact tests for categorical variables with cell sizes < 5

Table 3. Adjusted Odds of Brain Injury among Rhode Island Young Adults, N=1,022

	Adjusted Odds Ratio	95% CI
Sexual and Gender Identity		
Cisgender Heterosexual Males	1.00 ref	
Cisgender Heterosexual Females	0.66	0.39, 1.10
Sexual and Gender Minorities	0.93	0.56, 1.55
Race/Ethnicity		
White, non-Hispanic	1.00 ref	
Black	**0.23**	**0.07, 0.74**
Asian	**0.21**	**0.06, 0.68**
Hispanic	**0.42**	**0.25, 0.69**
Multiracial or Something Else	0.90	0.51, 1.59
Social Status	1.00	0.90, 1.10
Age	1.08	0.99, 1.17

Note: Adjusted odds ratios were calculated using multivariable logistic regression

Table 4. Adjusted Associations Between Brain Injury and Substance Use Outcomes among Rhode Island Young Adults, N=1,022

	Adjusted Odds Ratio	95% CI
Hazardous Alcohol Use	**1.72**	**1.14, 2.60**
Hazardous Marijuana Use	**2.26**	**1.53, 3.34**
OTC Drug Misuse	1.29	0.74, 2.21
Prescription Drug Misuse	1.33	0.82, 2.15
Illicit Drug Use	**1.89**	**1.14, 3.15**

Note: Adjusted odds ratios for each substance use outcome were calculated using multivariable logistic regressions controlling for sexual and gender identity, race/ethnicity, social status, and age.

brain injury, respectively, compared to White, non-Hispanic young adults while controlling for sexual and gender identity, social status, and age. There were no other significant associations with brain injury in the multivariable model (**Table 3**).

Multivariable logistic regressions for substance use outcomes showed that brain injury increased the odds of hazardous alcohol use by 72% (95%CI: 14%, 160%), hazardous marijuana use by 126% (95%CI: 53%, 234%), and illicit drug use by 89% (95%CI: 14%, 215%), controlling for all covariates. Brain injury was not significantly associated with OTC or prescription drug misuse (**Table 4**).

DISCUSSION

The current study suggests that older and White young adults were more likely to experience TBI. White young adults have greater access to information and health care services for TBIs, thus allowing for higher reporting of these experiences.[31] Literature suggests that the overall rate of TBI varies by race among young adults. Black youth have been less likely to visit the emergency department for suspected TBI than White youth.[32] One study found that Black Americans were more likely to acquire a TBI through violence compared to White Americans.[33]

In this study, TBI in young adults was associated with hazardous alcohol use, hazardous marijuana use, and illicit drug use, but not with OTC and prescription drug misuse. The literature shows that being a young adult and suspected substance intoxication at the time of TBI was associated with post-TBI substance use disorder.[34] Multiple studies have shown that TBI survivors were more likely to experience alcohol misuse post-injury which was associated with an increased risk for future TBIs.[6,35-37] Substance abuse can also be a causal factor in TBIs via falls, crashes, or assaults.[38] A study at various Level 1 trauma centers throughout the US showed young adults were most likely to test positive for substance use via urine toxicology screening while being assessed for a suspected TBI.[39] Adolescents with a history of TBI had greater rates of binge drinking, hazardous drinking, consuming illegal drugs, cannabis (aOR=2.4), and drug problems (aOR=2.1) compared to those who were never injured.[40]

Limitations

While this study offers a novel examination into the association between TBI and substance use among young adults in Rhode Island, it is not without limitations. First, this is a cross-sectional study design and causality cannot be inferred. Specifically, it is not clear whether self-reported TBIs occurred before or after the assessed substance use outcomes – this is always hard to tease out given the plausible bidirectional relationship.[1,14,41] This is also a convenience sample, and is skewed female and sexual/gender minority, likely not representative of the young adult population and may underestimate the prevalence of TBI, as many studies suggest males have higher rates.[2] This underestimate of concussions may be underestimates of sports- or physical-activity-related concussions associated with low representation of males in the sample. However, prior literature suggests that sports-related concussions are significantly associated with substance use across various substances, and therefore are unlikely to bias the findings herein.[42] Finally, given the self-report nature of the survey, it is likely minor concussions may be under-reported due to lack of awareness, and substance misuse may also be under-reported due to social desirability bias.

Implications

Since TBI and substance use disorders tend to overlap and exacerbate one another, screening, treatment, and referrals should be integrated across the continuum of care. Patients with co-morbid TBI and SUD may require adapted communication due to neurological deficits, some expected noncompliance due to executive function challenges, compensatory strategies for other cognitive challenges, and additional long-term community support.[4] For these integrated programs to be successful, patient engagement and empowerment must be incorporated into person-centered care.[1] This highlights the pressing need for behavioral health providers to be better trained and equipped to identify TBIs and address neurologic impairments across treatment modalities.

Adapting to a patient's needs as they relate to TBI can improve patient engagement and treatment benefits; however, a TBI must first be identified.[43] Studies suggest TBI assessment can help delineate between mental health and neurologic symptoms, leading to better mental health referrals and improved clinical care decisions.[39,44] While evidence-based short screening tools are available to administer during behavioral health sessions, TBIs are still underrecognized by providers.[43] Failure to detect TBI in SUD patients often results in misdiagnosis or inappropriate treatment and rehabilitation plans.[16] Greater uptake of evidence-based TBI screening is needed.

Screenings for mental health and substance use disorders in the triage and emergency departments should also be introduced. Studies suggest that standardized data collection and review of mental health and substance use histories during initial TBI hospital presentations can aid in identifying patients at risk for developing mental illness or substance use disorder.[45] Unfortunately, this screening is not standard across medical facilities and the intervention and follow-up of substance use disorder in TBI patients is low.[39]

CONCLUSION

While small-scale, single-program initiatives exist, there is a need for larger-scale, multidisciplinary programs to address TBI and SUD in various medical settings for behavioral

health and emergency care.[1] Increased workforce capacity with appropriate training, knowledge, and resources is needed for integrated behavioral healthcare to better address the short- and long-term needs of young adults with TBI and SUD.

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