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Violence-Related Traumatic Brain Injury In Justice-Involved Women

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Abstract

Study Questions: This study investigated the rates of violence-related TBI among justice-involved women compared to justice-involved men. This study also investigated whether a number of sociological vulnerabilities were associated with violence-related TBI among justice-involved women.

Method: Archival data from 409 justice-involved individuals were used in this study. Men and women were compared on the prevalence and incidence of violence-related TBI, violence-related multiple TBIs, and all multiple TBIs using Pearson Chi-Squares. Men and women were compared on the total number of TBIs and youngest age of TBI using Mann-Whitney U Tests. Women were grouped by violence-related TBI history and compared on multiple vulnerabilities such as physical health problems, mental illness, and length of incarceration. Women were then re-grouped into violence-related multiple TBI, violence-related single TBI, and non-violence-related TBI and compared on the same variables using Kruskall-Wallis one-way ANOVAs with post hoc tests.

Results: There was no significant difference between genders in prevalence or incidence of violence-related TBI. Gender was, however, significantly associated with multiple TBIs (10.330, $df = 1$, $p = .001$), and multiple violence-related TBIs (7.074, $df = 1$, $p = .008$). History of violence-related TBI was significantly associated with physical health problems (7.902, $df = 1$, $p = .005$) and length of incarceration ($p = .022$). There were significant differences between multiple violence-related TBIs, single violence-related TBI, and non-violence related TBI groups on length of incarceration ($p = .001$).

Discussion: This study revealed a higher prevalence of multiple TBIs and violence-related multiple TBIs among justice-involved women compared to justice-involved men. Violence-

related TBIs were associated with more reports of physical illness and increased incarceration times. Clinicians can use this information to justify the identification of justice-involved women with these injuries so they may better tailor services to improve personal outcomes and reduce cost burdens to justice systems.

Keywords

Justice-involved; corrections; women; TBI; violence

Introduction

Traumatic brain injury (TBI) has been recognized as a significant public health problem, with an estimated 1.4 million TBIs occur each year, resulting in 1.1 million Emergency Department visits, 235,000 hospitalizations, and 50,000 deaths (Centers for Disease Control and Prevention [CDC], 2015; Corrigan, Selassie, & Langois Orman, 2010; Langois, Rutland-Brown, & Wald, 2006). In addition to acute morbidity, an estimated 2% of the United States population (5.3 million people) currently suffers from long-term or life-long disability associated with TBI (Langois, Rutland-Brown, & Wald, 2006). Incarcerated individuals are over-represented in these data. While the prevalence of TBI in the general population is 8.5%, estimates for the prevalence of TBI among incarcerated individuals ranges from 41-60% (CDC, 2010; Farrer & Hedges, 2011; Shiroma, Ferguson, & Pickelsimer, 2010).

Another over-represented characteristic of justice-involved individuals is a history of exposure to violence across the lifespan. One study found that 64.5% of incarcerated adult male felons reported early childhood physical abuse, compared to a rate of 29.9% among adult males in a general population survey (CDC & Kaiser Permanente, 2016; Weeks & Widom, 1998). Regarding adult victimization, Wolff and Shi (2012) found that 31.5% of incarcerated males reported experiencing physical trauma as an adult. Another study reported that 21% of inmates had experienced physical victimization within a 6-month period during incarceration (Wolff, Blitz, Shi, Siegel, & Bachman, 2007). In contrast, the prevalence of violence victimization in the general population is estimated to be 2.0% (Bureau of Justice Statistics, 2015). All told, the rates of interpersonal violence in this group are much higher than the rates of violence victimization among the general population.

Considering women specifically, a national survey found that 23% of women in the

general population report a lifetime history of physical violence by a partner, whereas prison wardens and healthcare workers estimate that 75-90% of incarcerated women have experienced intimate partner violence (Moracco, Runyan, Bowling, & Earp, 2007; Zust, 2009). The literature on intimate partner violence in particular, suggests that women who are exposed to violence are at greater risk for TBI. In one study, 92% of women reported a history of being hit in the head or face during partner violence (Jackson, Philp, Nuttall, & Diller, 2002). Valera and Berenbaum (2003) found that 74% of women in their study had sustained at least one brain injury related to domestic violence, and 51% had sustained multiple brain injuries related to domestic violence. Additionally, Gagnon and DePrince (in press) found that 80% of identified victims of intimate partner violence in their study reported a lifetime history of head injury, with 65% of those head injuries caused by violence (i.e., child abuse, partner violence).

Exposure to violence among justice-involved individuals may be related to greater risk for TBIs due to that violence, or 'violence-related TBI'. There is no standard definition for 'violence-related TBI' in the literature. As Schopp, et al. (2006) pointed out, violence is a separate construct from mechanism of injury, and could be present in any TBI. Mosby's Medical Dictionary (2009, para. 2) defines violence as "great force, either physical or emotional, usually exerted to damage or otherwise abuse something or someone." In the present study, violence-related TBI is defined as an alteration in brain function caused by an external force, exerted to damage or otherwise abuse an individual. With that, the only mechanism of injury that appears to clearly indicate the role of violence in incurring a TBI is assault, since assault is defined as a deliberate act to cause "injury to another person" (Wex Legal Dictionary, 2016, para. 3).

Some evidence indicates that violence-related TBI's are more prevalent among incarcerated individuals and are associated with poorer outcomes. Approximately 11% of TBIs

in the US are due to assault (Corrigan, Selassie, & Langois; Orman, 2010), while Australian and US studies have found the rates of TBI due to assault in justice-involved populations to be 37% and 38%, respectively; more than any other mechanism of injury (Schofield, et. al., 2006; Wall, Gorgens, Yeo, & Alexander, 2016).

Bruns and Hauser (2003) and Wenden, Crawford, Wade, King, and Moss (1998) both reported that TBIs from assault result in more severe injuries than many other etiologies, and many studies have demonstrated differences in recovery post-TBI. Gerhardt, Mellick, and Weintraub (2003) found that violent TBI survivors complained of more symptoms and did not reintegrate into the community as well as survivors of non-violent TBI. Similarly, another study found that participants injured by assault showed significantly poorer outcomes at six months relative to all other cause of injury groups combined (Wenden, et al., 1998). Those authors posited that traumatic stress from the assault incidents and/or a greater severity of injury among the assault victims in their sample may have contributed to the poorer outcomes (Wenden, et al., 1998). Additionally, Hanlon, Demery, Martinovich, and Kelly (1999) found that those injured by assault had poorer neuropsychological status at three to 40 months post-injury, and that 90% of the assault-related TBI group showed poor vocational outcomes at one year post-injury. And Schopp et al., (2006) found that, at one year post-injury, violently-injured TBI survivors showed poorer social productivity and social integration, as well as higher rates of public sector income sources relative to their non-violently brain injured peers. Finally, Bushnik, Hanks, Kreutzner, and Rosenthal (2003) found that, at one year post-injury, a violently injured group's unemployment rate and divorce rate increased more than any other group with TBI. This suggests that even those who had been engaged in productive activity prior to their injuries showed greater environmental, social, and economic instability post-TBI.

Another variable important to the discussion of TBI is gender. Research indicates that TBI outcomes, prevalence rates and mechanism of injury vary significantly by gender. While the research is somewhat mixed, several studies suggest that female sex is a risk factor for poor outcomes and that women have a higher rate of long-term disability. Bazarian, Blyth, Mooerjee, He, and McDermott (2010) suggested that women report significantly more post-concussive symptoms than men. Corrigan, Selassie, and Langois Orman (2010) also reported that the rate of TBI-related disability is significantly higher among women than men (49.5% vs 39.9%), and a meta-analysis of eight studies found that women demonstrated poorer outcomes on 85% of the 20 measured variables (Farace & Alves, 2000). The prevalence rates of TBI are also very different for each sex. For example, research indicates that men are twice as likely to incur a TBI during their lifetime as women (Langlois, Rutland-Brown, & Thomas, 2004) but the male-female (M/F) ratio of TBI changes with life-course (Bruns & Hauser, 2003). At the extremes of age, the M/F ratio is roughly equal, but in the adolescent/young adult age group, the M/F ratio can exceed 4:1.

Interestingly, in correctional settings, the "gender gap" in TBI closes significantly or disappears completely. Some research even indicates that the rate of TBI is higher among incarcerated women compared to incarcerated men. Shiroma, Ferguson, and Pickelsimer (2010) estimated a prevalence rate of 64.41% for men, compared to 69.98% for women. Fishbein, Dariotis, Ferguson, and Pickelsimer (2014) found a prevalence rate of 71.5% for women and 64.1% for men. Similarly, Ferguson et al. (2012) found a rate of 72% among women vs. 65% among men. Diamond, Harzke, Magaletta, Cummins, and Frankowski (2007) found that assault was the leading cause of TBI among women in their sample, causing 46.6% of TBIs sustained by women. In contrast, the leading cause of TBI for men was motor vehicle accidents (35.6%).

Assault was the second most prevalent cause of injury among men at 27%.

Not only do rates and types of injuries appear to be different for incarcerated women compared to incarcerated men and non-incarcerated women, justice-involved women with TBI differ from justice-involved women and men without TBI in many other important ways. According to Colantonio, et al. (2014), incarcerated women with histories of TBI were more likely than incarcerated men to have sustained their TBI prior to their first criminal offense (54.3% vs. 31.7%). The women were also more likely to begin abusing alcohol or other substances after their first TBI (Colantonio, et al., 2014). Additionally, incarcerated women with a TBI history were more likely than incarcerated men to have witnessed family violence, suffered abuse or neglect, or have a history of family alcohol or drug abuse (Colantonio, et al., 2014). All told, incarcerated women are more likely to have histories characterized by violence victimization, all of which result in a higher risk of incurring a violence-related TBI.

These traumatic brain injuries may contribute to future violence and criminality in women. Several studies have demonstrated increased violence and criminality in women following TBI (Brewer-Smyth, et al., 2004; Colantonio et al., 2014; Shiroma, Pickelsimer et al., 2010). Brewer-Smyth, et al. (2004) found that TBI with loss of consciousness, along with suicide attempts, recent physical abuse, and low cortisol levels were correlated with conviction for violent crimes, with number of traumatic brain injuries with loss of consciousness representing the strongest correlation. In fact, the authors note, "(t)he number of traumatic brain injuries with loss of consciousness was strikingly high in all subjects and significantly higher in those currently convicted of a violent crime." (p. 28). And Shiroma, Pickelsimer et al. (2010) found that, in both sexes, inmates with medically-attended TBI had a higher rate of prison behavioral infractions than inmates without a history of TBI. Specifically, women with TBI had a rate of

violent infractions that was 144% higher than women without TBI.

Present Study

Knowing that experiences of violence are more frequent among justice-involved women compared to their non-justice involved peers, that experiences of violence increase risk for TBI, that there is some evidence for increased rates of violence-related TBI among justice-involved women, and that violence-related TBI is related to multiple negative outcomes, it is important to understand the additional vulnerabilities associated with violence-related TBI among justice-involved women. A better understanding of the vulnerabilities associated with these injuries will help correctional mental health providers better tailor and deliver services to mitigate the adverse outcomes associated with these injuries.

The purpose of the present study is to confirm previously reported research suggesting an increased prevalence of violence-related TBI among justice-involved women. This study will describe the characteristics of justice-involved women who sustain these injuries. Additionally, this study will identify the additional vulnerabilities associated with TBIs among justice-involved women by investigating the physical health, mental health, and criminal behavior characteristics associated with violence-related TBIs in this at-risk population.

Methods

Research Design

The TBI Implementation Grant database, DU IRB Protocol #674894-2, was originally developed as a research and program development partnership between the University of Denver, the Colorado Department of Human Services Brain Injury Program, and multiple county jails and probation systems in the Front Range area of Colorado. The program identifies inmates and probationers who have a TBI history, provides cognitive screens to identify strengths and

deficits, and offers intervention services and resources to qualifying participating individuals during probation or after incarceration, in addition to developing intervention programs designed for use during incarceration and providing a research database to better understand the needs and vulnerabilities of justice-involved individuals with TBI.

Data Collection

Assessments were completed at five county jails, one juvenile probation program and four adult probation programs in Colorado. Data entered through November 4th, 2016 were included in these analyses. The sample consisted of 409 individuals total; 274 males and 135 females. Participant demographics are presented in Table 1.

Study data were collected and managed using the REDCap electronic data capture tools hosted at the University of Denver (Harris, et al., 2009). REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing: 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources.

Measures

The Ohio State University TBI Identification Method (OSU-TBI-ID; Corrigan & Bogner, 2007) is a standardized structured interview procedure used to elicit lifetime TBI histories from participants. It utilizes interview techniques designed to reduce the weaknesses inherent in self-report methods (Corrigan & Bogner, 2007). The OSU-TBI-ID has been demonstrated to have high inter-rater reliability, as well as acceptable-to-high test-retest reliability (Bogner & Corrigan, 2009; Corrigan & Bogner, 2007). This study used a modified version of the tool, as

described in Glover et al. (under review). Participants were considered to have a significant history of TBI if they report a "first" TBI with loss of consciousness (LOC) before age 15, a "worst" TBI with LOC longer than 30 minutes, or a "multiple" TBI event, defined as "a period where three or more blows to the head caused altered consciousness OR two or more TBI's with LOC within a 3-month period" (Glover et al., under review, p. 16). A semi-structured clinical interview was also conducted to gather history of criminality, mental illness, physical health, development, and self-harm.

The Automated Neuropsychological Assessment Metric Core Battery (ANAM; Reeves, et. al., 1992) or Neuropsychological Assessment Battery-Screening Module (NAB-SM; Stern & White, 2003), along with the Rey 15 Item Test (FIT; Rey, 1964), and Trail Making Test B:A Ratio (Golden, Osmon, Moses, & Berg, 1981) were administered to participants with a significant history of TBI to screen for gross neuropsychological deficits and assess performance validity. Participants given the NAB-SM (Stern & White, 2003) were also administered either the Miller Forensic Assessment of Symptoms Test (M-FAST; Miller, 2001) or the Validity Indicator Profile (VIP, Frederick, 1997) as a third measure of effort to ensure adequate assessment of validity.

The ANAM (Reeves, et. al., 1992) is a valid measure of several neuropsychological constructs (Bleiberg, Kane, Reeves, Garmoe & Halpern, 2000; Jones, Loe, Krach, Rager, & Jones, 2008; Kabat, Kane, Jefferson, & DiPino, 2001). Subtests include the Core Battery tests of Reaction Time (administered twice), Learning, Attention/Processing Speed, Working Memory, Spatial Working Memory, Delayed Memory, and Inhibition. The ANAM also includes a clinically validated embedded performance validity measure (Roebuck-Spencer, Vincent, Gilliland, Johnson & Cooper, 2013)

The NAB-SM measures five domains of neuropsychological functioning: Attention, Executive Functions, Language, Spatial, and Memory (Stern & White, 2003). The test has demonstrated reliability and validity, including ecological validity in two TBI clinical population samples (Temple, Zgaljardic, Abreu, Seale, Ostir, & Ottenbacher, 2009; Zgaljardic & Temple, 2010). The FIT is a test of visual memory malingering (Rey, 1964). At the traditional cutoff listed in Strauss, Sherman, and Spreen (2006), the FIT has been shown to have high specificity in identifying non-feigned performance (Reznek, 2005). The Trail Making Test B:A ratio (Golden, Osmon, Moses, & Berg, 1981) has been demonstrated to have a sensitivity of 68% and specificity of 57% in detecting feigned impairment (Egeland & Langfjaeran, 2007). Egeland and Langfjaeran (2007) note that these levels of sensitivity and specificity are too low to be useful as a sole measure of performance validity, but that the measure gains clinical utility as one of several measures of performance validity.

The M-FAST is a test to detect strategies of malingering symptoms among forensic populations (Miller, 2001). In a correctional population seeking mental health services, the M-FAST was found to have high reliability and good validity as measured by high correlation with a previously accepted measure of malingering (Guy & Miller, 2004). The VIP is a measure of performance validity using verbal and non-verbal forced choice tests (Frederick, 1997). In a cross-validation sample, the VIP achieved a classification rate of 80% for the non-verbal subtest and 76% for the verbal subtest (Frederick & Crosby, 2000).

Analyses

All statistical analyses were conducted using IBM SPSS Student BASE version 24 Software. Normality was tested using the Kolgomorov-Smirnov (K-S) test and evaluations of skewness and kurtosis. All continuous variables in these analyses were significant at $p < .05$.

Additionally, skewness and kurtosis values for all variables were unacceptably high. Since data were not normally distributed, nonparametric tests were used for all analyses.

The present study sought to determine whether the rate of violence-related TBI is higher than would be expected among justice-involved women compared to their justice-involved male peers and whether the nature of violence-related TBI among justice-involved women differed from justice-involved men. These researchers also sought to investigate whether a history of violence-related TBI was associated with other vulnerabilities, such as medical illness, mental illness, substance use history, suicide attempt, and neuropsychological deficits. Additionally, these researchers sought to investigate whether a history of violence-related TBI was associated with certain criminal behavior characteristics such as convictions for violent crime and longer length of incarceration. Finally, this study explored whether rates of comorbid vulnerabilities and criminal behavior characteristics were impacted by the nature of injury; i.e. whether women with violence-related multiple TBI had higher rates of comorbidities than women with single violence-related TBI, and whether both groups had higher rates of comorbidities than women with non-violence related multiple or single TBI.

The prevalence and incidence rates of violence-related TBI among women and men in this sample were calculated and reported. Men and women were compared using a Chi-square test of independence to determine group differences in prevalence, and a Mann-Whitney U test to evaluate group differences in median incidence. A Chi-square test of independence was used to determine whether gender was associated with occurrences of multiple TBI and violence-related multiple TBI injuries. Mann Whitney U tests were used to evaluate group differences in median youngest age of TBI and median number of TBIs.

For investigation of vulnerabilities and criminal behavior characteristics, women were

grouped by violence-related TBI history, and group differences were evaluated for reported mental illness, physical health problems, substance abuse, younger age of first substance use, previous suicide attempt, neuropsychological deficits, conviction for violent crime, and length of incarceration. Then, women were grouped by history of violence-related multiple TBI, violence-related single TBI, and TBI not related to violence. Group differences were then evaluated for all variables. Chi-square analysis was used to evaluate group differences on medical illness, physical illness, history of substance use, suicide attempt, neuropsychological deficits, and convictions for violent crime. A Kruskall-Wallis One-Way ANOVA by ranks was used to evaluate group differences on median age of first substance use and median length of incarceration.

Neuropsychological deficits were defined as a score of "clearly below average" on any neuropsychological domain on the ANAM or a score of "Mildly Impaired" or below on any domain of the NAB. Consistent with the findings of Meyers and Volbrecht (2003), individuals failing two or more performance validity measures were identified as providing suboptimal effort, and were eliminated from the neuropsychological deficit analysis. Additionally, individuals failing the embedded performance validity measure on the ANAM were eliminated as failure on the embedded measures invalidates the ANAM.

Results

Results of all analyses are represented in Tables 2 – 9. An alpha level of .05 was used for all statistical tests. The sample consisted of 409 participants, 274 males and 135 females. Demographic data, including total number of TBIs and average number of TBIs per participant, are presented in table 1. The prevalence rate of violence-related TBI was 66.7% for women (n = 90) and 62.8% for men (n = 127). The incidence rate violence-related TBI was 38.4% for women

and 36.6% for men. A Chi-square test of independence between gender and history of violence-related TBI was not significant, indicating that gender was not significantly related to history of violence-related TBI in this sample (Table 2). A Mann-Whitney U test indicated that there was no difference between the median number of violence-related TBIs for men and women (Table 3).

Excluding missing entries, data from 348 participants were included in the analysis of gender difference in multiple TBI history. The Chi-square test of independence indicated that gender was weakly associated with history of multiple TBIs (Table 2). Forty-nine participants had responses recorded for cause of multiple TBI. The Chi-square test of independence indicated that gender was very strongly associated with violence-related "multiple" TBI (Table 2). A Mann-Whitney U test indicated no difference in the median total number of TBIs between men and women (Table 3). A Mann Whitney U test also indicated no difference in the median youngest age of TBI between men and women (Table 3).

Of the sample of 135 women, all available data were analyzed, with cases of missing data excluded. A Chi-square test of independence comparing prevalence of physical health diagnoses between women with a history of violence-related TBI versus no history of violence related TBI indicated a moderately strong association (Table 4). Women with a history of violence-related TBI were 4 times more likely to have a physical health diagnosis than women without a history of violent TBI. Violence-related TBI among women was, however, not significantly associated with mental health diagnoses, history of substance use, suicide attempt, neuropsychological deficits, and conviction of violent crime (Table 4). A Mann Whitney U test indicated that there was no difference in the median age of first substance use between the women with a history of violence-related TBI and women with no history of violence-related TBI; however, length of

incarceration (in months) was significantly greater for women with a history of violence-related TBI than those without a history of violence-related TBI (Table 5).

When women were considered in three groups, violence-related multiple TBI, single violence-related TBI, and non-violence related TBI, Chi-square tests of independence indicated no significant differences on the variables physical health diagnoses, mental health diagnoses, history of substance abuse, suicide attempt, neuropsychological deficits, or convictions for violent crime (Table 6). There was also no significant difference between the groups on age of first substance use (Table 7). The groups were significantly different only on their length of incarceration (Table 7). Post-hoc Mann Whitney U tests with Bonferroni correction were used to analyze significant group comparisons (Table 8). Specifically, there was a large difference in the median length of incarceration between the violence-related multiple TBI group and the non-violence related TBI group. Additionally, there was a small difference in the median length of incarceration between the violence-related single TBI group and the non-violence related TBI group. There was no significant difference between the violence-related multiple TBI group and the violence-related single TBI group.

Discussion

The analysis of the TBI Implementation Grant data suggests that there is no difference in the prevalence and incidence of violence-related TBI between justice-involved men and women in this sample of justice-involved individuals in the Front Range area of Colorado. This study suggests an equal prevalence and incidence of violence-related TBI between males and females, a significant deviation from the trends in the general population.

Unfortunately, data regarding gender differences in mechanism of TBI both in the general population and the justice-involved population remain limited, and thus difficult to

compare using rigorous statistical methods. This study is the most comprehensive examination to date focusing specifically on gender differences in TBI rates among incarcerated individuals. Further study of gender differences in the mechanisms of TBI is needed, both for general and correctional populations.

These analyses revealed several significant differences between justice-involved men and women on the frequency of multiple TBIs and violence-related multiple TBIs. Women were 2.2 times more likely than men to incur multiple TBIs of any kind. Women were 7.7 times more likely to have multiple TBIs related to violence. These results suggest that even though men and women in this sample had the same prevalence and incidence of violence-related TBIs, the features and quality of these injuries varied significantly. Women were overwhelmingly more likely to have two or more violence-related injuries within close proximity to each other, which can increase both acute medical risk and possibly increase the risk of long-term effects due to TBI, depending on the frequency and severity of injuries (Shively, Scher, Perl, & Diaz-Arrastia, 2012; Theadom et al., 2015).

The research regarding those long-term implications of multiple injuries over periods of years remains incomplete (Solomon & Zuckerman, 2015). The injury patterns implicated as increasing the risk for long-term neuropathology are clearly demonstrated in this population. Despite the relevance of the research into the cumulative effects of TBI to the justice-involved population, there is no research into the impact of cumulative injuries in this population. O'Rourke et. al (2016) has noted the lack of research in the justice-involved population regarding cumulative effects of multiple TBI for both genders, and this study further highlights the need for more research on the cumulative effects of multiple TBIs in women specifically.

This study revealed significant differences in physical health problems and length of

incarceration for justice-involved women based on violence-related TBI history. The findings of this study have significant implications for clinical practice with justice-involved women. First, this research highlights the importance of screening for history of violence-related TBI in justice-involved women. Not only do women with this history appear to represent a significant proportion of justice-involved women, this research suggests that these violently injured women are at higher risk for physical health problems. Identifying women who have violence-related TBIs in the justice system can help clinicians identify individuals who may benefit from health interventions; chronic pain groups, or stress management, for example. Clinicians should provide health improvement and health education programming to help reduce systemic costs and burden created by these health problems.

The finding of longer incarceration histories suggests both a direction of future research and an area of potential intervention. Longer periods of incarceration may result either from multiple rearrests or from arrests for more serious crimes with longer sentences. The findings of this research, that women with violence-related TBIs do not have a higher rate of conviction for violent crimes, may suggest that their longer incarceration histories are due to rearrests. More research is needed to investigate this question. If women with violence-related TBI are at higher risk of developing histories of frequent or chronic incarceration, then early identification of these women may allow for earlier enrollment in programs designed to reduce recidivism risk and reintegrate individuals into the community. For example, provision of therapeutic interventions such as CBT may help reduce likelihood of rearrest (Landenberger & Lipsey, 2005), and may therefore reduce the length of incarceration over the lifespan. In combination with other targeted services such as vocational and educational programs, the reduction in recidivism (and therefore lifetime length of incarceration) may be even more significant (Landenberger & Lipsey, 2005).

Furthermore, identifying these women as having a history of TBI can help direct even more specialized services, such as cognitive rehabilitation and accommodations that may help women benefit more fully from targeted health and vocational programs (Cicerone, et al., 2005).

There are several limitations to this research. Because these data were collected in jails and probation systems along the Front Range of Colorado, they may not fully represent the larger population of incarcerated or justice-involved individuals. Particularly, the demographic make-up of participants in this study was different than the national incarcerated population as a whole. According to the Prison Policy Initiative (2014), white individuals comprise 39% of the national incarcerated population, African-Americans comprise 40%, and Hispanic individuals comprise 19%, with no data provided for other ethnic groups. In this study, white participants were over-represented by more than 10 percentage points, while African-Americans were under-represented by more than 25 percentage points. This study should be replicated with justice-involved individuals in other areas to ensure a more complete representation of the entire population of justice-involved women, particularly with more representative demographics. Additionally, racial differences in rates of violence-related TBI have not been thoroughly explored in men or women, and could be investigated in future research (O'Rourke, et al., 2016).

Another important limitation involves the inclusion criteria and injury reporting. The original purpose of the data collection was to identify and treat individuals who may be vulnerable to complications resulting from TBI. While the severity of injury is one factor involved in determining risk, the addition of other factors such as younger age of first TBI and multiple TBIs resulted in a mixed sample that included the entire range of injury severity, even though individuals who incurred only mild TBIs as an adult were screened out of this sample. This limits the comparison between the results of this study and the results of other studies, such

as the prevalence and incidence rates presented by the CDC, which include all reported TBI injuries regardless of severity (CDC, 2015).

This study was also limited by the small number of participants who did not have mental illness or substance abuse histories. Only ten women of 135 reported no history of mental illness, and only one reported no history of substance use. Mental health and substance use histories were so prominent that these variables likely could not be adequately analyzed. Given previous research documenting the significant association between these variables and TBI, and among women specifically, these variables clearly warrant further investigation with more robust, heterogeneous data (Colantonio, et al., 2014; Ray, Sapp, and Kincaid, 2014).

This study planned to stratify patterns of vulnerabilities between women with multiple violence-related TBIs, single violence-related TBI, multiple non-violence-related TBI, and single non-violence related TBI but the limited availability of multiple non-violence related TBI among female participants prevented that analysis. Those two cases were consolidated into the non-violence group. A larger group of women with non-violence related multiple TBI would allow meaningful comparison of women with similar injury patterns with and without the presence of violence.

Regarding the neuropsychological data, two neurocognitive screening methods were used. This study attempted to compare the data by setting similar cutoff scores and evaluating only the presence or absence of impairment in any domain. Future research should re-visit the question of group differences in overall neuropsychological performance as well as domain-specific deficits using a consistent assessment method.

Finally, as discussed by O'Rourke et al., TBI in the justice-involved population occurs alongside a myriad other treatment issues that need to be further explored. For violence-related

TBI, this observation is even more true. Violence-related TBIs are inextricable from emotional trauma, and the economic and sociological sequelae associated with domestic violence and criminal lifestyles. The complex interaction of these factors may actually impart the additional vulnerability to justice-involved women with violent TBI histories. Violence-related TBI is a manifest variable that can alert clinicians to the complex histories and vulnerabilities of women requiring unique, focused intervention.

Conclusion

The body of research investigating the intersection of violence, gender, and justice-involvement suggests that TBI is a significant problem in justice-involved individuals, that violence-related TBI is common, and that these injuries may present special concern for justice-involved individuals' abilities to function in the community (Bushnik, et al., 2013; Shiroma, Ferguson, & Picklesimer, 2010; Wall, et al., 2016). Additionally, a limited body of research suggests that there are unique concerns regarding the injury histories and vulnerabilities of justice-involved women (O'Rourke, et al., 2016). This study expanded on that research by exploring questions proposed by O'Rourke, et al. (2016). Specifically, this research investigated the prevalence and injury patterns of violence-related TBI among justice-involved women, and explored the associations of these injuries to other vulnerabilities and criminal behavior characteristics.

This study documents a prevalence rate of 66.7% of lifetime history violence-related TBI and an incidence rate of 38% for justice-involved women. These data reflect an over-representation of violence-related TBI among justice-involved women compared to women in the general population; however, these comparisons are limited by the varying criteria used for documenting TBI from study to study (O'Rourke, et al., 2016), and by the fact that direct

statistical comparisons to the general population could not be made. Additionally, this study revealed differences in the pattern of violence-related injuries suffered by women and men, with women being 7.7 times more likely to experience violence-related multiple TBIs. The higher frequency of multiple injuries in these women may increase their risk for developing neuropathological conditions as they age (Shively, Scher, Perl, & Diaz-Arrastia, 2012). Finally, this study revealed differences in the physical health and lifetime histories of incarceration between women with violence-related TBI and those without, where violently injured women are more likely to experience health problems and serve longer incarcerations.

This study suggests many directions for future research, including the investigation of the impact of multiple injuries and the specific vulnerabilities in greater detail. Those vulnerabilities, physical illness and incarceration length, can also serve as specific targets for programming and clinical intervention, as described previously. This study also has important implications for policy and clinical practice with justice-involved women. The staggering prevalence of these injuries and their documented comorbid problems underscores the importance of implementing standardized screening procedures to identify these women and provide the opportunity for early intervention. TBI represents a significant concern among all justice-involved individuals. A specific focus on the needs of justice-involved women, with their unique injury patterns and vulnerabilities, will allow for targeted programs that can improve both personal and social outcomes.

References

Assault [Def. 3]. (n.d.). In *Wex Legal Dictionary,* Retrieved March 3, 2016 from https://www.law.cornell.edu/wex/assault

Bazarian, J. J., Blyth, B., Mooerjee, S., He, H., & McDermott, M. P. (2010). Sex differences in outcome after mild traumatic brain injury. *Journal of Neurotrauma, 27*, 527-539. doi:10.1089/neu.2009.1068

Bleiberg, J., Kane, R. L., Reeves, D. L., Garmoe, W. S., & Halpern, E. (2000). Factor analysis of computerized and traditional tests used in mild brain injury research. *The Clinical Neuropsychologist, 14*(3), 287-294. doi:10.1076/1385-4046(200008)14:3;1-P;FT287

Bogner, J. A., & Corrigan, J. D. (2009). Reliability and predictive validity of the Ohio State University TBI Identification Method with prisoners. *Journal of Head Trauma Rehabilitation, 24*(6), 279-291. doi:10.1097/HTR.0b013e3181a66356

Brewer-Smyth, K., Burgess, A. W., & Shults, J. (2004). Physical and sexual abuse, salivary cortisol, and neurological correlates of violent criminal behavior in female prison inmates. *Biological Psychiatry, 55*(1), 21-31. doi:10.1016/S0006-3223(03)00705-4

Bruns, J. J. , & Hauser, W. A. (2003). The epidemiology of traumatic brain injury: A review. *Epilepsia, 44*(10), 2-10. doi:10.1046/j.1528-1157.44.s10.3.x

Bureau of Justice Statistics. (2015). Criminal Victimization, 2014 (NCJ 248973). Retrieved from: https://www.bjs.gov/content/pub/pdf/cv14.pdf

Bushnik, T., Hanks, R. A., Kreutzner, J., & Rosenthal, M. (2003). Etiology of traumatic brain injury: Characterization of differential outcomes up to one year post-injury. *Archives of Physical Medicine and Rehabilitation, 84*, 255-262. doi: 10.1053/apmr.2003.50092

Centers for Disease Control and Prevention. (2015). Basic information about traumatic brain

injury and concussion. Retrieved from: http://www.cdc.gov/traumaticbraininjury/basics.html

Centers for Disease Control and Prevention. (2010). Get the stats on traumatic brain injury in the United States. Retrieved from: http://www.cdc.gov/traumaticbraininjury/pdf/BlueBook_factsheet-a.pdf

Centers for Disease Control and Prevention & Kaiser Permanente (2016). [Table, Prevalence of ACEs by category]. Adverse Childhood Experiences Study. Retrieved from: https://www.cdc.gov/violenceprevention/acestudy/about.html

Cicerone, K. D., Dahlberg, C., Malec, J. F., Langenbahn, D. M., Felicetti, T., Kneipp, S., … Catanese, J. (2005). Evidence-based cognitive rehabilitation: Updated review of the literature from 1998 through 2002. *Archives of Physical Medicine and Rehabilitation, 86*, 1681-1692. doi:http://dx.doi.org/10.1016/j.apmr.2005.03.024

Colantonio, A., Kim, H., Allen, S., Asbridge, M., Petgrave, J., & Brochu, S. (2014). Traumatic brain injury and early life experiences among men and women in a prison population. *Journal of Correctional Health Care, 20*(4), 271-279. doi:10.1177/1078345814541529

Corrigan, J. D. & Bogner, J. A. (2007). Initial reliability and validity of the OSU TBI Identification Method. *Journal of Head Trauma Rehabilitation, 22*(6), 318-329. doi:10.1097/01.HTR.0000300227.67748.77

Corrigan, J. D., Selassie, A. W., & Langois Orman, J. A. (2010). The epidemiology of traumatic brain injury. *Journal of Head Trauma Rehabilitation, 25*(2), 72-80. doi:10.1097/HTR.0b013e3181ccc8b4

Diamond, P. M., Harzke, A. J., Magaletta, P. R., Cummins, A. G., & Frankowski, R. (2007). Screening for traumatic brain injury in an offender sample: A first look at the reliability

and validity of the Traumatic Brain Injury Questionnaire. *Journal of Head Trauma Rehabilitation, 22,* 330-338. doi:10.1097/01.HTR.0000300228.05867.5c

Egeland, J., & Langfjaern, T. (2007). Differentiating malingering from genuine cognitive dysfunction using the Trail-Making Test ratio and Stroop interference scores. *Applied Neuropsychology, 14*(2), 113-119. doi:10.1080/09084280701319953

Farace, E., & Alves, W. M. (2000). Do women fare worse: A meta-analysis of gender differences in traumatic brain injury outcome. *Journal of Neurosurgery, 93*, 539-545. doi:10.3171/jns.2000.93.4.0539

Farrer, T. J., & Hedges, D. W. (2011). Prevalence of traumatic brain injury in incarcerated groups compared to the general population: A meta-analysis. *Progress in Neuro-Psychopharmacology and Biological Pyschiatry. 35*, 390-394. doi:10.1016/j.pnpbp.2011.01.007

Fishbein, D., Dariotis, J. K., Ferguson, P. L., & Pickelsimer, E. E. (2014). Relationships between traumatic brain injury and drug use and their association with aggression in inmates. *International Journal of Offender Therapy and Comparative Criminology, 60*(5), 575-597. doi:10.1177/0306624X14554778

Frederick, R. I. (1997). *Validity Indicator Profile Manual.* Minnetonka, MN: NCS Assessments.

Frederick, R. I., & Crosby, R. D. (2000). Development and validation of the Validity Indicator Profile. *Law and Human Behavior, 24*(1), 59-82. doi:10.1023/A:1005426803586

Ferguson, P. L., Pickelsimer, E. E., Corrigan, J. D., Bogner, J. A., & Wald, M. (2012). Prevalence of traumatic brain injury among prisoners in South Carolina. *Journal of Head Trauma Rehabilitation, 27*(3), 11-20.

Gagnon, K. L., & DePrince, A. P. (in press). Head injury screening and intimate partner

violence: A brief report. Journal of Trauma and Dissociation. doi: 10.1080/15299732.2016.1252001

Gerhart, K. A., Mellick, D. C., & Weintraub, A. H. (2003). Violence-related traumatic brain injury: A population-based study. *The Journal of Trauma, Injury, Infection, and Critical Care. 55*, 1045-1053. doi:10.1097/01.TA.0000044353.69681.96

Glover, N. M., Gorgens, K., Lehto, M., Meyer, L., Dettmer, J., & Gafford, J. (under review). Sensitivity and specificity of the Ohio State University Traumatic Brain Injury Identification Method (OSU-TBI-ID) to neuropsychological impairment. *Criminal Justice & Behavior.*

Golden, C. J., Osmon, D. C., Moses, J. A., & Berg, R. A. (1981). *Interpretation of the Halstead-Reitan neuropsychological test battery.* New York, NY: Grune & Stratton.

Guy, L. S., & Miller, H. A. (2004). Screening for malingered psychopathology in a correctional setting: Utility of the Miller-Forensic Assessment of Symptoms Test (M-FAST). *Criminal Justice and Behavior, 31*(6), 695-716. doi:10.1177/0093854804268754

Hanlon, R. E., Demery, J. A., Martinovich, Z., & Kelly, J. P. (1999). Effects of acute injury characteristics on neuropsychological status and vocational outcome following mild traumatic brain injury. *Brain Injury, 13*, 873-887. doi:10.1080/026990599121070

Harris, P.A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., Conde, J.G. (2009). Research electronic data capture (REDCap): A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informantics, 42*(2), 377-81. doi:10.1016/j.jbi.2008.08.010

Jackson, H., Philp, E., Nuttall, R. L., & Diller, L. (2002). Traumatic brain injury: A hidden consequence for battered women. *Professional Psychology: Research and Practice*, *33*,

39-45. doi: 10.1037/0735-7028.33.1.39

Jones, W. P., Loe, S. A., Krach, K., Rager, R. Y., & Jones, H. M. (2008). Automated Neuropsychological Assessment Metrics (ANAM) and Woodcock-Johnson III Test of Cognitive Ability: A concurrent validity study. *The Clinical Neuropsychologist, 22*, 305-320. doi:10.1080/13854040701281483

Kabat, M. H., Kane, R. L., Jefferson, A. L., & DiPino, R. K. (2001). Construct validity of selected Automated Neuropsychological Assessment Metrics (ANAM) battery measures. *The Clinical Neuropsychologist, 15*(4), 498-507. doi:10.1076/clin.15.4.498.1882

Landenberger, N. A., & Lipsey, M. W. (2005). The positive effects of cognitive-behavioral programs for offenders: A meta-analysis of factors associated with effective treatment. *Journal of Experimental Criminology, 1*, 451-476. doi: http://dx.doi.org/10.1007/s11292-005-3541-7

Langlois, J. A., Rutland-Brown, W., & Thomas, K. E. (2004). *Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations, and Deaths.* Atlanta: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control.

Langlois, J. A., Rutland-Brown, W., & Wald, M. M. (2006). The epidemiology and impact of traumatic brain injury. *Journal of Head Trauma Rehabilitation, 21*, 375-378. doi:10.1097/00001199-200609000-00001

Meyers, J. E. & Volbrecht, M. E. (2003). A validation of multiple malingering detection methods in a large clinical sample. *Archives of Clinical Neuropsychology, 18*(3), 261-276. doi:10.1093/arclin/18.3.261

Miller, H. A. (2001). *The Miller Forensic Assessment of Symptoms Test (M-FAST) Professional*

Manual. Odessa, FL: Psychological Assessment Resources.

Moracco, K. E., Runyan, C. W., Bowling, J. M., & Earp, J. A. L. (2007). Women's experiences with violence: A national study. *Women's Health Issues, 17*, 3-12. doi:10.1016/j.whi.2006.03.007

O'Rourke, C., Linden, M. A., Lohan, M., Bates-Gatson, J. (2016). Traumatic brain injury and co-occurring problems in prison populations: A systematic review. *Brain Injury, 30,* 1-16. Retrieved from: http://dx.doi.org/10.3109/02699052.2016.1146967

Prison Policy Institute (2014). Breaking down mass incarceration in the 2010 census: State-by-state incarceration rates by race/ethnicity. Retrieved from: https://www.prisonpolicy.org/reports/rates.html

Ray, B., Sapp, D., Kincaid, A. (2014). Traumatic brain injury among Indiana state prisoners. *Journal of Forensic Sciences, 59,* 1248-1253. doi:10.1111/1556-4029.12466

Reeves, D. L., Winter, K., LaCour, S., Raynsford, K., Kay, G., Elsmore, T, & Hegge, F. W. (1992). *Automated Neuropsychological Assessment Metrics documentation: Vol. I. Test administration guide (Technical Report).* Office of Military Performance Assessment Technology, Silver Spring, Maryland.

Rey, A. (1964). *L'examen Clinique en Psychologie.* Paris, France: Presses Universitaires de France.

Reznek, L. (2005). The Rey 15-item memory test for malingering: A meta-analysis. *Brain Injury, 19*, 539-543. doi:10.1080/02699050400005242

Roebuck-Spencer, T. M., Vincent, A. S., Gilliland, K., Johnson, D. R., & Cooper, D. B. (2013). Initial clinical validation of an embedded performance validity measure within the Automated Neuropsychological Metrics (ANAM). *Archives of Clinical*

Neuropsychology, 28, 700-710. doi:10.1093/arclin/act055

Schofield, P. W., Butler, T. G., Hollis, S. J., Smith, N. E., Lee, S. J., & Kelso, W. M. Traumatic brain injury among Australian prisoners: Rates, recurrence and sequelae. *Brain Injury, 20*, 499-506. doi:10.1080/02699050600664749

Schopp, L. H., Shigaki, C. L., Bounds, T. A., Johnstone, B., Stucky, R. C., & Conway, D. L. (2006). Outcome in TBI with violent versus nonviolent etiology in a predominantly rural setting. *Journal of Head Trauma Rehabilitation, 21*(3), 213-225. doi:10.1097/00001199-200605000-00002

Shiroma, E. J., Ferguson, P. L., & Pickelsimer, E. E. (2010). Prevalence of traumatic brain injury in an offender population: A meta-analysis. *Journal of Head Trauma Rehabilitation, 27*(3), 1-10. doi:10.1177/1078345809356538

Shiroma, E. J., Pickelsimer, E. E., Ferguson, P. L., Gebregziabher, M., Lattimore, P. K., Nicholas, J. S., … & Hunt, K. J. (2010). Association of medically attended traumatic brain injury and in-prison behavioral infractions: A state-wide longitudinal study. *Journal of Correctional Health Care, 16*(4), 273-286. doi:10.1177/1078345810378253

Shively, S., Scher, A. I., Perl, D. P., & Diaz-Arrastia, R. (2012). Dementia resulting from traumatic brain injury: What is the pathology? *Journal of the American Medical Association Archives of Neurology, 69,* 1245-1251. doi: 10.1001/archneurol.2011.3747

Solomon, G. S., & Zuckerman, S. L. (2015). Chronic traumatic encephalopathy in professional sports: Retrospective and prospective views. *Brain Injury, 29*, 164-170. doi:10.3109/02699052.2014.965205

Stern, R. A., & White, T. (2003). *Neuropsychological Assessment Battery: Administration, Scoring, and Interpretation Manual*. Lutz, FL: Psychological Assessment Resources.

Strauss, E., Sherman, E. M. S., Spreen, O. (2006). *A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary.* (3rd ed.). New York, NY: Oxford University Press.

Temple, R. O., Zgaljardic, D. J., Abreu, B. C., Seale, G. S., Ostir, G. V., & Ottenbacher, K.J. (2009). Ecological validity of the Neuropsychological Assessment Battery Screening Module in post-acute brain injury rehabilitation. *Brain Injury, 23*, 45-50. doi:10.1080/02699050802590361

Theadom, A., Parmar, P., Jones, K., Barker-Collo, S. Starky, N. J., McPherson, K. M., … Feigin, V. L. (2015). Frequency and impact of recurrent traumatic brain injury in a population-based sample. *Journal of Neurotrauma,* 32, 674-681. doi:10.1089/neu.2014.3579

Valera, E. M., & Berenbaum, H. (2003). Brain injury in battered women. *Journal of Consulting and Clinical Psychology, 71*, 797-804. doi:10.1037/0022-006X.71.4.797

Violence. (n.d.) *Mosby's Medical Dictionary, 8th edition*. (2009). Retrieved March 3 2016 from http://medical-dictionary.thefreedictionary.com/violence

Wall, K., Gorgens, K., Yeo, J., & Alexander, C. (2016, August). *Mechanisms of Traumatic Brain Injury in a Justice-Involved Population.* Poster presented at the annual meeting of Division 18: Psychologists in Public Service, of the American Psychological Association, Denver, CO.

Weeks, R., & Widom, C. S. (1998). Self-reports of early childhood victimization among incarcerated adult male felons. *Journal of Interpersonal Violence, 13*, 346-361. doi:10.1177/088626098013003003

Wenden, F. J., Crawford, S., Wade, D. T., King, & Moss (1998). Assault, post-traumatic amnesia, and other variables related to outcome following head injury. *Clinical*

Rehabilitation, 12, 53-63. doi:10.1191/026921598675567949

Wolff, N., & Shi, J. (2012). Childhood and adult trauma experiences of incarcerated persons and their relationship to adult behavioral health problems and treatment. *International Journal of Environmental Research and Public Health, 9*, 1908-1926. doi:10.3390/ijerph9051908

Wolff, N., Blitz, C., Shi, J., Siegel, J., & Bachman, R. (2007). Physical violence inside prison: Rates of victimization. *Criminal Justice and Behavior, 34*, 588-599.

Zgaljardic, D. J., & Temple, R. O. (2010). Reliability and validity of the Neuropsychological Assessment Battery-Screening Module (NAB-SM) in a sample of patients with moderate-to-severe acquired brain injury. *Applied Neuropsychology, 17*, 27-36. doi:10.1080/09084280903297909

Zust, B. L. (2009). Partner violence, depression, and recidivism: The case for incarcerated women and why we need programs designed for them. *Issues in Mental Health Nursing, 30*, 246-251. doi:10.1080/01612840802701265

Tables

Table 1. *Demographics*

	Female	Male	Total Sample
N	135	274	409
Age	36.68 (10.82)	38.65 (11.18)	38.00 (11.09)
Education	11.54 (2.4)	11.77 (2.11)	11.69 (2.22)
Race/Ethnicity, % (N)			
White	50.4 (68)	50.7 (139)	50.6 (207)
Hispanic	25.2 (34)	20.8 (57)	22.2 (91)
African-American	12.6 (17)	16.8 (46)	15.4 (63)
American Indian / Alaskan Native	5.9 (8)	4.0 (11)	4.6 (19)
Native Hawaiian / Pacific Islander	0.7 (1)	0.0 (0)	0.2 (1)
More than one race	3.7 (5)	5.1 (14)	4.6 (19)
Not reported	1.57 (2)	2.6 (7)	2.0 (8)
Reported TBIs	409	781	1190
Average TBIs per participant	3.0	3.2	2.9

Continuous variables are presented as mean (SD); categorical variables are presented as percentage (N)

Table 2. *Results of Chi-Square Tests of Independence Between Genders*

	X^2	*df*	*N*	*p*	*phi*
Prevalence of Violence-Related TBI	3.77	1	409	.052	*ns*
Multiple TBI	10.33	1	348	.001	.17
Multiple Violence-Related TBI	7.07	1	49	.008	.38

Table 3. *Results of Mann Whitney U Tests of Median Differences Between Genders*

	N	Women	Men	*U*	*p*
Number of Violence-Related TBIs	409	1	1	17676	.441
Youngest age of TBI	409	12	10	12308	.294
Total Number of TBIs	409	4	3	11880	.054

Table 4. *Results of Chi-Square Tests of Independence Between Women With and Without a History of Violence-Related TBI*

	N	*df*	X^2	*p*	*phi*

Physical Health Diagnosis	106	1	7.90	.005	.27
Mental Health Diagnosis	109	1	1.47	.225	*ns*
Substance Use	109	1	4.49	.183	*ns*
Suicide Attempt	103	1	2.07	.151	*ns*
Neuropsychological Deficits	89	1	2.37	.124	*ns*
Conviction for Violent Crime	100	1	1.69	.193	*ns*

Table 5. *Results of Mann-Whitney U Tests of Median Differences Between Women With and Without a History of Violence-Related TBI*

	N	**V-TBI**	**NV-TBI**	***U***	***p***	***r***
Age of First Substance Use	105	14	14	775	.722	*ns*
Length of Incarceration	97	6	2	490	.022	.23

Table 6. *Results of Chi-Square Tests of Independence between Multiple Violence-Related TBI, Single Violence-Related TBI, and Non-Violence Related TBI Groups*

	N	***df***	X^2	***p***
Physical Health Diagnosis	109	2	4.46	.108
Mental Health Diagnosis	112	2	.160	.923
Substance Use	112	2	5.27	.072
Suicide Attempt	106	2	2.58	.275
Neuropsychological Deficits	92	2	3.11	.212
Conviction for Violent Crime	102	2	.801	.670

Table 7. *Results of Kruskal-Wallis Analyses Between Multiple Violence-Related TBI, Single Violence-Related TBI, and Non-Violence Related TBI Groups*

	N	***df***	***H***	***Mult. VTBI***	***Single VTBI***	***NVTBI***	***p***
Age of First Substance Use	107	2	.044	55.10	53.56	54.44	.978
Length of Incarceration	81	2	13.73	67.35	50.06	32.32	.001

Numbers in the columns "Mult. VTBI", "Single VTBI", and "NVTBI" represent mean ranks.

Table 8. *Results of Post Hoc Mann Whitney U Tests Between Multiple Violence-Related TBI, Single Violence-Related TBI, and Non-Violence Related TBI Groups*

	N	**Median 1**	**Median 2**	***U***	***p***	***r***
Multiple V-TBI vs. NV-TBI	31	21.3	2	60	.001	.55
Multiple vs. Single V-TBI	67	21.3	6	402	.018	*ns*
Single V-TBI vs. NV-TBI	64	6	2	321	.013	.29

Median group 1 represents the first group listed in each comparison. Median group 2 represents

the second group listed in each comparison, p was significant at <.017