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Chapter

The Impact of Traumatic Brain Injury on the Receipt of Services Following Release from Prison

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Abstract

Traumatic brain injury (TBI) is found at substantially higher rates among incarcerated individuals compared to the general adult population. Individuals with TBI report a higher likelihood to experience a range of deleterious outcomes including substance abuse, depression, post-traumatic stress disorder, aggressive behavior, and violence. Thus, a history of TBI is likely to lead to the types of behaviors that will significantly increase the odds of an individual returning to incarceration post-release, as supported by recent research with a cohort of state prisoners. TBI has largely gone unaddressed by prison reentry programs that are integral to rehabilitating individuals returning to the community. Relatively little is known, however, about the effects of TBI on the receipt of services post-release. Additionally, few studies have examined sex differences in the prevalence of TBI in reentry populations. This chapter uses data from a multi-state prisoner reentry program randomized control trial to examine whether individuals with TBI are significantly different than their peers without TBI with respect to a variety of demographic and psychological metrics and in expressions of needs for and participation in services and programming during the transition from incarceration to the community.

Keywords: traumatic brain injury, post-traumatic stress disorder, criminal recidivism, mental health, substance abuse

1. Introduction

Over the past decade, traumatic brain injury (TBI) has become more widely recognized as a risk factor for criminal justice involvement. While there is no research that provides a causal link between TBI and criminal offending, studies have found TBI among justice-involved individuals to be as high as 10 times that in the general population. Research indicates that between 23–86% of individuals who are incarcerated have a history of TBI [1–4], significantly larger than estimates of TBI in the general population of 8.5% [5]. Like has been observed in adult populations, research has also found large proportions of youth in juvenile justice settings have a history of TBI [6, 7].

TBI is a significant concern among both men and women who are incarcerated. In the general population, epidemiological studies have found TBI rates among men to be almost twice as high as women [8], while the rates of TBI among incarcerated women are the same or slightly higher than their male counterparts [4, 9]. Recent research review articles have pointed to the male bias in TBI research due in large part to the higher incidence of TBI among men in the general population [10–13]. Mollayeva et al.'s analysis of 58 TBI studies that included a focus on sex/gender, found that women were under-represented in most studies and few researchers made hypotheses specific to sex/gender effects [10, 11, 14]. The potential for similarly high rates of TBI among incarcerated individuals warrants attention to the sex differences in this population.

Although there has been little attention devoted to addressing TBI as a risk factor for criminal behavior, there has been extensive focus in the United States since the late 1980s on identifying programs and approaches to assist those returning to the community from prisons and jails to achieve a pro-social future. Reentry services and programming can be characterized as those like cognitive behavior therapy (CBT) that are intended to promote individual change and those like employment services that are practical. To date, much of the evidence suggests that services that focus on individual change may be most effective at reducing recidivism [15–21]. Thus, although the high prevalence of TBI has not been explicitly addressed in reentry efforts, to the extent that programs and services focused on behavioral change and mental health have proven effective in improving outcomes for justice-involved individuals, it is reasonable that there is value in learning more explicitly about the relationships among TBI and service need and receipt during the reentry from incarceration.

After briefly reviewing relevant literature, this chapter describes the 265 individuals who were included in a randomized control trial to examine the impact of a wellness-based prisoner reentry program (5-Key Reentry Program) [22] and who participated in an interview 18-months after release from incarceration. The 18-month interview included the administration of the Ohio State University TBI Identification Method (OSU TBI-ID). [23, 24] Information on the rate of TBI and a comparison of those with TBI to study participants without TBI on a variety of demographic characteristics is provided. The chapter then statistically examines self-reported receipt of mental health and substance use disorder services over time and whether the receipt of those services is differently impacted by either TBI or sex. The discussion and conclusions section summarizes the key findings and describes plans for future research.

2. Literature review

2.1 Sex differences in acquiring TBI

TBI results from a blow to the head from an assault, a fall, sporting accident, traffic accidents, or some sort of external force, and often leads to internal bleeding, bruising, and/or a reduced lack of oxygen flow to brain tissues. Men and women acquire TBI-related injuries in different ways. Men are more likely to receive their injuries from being struck by or against an object, interpersonal violence (i.e., fights), motor vehicle accidents, sports-related or workplace injuries, and in military combat; in contrast, women incur TBI more often in falls, concussive impacts, and in incidences of intimate partner violence (IPV) [11, 12, 25, 26].

Women who experience IPV are at great risk for TBI. According to the National Intimate Partner and Sexual Violence Survey, about 41% of women and 26% of men experience IPV in their lifetime [27]. IPV is defined as a pattern of physical violence, sexual violence, psychological aggression, and stalking behaviors inflicted by a current or former intimate [27]. The majority of IPV injuries sustained by women are to the neck, head, face, or strangulation [28]. While there are no epidemiological studies on the rates of TBI among IPV victims, one literature review on TBI from IPV found rates between 35–92% [29]. Jackson et al.'s study of women attending domestic violence support groups found that 92% reported a blow to the head or face and 44% reported loss of consciousness (LOC) [30]. Valera and Berenbaum found 74% of a shelter sample of women exposed to IPV sustained TBI and 50% had a history of multiple TBI [31].

Incarcerated women report high rates of violence and victimization. Three-quarters of women in prison report experiencing IPV, and 70% report experiencing severe physical violence from a parent or caretaker [32]. Colantonio et al. found that incarcerated women with TBI experienced more physical and sexual abuse than those without TBI [33]. Some research also suggests that TBI history increases the odds of reoccurring victimization compared to non-victims and single-event victims [34].

2.2 Impact of TBI

While not all individuals who experience TBI will have negative long-term outcomes, many will experience a decline in their daily functioning [35]. TBI may cause problems with various brain functions that can lead to slowed information processing, diminished decision-making capacity, attention disorders and other executive functioning impairments [36–38]. TBI is associated with cognitive impacts, including memory and attention deficits, impulsive behavior, and slowed responses [35]. The long-term social–emotional effects of TBI make individuals vulnerable for the risk factors associated with justice involvement, including aggression, rule-breaking, violence, irritability and risk-taking [37–39].

Research finds that individuals with TBI have a significantly higher occurrence of mental illness, suicide attempts, and poorer quality of life compared to individuals without TBI [5]. TBI in youth is linked to violent behavior, substance use, and mental health problems [35, 40]. Petrucelli et al.'s meta-analysis of research on adverse child experiences (which may include TBI) found strong associations between exposure to childhood violence and poor behavioral health outcomes [41]. Even individuals experiencing mild-TBI are three times more likely to experience depression compared to those without a TBI history [42].

Many TBI injuries are sustained through traumatic events, and some research suggests that PTSD can develop after severe, and even mild TBI [43]. TBI and PTSD have many symptoms in common, including concentration and information processing difficulties, memory problems, irritability, depression, sleep disturbance, nausea, and headaches [44, 45]. Among a sample of female veterans who experienced IPV, those with current IPV-related TBI symptoms were 5.9 times more likely to meet criteria for PTSD symptoms [26]. Given the higher rates of traumatic and TBI experiences, rates of PTSD and TBI co-occurrence are higher among incarcerated populations. Harner found almost half (45%) of the incarcerated women in their sample met criteria for PTSD at the time of the interview, and 23% with severe symptoms [46]. In one of the few large studies examining the relationship between TBI, PTSD, and criminal reoffending, Lattimore et al. found that TBI and PTSD predicted violent offending

but not general criminal behavior [47]. These findings suggest the need for officials to identify individuals with a history of TBI and PTSD and to develop appropriate interventions that could be provided during and after incarceration to reduce the post-release likelihood of violence.

Rates of substance use disorder (SUD) among individuals with TBI is significantly higher than among the general population, with ranges for those with TBI from 37–66% compared to 11% among those without TBI [48, 49]. There is a high co-occurrence of TBI and risky substance use, and while the causal link is unclear, there is evidence that each increases the incidence of the other [50]. Fishbein et al.'s study of TBI and SUD co-occurrence among incarcerated individuals found early TBI predicted early on set and severity of drug use, and earlier drug use predicted greater aggression regardless of TBI [9].

2.3 Sex differences in outcomes

Most of the limited research on sex differences in TBI-related symptoms has found that women experience worse functioning symptoms than men [10, 13, 34, 51]. Farace et al.'s meta-analysis of sex differences found that women fare worse on 85% of outcomes, including higher rates of anxiety and depression, concussive syndrome such as dizziness, fatigue, irritability, impaired concentration, insomnia, headache, anxiety, and lower rate of returning to work [13]. Using the Glasgow Outcome Scale-Extended (GOSE), a widely known instrument tool for TBI, Kirkness et al. found that women aged 30 and older had poorer outcomes than younger women and men in all age groups 6 months following the injury, even when controlling for injury severity [51].

While research suggests that TBI is associated with problems during incarceration and post-release, including increasing the risk of reincarceration [1, 47, 52–54], there is limited research exploring sex differences. Wall et al. found women with a history of violence-related TBI were four-times more likely to have physical health problems than women without violence-related TBI [55]. However, they did not find differences in rates of mental health or substance abuse between the groups. Gorgens et al. found that women with TBI on probation have similar recidivism rates to men with TBI, though women without TBI had a lower risk of reoffending than men without TBI [1]. The authors also found that women with TBI were more likely than their male counterparts to have mental illness and substance use disorders [1].

2.4 Service utilization by TBI and sex

Research on the role of sex in treatment-seeking behavior is largely mixed. While many researchers have suggested that women are less likely to participate in substance use services than men [56, 57], other research suggests that women are at least as likely or more likely [58–60] to engage in these services. Similarly, some research finds women are more likely to use mental health services than men [61, 62]; while research on specialty psychiatric services shows higher utilization by men [63]. Coxe et al. found that mental service utilization among individuals with a head injury with loss of consciousness was higher for those with military service, a history of drug use, and moderate to severe depression, but no differences were observed by sex [64].

While there is limited research on post-release service utilization for TBI populations, Piccolino and Solberg's study of prison-based services found incarcerated men with high probable TBI used medical and psychological services at significantly higher rates than the low and moderate probable TBI groups and required more crisis services [53].

Overall, TBI is an important factor in the likelihood of success for individuals transitioning from incarceration to the community. However, there has been limited attention to how TBI can impact an individual's receipt of the services aimed at helping them reintegrate into the community. Given this current lack of knowledge, this paper provides an exploratory examination into whether services, specifically targeted for mental health and substance abuse, are impacted by an individual's history of TBI during the 18-months following incarceration, as well as the role of sex in service receipt.

3. Methods

3.1 Study overview

Data were drawn from individuals recruited into a multistate randomized controlled trial of a behavioral health reentry intervention conducted in two Midwestern states and one southeastern state in the United States. Eligibility for study participation included being 18 years of age or older, incarcerated in a correctional facility study site, approximately 6 months from release from prison, and scheduled for release to a county study site. Upon providing informed consent into the study, participants completed the baseline research interview using computer-assisted interview software. Following completion of the baseline interview, participants were randomized into either a treatment group to receive the 5-Key behavioral health intervention [22] or a comparison group to receive services-as-usual both while incarcerated and following release from prison. Once individuals released into the community, research interviews were conducted with all study participants 1 week later. Additional interviews were conducted at months 8, 14 and 18. Participants received compensation of \$40 per follow-up research interview and \$5 to update location tracking monthly. No compensation was provided to participants who were incarcerated. Analyses presented here are for the 265 individuals who completed the fourth (T4) follow-up interview at 18 months following release.

3.2 Measures

3.2.1 Ohio State University TBI identification method

A modified version of the Ohio State University TBI Identification Method (OSU TBI-ID) [24] was used to determine history of exposure to TBI. A history of TBI was indicated if the participant endorsed having had a head or neck injury event on any one of the five screener questions from the OSU TBI-ID. If at least one screener question was endorsed, the participant was prompted to answer the question whether they were ever knocked or lost consciousness. If they responded affirmatively, participants were asked if they were knocked out or lost consciousness for 30 minutes or longer. Finally, participants were asked the age when they first injured their head or neck. This assessment was administered at the T4 18-month follow-up interview in the community.

3.2.2 Service assessment for children and adults

The Service Assessment for Children and Adults (SACA) is a modified version of the Service Assessment for Children and Adolescents [65] that was adapted to ask

about service needs relevant to an individual in the transition from prison to the community. The SACA asked respondents about services in the following nine domains: life skills, mental health, substance abuse, relationships, job readiness, education, physical health, housing, and cognitive. Within each of the service domains, participants were asked whether they needed help in that domain and whether they received help. When an individual endorsed receiving a service, they were asked how many times they received help and whether services were helpful. The domains of mental health and substance abuse were asked at both baseline and follow-up interviews; the remaining seven domains were only asked at follow-up. At baseline, the queries were for any prior need or receipt (i.e., lifetime); at follow-up, the queries were asked relative to the time since last interview.

3.2.3 Mini neuropsychiatric interview

Substance use disorder and mental health disorder were assessed with the Mini Neuropsychiatric Interview (MINI) [66]. Participants were assessed for symptoms consistent with major depressive episode, manic episode generalized anxiety disorder, alcohol use disorder, and substance use disorder. The MINI has good test–retest and inter-rater reliability [66] and the MINI has demonstrated effectiveness in correctional settings [67]. All domains of the MINI were administered at the baseline research interview, and alcohol use disorder and substance use disorder were also asked at follow-up.

3.2.4 Traumatic history questionnaire

The Trauma History Questionnaire (THQ) is a 25-item measure of lifetime trauma that captures a variety of events, including forced robbery, home break-in, natural disaster, man-made disaster, military combat, close friend/family member murdered, life-threatening illness, intercourse against one's will, and attacked by family member [68]. For each traumatic event, the respondent who answered in the affirmative was asked the number of times the event occurred and the age of the individual at each event. This analysis used a total score from zero to 25 that summed the number of traumatic events endorsed by a participant.

3.2.5 Childhood trauma questionnaire

The Childhood Trauma Questionnaire is a 28-item measure of physical abuse, sexual abuse, emotional abuse, physical neglect, and emotional neglect that occurred during the individual's childhood. The total score of each subscale can range between 5 to 25, with higher scores indicating a higher level of trauma exposure. Cutoffs for moderate–severe exposure are: ≥ 13 for emotional abuse; ≥ 10 for physical abuse; ≥ 8 for sexual abuse; ≥ 15 for emotional neglect; and ≥ 10 for physical neglect. The CTQ has shown to have strong inter-rater reliability and criterion-related validity [69].

3.2.6 Demographic information

Participants were asked at the baseline interview about their race, sex, age, education level, and employment. Race was a three-category variable coded as Black, White, and other. Sex was also a three-category variable of man, woman, and

non-binary. Age was computed based on the date of birth reported by the participant. Education captured an individual's current level achieved and was coded as less than a high school diploma/GED, high school diploma/GED completed, and post-secondary education. Finally, employment asked about the respondent's work situation prior to their incarceration and was coded as unemployed, working full/part-time, or other.

3.3 Analytic methods

Analyses focus on respondents who completed a T4 interview, the interview at which the OSU TBI-ID was collected. We first examined how the respondents to the T4 interview compared with the original sample of individuals enrolled at baseline but who did not complete the T4 interview. Bivariate statistics of independent t-tests for continuous measures and chi-square statistics for categorical measures were used to compare the two groups. Within the T4 sample, descriptive statistics are presented overall and stratified by sex and by TBI status. The same bivariate tests were used when comparing service use and need across the interview waves for the T4 sample.

Among respondents completing a T4 interview, fixed effects linear probability models (LPM) were used to estimate within-person changes in service receipt within the mental health and substance abuse domains of the SACA. The analysis sample was further constrained into two, but not mutually exclusive, samples to examine each outcome. For the mental health receipt outcome, analysis was focused on those who indicated a need for mental health services at the baseline interview; similarly, for the substance abuse receipt outcome, analysis only included those with an identified substance abuse need at baseline. Fixed effects LPM allow us to estimate the effects for the full analysis sample by including responders with no change over time in each respective outcome variable. The LPM is shown to have comparable statistical properties to logit models under certain conditions, such as for outcome variable proportions not close to 0 or 1 [70–74]. Moreover, the fixed effects LPM suffers little from the convergence challenges seen with conditional logit, and LPM produces estimates in natural, interpretable percentage point units. Because the fixed effects LPM tests the within-person change in the outcome variable (i.e., mental health or substance use service receipt), each participant effectively acts as their own comparison, which allows for the control of all observed (e.g., sex or race) as well as unobserved time-invariant covariates (e.g., unmeasured health status). Moreover, to further test for between-group difference in within-person change (i.e., by TBI and by sex) we fitted separate models that included interaction terms between each time-invariant covariate and an indicator of time (i.e., 8 months, 14 months, and 18 months with the T1 interview serving as reference). All analysis were completed with Stata version 17.

4. Results

4.1 Subject characteristics

Table 1 shows characteristics of the 265 participants who completed the T4 interview at 18-months post-release. Individuals who completed the T4 interview were majority Black (52.08%) and men (83.40%) and reported an average age of 37.79 years old at the baseline interview. Prior to incarceration a majority had been employed (59.25%) and achieved either a high school diploma or GED (72.83%).

Characteristic	Mean (standard deviation) or percentage (%)	
	T4 Completers (n = 265)	T4 Did not Complete (n = 625)
Age	37.79(11.50)	37.03(10.61)
Sex		
Women	16.60%	15.22%
Men	83.40%	84.62%
Race*		
Black	52.08%	42.00%
White	34.34%	46.79%
Other	13.58%	11.22%
Education Level		
Less than HS/GED	26.62%	28.89%
HS/GED Completed	39.16%	39.65%
Post-secondary Education	34.22%	31.46%
Employment Status*		
Working (Full or part-time)	59.70%	51.69%
Unemployed	28.90%	41.57%
Major Depressive Episode*	41.13%	32.80%
Manic Episode	23.02%	17.60%
Alcohol Use Disorder*	46.42%	38.88%
Substance Use Disorder	70.94%	73.12%
Generalized Anxiety Disorder*	18.87%	13.12%
Posttraumatic Stress Disorder	30.19%	25.76%
Ever needed help for mental health?*	61.07%	52.33%
Ever received help for mental health?	56.06%	45.59%
Ever needed help for substance abuse?	55.30%	51.85%
Ever received help for substance abuse?	56.44%	52.01%
CTQ emotional abuse*	10.13(5.30)	9.36(4.98)
CTQ physical abuse	9.48(4.70)	8.98(4.72)
CTQ sexual abuse	6.89(4.35)	6.59(3.96)
CTQ emotional neglect*	11.11(5.08)	10.45(4.95)
CTQ physical neglect	8.74(4.20)	8.44(4.21)
THQ total score*	8.17(3.79)	7.18(3.66)

Table 1.

Means and percentages of subjects who completed the T4 interview compared to subjects who did not complete the T4 interview (* = $p < 0.05$).

The sub-sample of T4 responders comprises approximately 29.78% of the original sample of 890 individuals enrolled into the study at baseline. The T4 responders were shown to have significant differences ($p < 0.05$) compared with the sample of study participants who did not complete the T4 interview (**Table 1**) in some categories. Participants who completed the T4 interview reported a higher total score on the trauma history questionnaire (8.17 vs. 7.18) as well as higher scores on both emotional abuse (10.13 vs. 9.36) and emotional neglect (11.11 vs. 10.45) on the childhood trauma questionnaire. T4 responders were also more likely to indicate their race as Black (52.08 vs. 42.00%), and T4 responders reported higher level of major depression (41.13 vs. 32.80%), alcohol use disorder (46.42 vs. 38.88%), and generalized anxiety disorder (18.87 vs. 13.12%). Lastly, T4 responders showed higher levels of need for mental health services prior to incarceration (61.07 vs. 52.33%), and they reported being unemployed prior to incarceration at a statistically lower level (28.90 vs. 41.57%). For all remaining variables, the T4 responders were statistically similar to their counterparts who did not complete the T4 interview.

Members of the T4 sample reported at baseline high levels of lifetime need with help for emotional problems and substance use disorder. Fully 61.07% reported needing help in the past for emotional problems and 55.30% reported needing help for drug and alcohol problems. Most also reported having received help in the past with 56.06% reporting having received help with emotional problems and 56.44% receiving help for drug and alcohol problems.

Nearly one-third (30.2%) of the sample reported having experienced PTSD. The TBI-ID scale wasn't administered at baseline, but individuals reported high levels of physical and emotional trauma. **Table 2** shows the responses to the OSU TBI-ID by sex. Nearly 40% of the respondents reported having been hospitalized following a head or neck injury, with no significant difference between the men and women. Large numbers also reported having head or neck injuries as a result of an accident (35.43%), from a fall or playing sports (39.53%), and from being in a fight or being shot (32.81%)—again the differences in reporting by men and women were not significant. Men were more likely than women to report having been exposed to an explosion or blast (19.91 v. 7.14%; $p < .05$). Of the 146 who reported sustaining head or neck injuries, 88 (60.27%) reported losing consciousness and 39 of those 88 (49.37%) reported losing consciousness for more than 30 minutes. Although women were somewhat more likely to report losing consciousness (68.00 v. 58.68%) and men

TBI Item	Men	Women	Total
Hospitalization following head or neck injury	86 (40.57%)	15 (35.71%)	101 (39.76%)
Head or neck injury in accident	71 (33.49%)	19 (45.24%)	90 (35.43%)
Head or neck injury from fall or sports	81 (38.39%)	19 (45.24%)	100 (39.53%)
Head or neck injury from fight or being hit, shaken, or shot	70 (33.02%)	13 (31.71%)	83 (32.81%)
Near explosion or blast*	42 (19.91%)	3 (7.14%)	45 (17.79%)
If injured, knocked out or lost consciousness	71 (58.68%)	17 (68.00%)	88 (60.27%)
If knocked out, lost consciousness for 30 minutes or more	34 (51.52%)	5 (38.46%)	39 (49.37%)

Table 2.
Numbers and percentages of subjects reporting ever experiencing the TBI event by sex (= $p < 0.05$).*

Item	Men	Women	Total
Robbed by force or threat of force	132 (59.73%)	20 (45.45%)	152 (57.36%)
Robbed without force or threat of force	103 (46.61%)	21 (47.73%)	124 (46.79%)
Someone attempted or succeeded in breaking into your home when you were there*	34 (15.38%)	13 (29.55%)	47 (17.74%)
Serious accident at work or elsewhere	137 (61.99%)	27 (61.36%)	164 (61.89%)
Experienced a natural disaster	51 (23.08%)	8 (18.18%)	59 (22.26%)
Experienced a man-made disaster*	48 (21.72%)	18 (40.91%)	66 (24.91%)
Seen someone seriously injured or killed*	173 (78.28%)	24 (54.55%)	197 (74.34%)
Seen dead bodies (other than funeral)	128 (57.92%)	19 (43.18%)	147 (55.47%)
Had close family member or friend murdered*	165 (74.66%)	26 (59.09%)	191 (72.08%)
Had spouse, partner, or child die other than by murder or killed by drunk driver*	55 (24.89%)	18 (40.91%)	73 (27.55%)
Had a serious or life-threatening illness	65 (29.42%)	18 (40.91%)	83 (31.32%)
Made to have sex against your will*	24 (10.86%)	21 (47.73%)	45 (16.98%)
Been touched (private parts) under force or threat*	27 (12.22%)	25 (56.82%)	52 (19.62%)
Anyone attacked you with a weapon	119 (53.85%)	18 (40.91%)	137 (51.70%)
Has anyone attacked you without a weapon and seriously injured you*	45 (20.36%)	15 (34.09%)	60 (22.64%)
Has anyone beaten or pushed you hard enough to cause injury*	55 (24.89%)	21 (47.73%)	76 (28.68%)

Table 3. Numbers and percentages of subjects reporting ever experiencing selected traumatic events by sex (* = $p < 0.05$).

were somewhat more likely to report losing consciousness for more than 30 minutes (51.52 v. 38.46%), these differences were not statistically significant.

Select items from the THQ also indicate high levels of lifetime trauma. **Table 3** provides information on the percentage of respondents at baseline who reported ever experiencing specific events. Women reported higher rates of traumatic events for more categories than did men. Women were shown to be exposed to more direct personal crime, such as being beaten (47.73 v. 24.89%) or having their home broken into (29.55 v. 15.38%). Additionally, women reported significantly higher levels of sexual abuse (47.73 v. 10.86%) than did male respondents and experienced more non-violent death within their immediate family and friends (40.91 v. 29.42%). On the flip side, male respondents also reported high levels of lifetime trauma, but it was concentrated in interpersonal violence; particularly, seeing someone killed or injured (78.28 v. 54.55%) as well as having a family member or friend murdered (74.66 v. 59.09%).

4.2 Demographic comparison of respondents with TBI versus No TBI at baseline

Among the 265 respondents to the T4 interview, a majority (55.47%) endorsed at least one of the five screener questions for TBI. When comparing those who indicated a lifetime TBI to those participants who did not, significant differences are found (**Table 4**). Individuals with TBI were found to have higher levels of trauma

Measure	Mean (standard deviation) or percentage (%)	
	TBI (n = 147)	No TBI (n = 118)
	M(SD) / %	M(SD) / %
Age	38.86(11.17)	36.46(11.80)
Sex		
Women	17.69%	15.25%
Men	82.31%	84.75%
Race*		
Black	41.59%	65.25%
White	43.54%	22.88%
Other	14.97%	11.86%
Education Level		
Less than HS/GED	23.13%	31.03%
HS/GED Completed	38.78%	39.66%
Post-secondary Education	38.10%	29.31%
Employment Status*		
Working (Full or part-time)	62.59%	56.03%
Unemployed	22.45%	37.07%
Major Depressive Episode	43.54%	38.14%
Manic Episode	27.21%	17.80%
Alcohol Use Disorder	50.34%	41.53%
Substance Use Disorder*	76.19%	64.41%
Generalized Anxiety Disorder*	23.13%	13.56%
Posttraumatic Stress Disorder	34.69%	24.58%
Ever needed help for mental health?*	68.28%	52.14%
Ever received help for mental health?	59.86%	51.28%
Ever needed help for substance abuse?	59.18%	50.43%
Ever received help for substance abuse?	57.82%	54.70%
CTQ emotional abuse	10.39(5.23)	9.80(5.38)
CTQ physical abuse	9.68(4.80)	9.23(4.59)
CTQ sexual abuse	6.95(4.45)	6.81(4.35)
CTQ emotional neglect	11.21(5.18)	10.99(4.97)
CTQ physical neglect	8.66(3.93)	8.83(4.51)
THQ total score*	9.17(3.70)	6.90(3.52)

Table 4.
 Means and percentages of subjects with TBI compared to subjects without TBI (* = $p < 0.05$).

as indicated by the THQ total score (9.17 v. 6.90) as well as were more likely to score as having a substance use disorder (76.19 v. 64.41%) and/or a generalized anxiety disorder (23.13 13.56%). Given these reported symptoms by individuals with TBI, it is expected they would also report a higher level of need for mental health services

(68.28 v. 52.14%). Nevertheless, no differences were found in self-reported need for substance use services nor the receipt of either mental health or substance use services. Individuals who screened positive for TBI were more likely to describe themselves as White than individuals without TBI (43.54 v. 22.88%). Employment prior to incarceration was significantly higher for those with TBI compared to their T4 counterparts who did not report TBI (62.59 v. 56.03%).

Table 5 provides information on the individuals who reported the need for mental health and substance abuse services at baseline. A participant was identified as receiving either mental health or substance abuse services in **Table 5** if they received the service at any point during the 18-month follow-up period. Looking at the results, there is a higher rate of receipt for mental health service (49.38%) among those with a mental health need compared to the rate of receipt for substance abuse service (41.78%) among those with a substance abuse need. Within the TBI subgroup, respondents with TBI reported a higher rate of service receipt for both mental health (51.52 v. 45.90%) and substance abuse (43.68 v. 38.98%) compared to those without TBI. Men with TBI identified a need for substance abuse services at a higher rate (60.53%) than did women with TBI (56.25%); a similar difference is not seen for mental health services. Lastly, women reported a higher rate of receipt than men for both types of services, and the difference was most notable for mental health services versus substance use services (54.29 v. 48.00%).

4.3 Impact of TBI and sex on service receipt

Estimation of the fixed effects models began by estimating with a base model that included only the indicators of time to show the average service receipt path over time up to 18 months following reentry. Then, two separate models were estimated that used interactions with time indicators to show how the service receipt path differed by TBI status (Model 2) and sex (Model 3).

Results are presented in **Table 6**. For the models focused on mental health services receipt, no direct effect of time or any of the interaction effects were found to be significant. For the models examining substance use services receipt, there was a

MH service need					
	Overall (n = 160)	TBI (n = 99)	No TBI (n = 61)	Men (n = 125)	Women (n = 35)
MH Service receipt	79 (49.38%)	51 (51.52%)	28 (45.90%)	60 (48.00%)	19 (54.29%)
TBI	99 (61.88%)	N/A	N/A	77 (61.60%)	22 (62.86%)
Women	35 (21.88%)	22 (22.22%)	13 (21.31%)	N/A	N/A
SA service need					
	Overall (n = 146)	TBI (n = 87)	No TBI (n = 59)	Men (n = 114)	Women (n = 32)
SA service receipt	61 (41.78%)	38 (43.68%)	23 (38.98%)	47 (41.23%)	14 (43.75%)
TBI	87 (59.59%)	N/A	N/A	69 (60.53%)	18 (56.25%)
Women	32 (21.92%)	18 (20.69%)	14 (23.73%)	N/A	N/A

Table 5. Service receipt by those expressing need at T4 follow-up by TBI and sex.

Mental Health Service Receipt (n = 157)						
	Model 1: Time Only		Model 2: TBI Interaction		Model 3: Sex Interaction	
Time	<i>b</i>	95% CI	<i>b</i>	95% CI	<i>b</i>	95% CI
8 mos	.02	(-.08, .12)	.001	(-.17, .17)	.05	(-.06, .16)
14 mos	.06	(-.04, .16)	-.001	(-.17, .17)	.07	(-.04, .18)
18 mos	.02	(-.07, .11)	.02	(-.14, .18)	.02	(-.09, .12)
TBI Interaction						
8 mos x TBI			.04	(-.17, .25)		
14 mos x TBI			.09	(-.12, .31)		
18 mos x TBI			.0001	(-.20, .20)		
Sex Interaction						
8 mos x Women					-.05	(-.41, .12)
14 mos x Women					.01	(-.32, .21)
18 mos x Women					.01	(-.24, .25)
Substance Abuse Service Receipt (n = 143)						
Time	<i>b</i>	95% CI	<i>b</i>	95% CI	<i>b</i>	95% CI
8 mos	-.02	(-.12, .08)	.03	(-.13, .20)	.01	(-.10, .12)
14 mos	-.07	(-.17, .03)	-.11	(-.27, .06)	-.04	(-.15, .07)
18 mos	-.13*	(-.22, -.04)	-.14	(-.30, .01)	-.11*	(-.21, -.003)
TBI Interaction						
8 mos x TBI			-.09	(-.30, .11)		
14 mos x TBI			.07	(-.14, .27)		
18 mos x TBI			.02	(-.17, .21)		
Sex Interaction						
8 mos x Women					-.20	(-.46, .07)
14 mos x Women					-.15	(-.41, .12)
18 mos x Women					-.14	(-.39, .10)

Table 6. Fixed effects linear probability models: Within-person change in service receipt and time interactions by TBI and sex (* = $p < 0.05$).

negative effect of time on the receipt of substance use services. As the follow-up time-period increased, the receipt of substance abuse services decreased and at 18 months was 13 percentage points lower compared to the T1 interview at one-week post-release ($b = -0.13, p < 0.05$). None of the interaction terms were significantly associated with substance abuse service receipt in models 2 and 3. However, the decrease in receipt at 18 months remained negative and similar in magnitude to the base model estimates.

5. Discussion and conclusions

Research focused on understanding the influence of lifetime experiences of TBI on incarceration and post-incarceration outcomes is in its infancy. However, scientific

discoveries related to the deleterious effects of TBI on lifetime outcomes among athletes and war veterans underscore the importance of this burgeoning body of inquiry. Within a criminal justice involved population, the influence of TBI on individual behavior has high stakes implications for the health and safety of those beyond the justice-involved individual with TBI because criminal behavior frequently impacts the lives of the public. Findings from the current study suggest that additional inquiry is needed into the post incarceration experiences and outcomes for persons with a history of TBI.

The current study results are preliminary yet highly relevant. Rather than assessing TBI during incarceration and at every subsequent time point during post incarceration follow up, we screened for TBI 18 months after release. The screening occurred at that time point not because TBI was a primary focus of the clinical trial, but rather because the participant reports during the study suggested that this additional data point was imperative to understanding reentry results. Because TBI was examined posteriori, we were only able to speak to TBI among those participants retained in the study a year and a half post release. Importantly however, those participants who remained in the study were not the highest functioning, rather statistical analyses indicated that these participants displayed comparatively high needs — suggesting that the study findings reflect the realities of those facing complex issues post incarceration.

Reentry to communities from incarceration is a lengthy experience and the social and behavioral supports needed to fully assimilate into societal expectations of positive and productive living can take a substantial amount of time. Yet, the results from the current study show that the receipt of supportive services declines over time for all reentering participants. And, although the study did not identify statistically significant differences for those who screened positive for a TBI and those who did not at 18-months post-release, this research finding needs further testing because the current study cannot tease out the cumulative impact of TBI because of attrition and the binary (yes/no) nature of the data on service receipt. Most importantly, the research supports what other studies have consistently found – services are needed and important to reentry success and these same services are difficult to access and that the limitations to access are exacerbated overtime.

Future research that is longitudinal in nature that utilizes more detailed measures of cognitive deficits like executive dysfunction can help to pinpoint which symptoms of TBI persist, and the myriad of ways those symptoms may impact how a person progresses through services provided during and after incarceration. Foundational research describing the prevalence and patterns of TBI of formerly incarcerated individuals in the community is still needed as is more causal research that can help to identify treatment targets and intervention components post-release. In turn, reentry services providers can screen for TBI and provide more tailored approaches to individual care with the expectation that such tailored approaches could improve the relatively limited impact that generic reentry approaches have accomplished to date.

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Conflict of interest

The authors declare no conflict of interest.

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