RESEARCH ARTICLE

Personality and Mental Health

Personality disorder and mild traumatic brain injury

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Abstract

Mild traumatic brain injury (mTBI) poses risk to the neurocognitive, emotional, and financial well-being of affected individuals. While aggression and impulsivity have been examined in relation to mTBI, little work has been done to evaluate the relationship between history of mTBI and personality disorder (PD). The authors examined the associations between history of mTBI and PD in a control group without history of mTBI ($N = 1189$) and individuals with history of mTBI ($N = 267$). Results demonstrated that any PD diagnosis is a significant risk factor for mTBI ($p < 0.001$). Cluster B diagnoses, particularly borderline and antisocial PD, were independently significant risk factors for mTBI. These data suggest a role for screening for a history of mTBI in patients with PDs and associated traits.

INTRODUCTION

Diagnosis and care of mild traumatic brain injuries (mTBI) place a significant physical, emotional, and economic burden on affected individuals and health-care systems (Humphreys et al., 2013; Rockhill et al., 2010). The World Health Organization Collaborating Center Task Force and the Centers for Disease Control and Prevention (CDC) define mTBI as "an acute brain injury resulting from mechanical energy to the head from external physical forces" (Carroll et al., 2004). mTBI affects over 42 million people worldwide each year (Gardner & Yaffe, 2015), a number that is likely an underestimate given the notion that many individuals who suffer from mTBI choose not to be clinically evaluated (Voss et al., 2015) or have symptoms that resolve quickly and do not require intervention. Diagnosis of mTBI is frequently associated with cognitive dysfunction and specific

deficits in attention, processing speed, executive function, and/or memory (Kay et al., 1992; Prince & Bruhns, 2017; Williams, Potter, & Ryland, 2010). Although most patients who sustain mTBI return to cognitive baseline within 90 days following mTBI (Karr et al., 2014), many will experience persistent post-mTBI symptoms including lingering physical symptoms and mood disturbances (Dean et al., 2012; Spinos et al., 2010). mTBI and associated care have also been shown to result in substantial healthcare resource utilization (HRU) costs within the first 90 days as well within a 12-month follow-up period of care in the United States (Pavlov et al., 2019). There are likely a variety of contributing factors to the length and cost of treatment including injury beliefs, stressors, and medical comorbidities (Snell et al., 2013; Yue et al., 2019).

mTBIs have been shown to be more prevalent in specific populations including athletes, veterans, and

criminal offenders. Up to 3.8 million sports-related head injuries and concussions occur annually in the United States, a number that is likely a significant underestimate given the unique pressure felt by athletes to minimize symptoms of mTBI in order to prevent removal from competition (Harmon et al., 2013). These injuries have been linked to short- and long-term psychiatric sequelae in athletes including mood symptoms, sleep disturbances, and emotional lability (Brent & Max, 2017; Hutchison et al., 2018). Hoge et al. showed that up to 20% of veterans deployed in Iraq and Afghanistan had evidence of mTBI upon return from combat (Hoge et al., 2008). Veterans who had blast-associated mTBI have also displayed evidence of multifocal white matter abnormalities associated with severity of the mTBI (Vasterling et al., 2009), as well as increased chronic posttraumatic stress disorder symptoms hypothesized to represent a post-concussive syndrome following mTBI (Trudeau et al., 1998). Forensic research has also shown that prisoners have a high rate of mTBI exposure. Williams et al. (2010) found that, in a sample of male offenders, nearly 50% had experienced mTBI, which was associated with high rates of repeat offending. Further, 60% of mTBIs were found to be repeat injuries in patients who had sustained previous mTBI, giving consideration to the impact of recurrent mTBI. Slaughter et al. (2003) reported that up to 58% of prisoners reported having previously suffered mTBI, including 29% within 1 year prior.

Further research has focused on identifying traits, behaviors, and/or neuroimaging findings common among those with head injuries and mTBI. Much of this work has focused on both verbal and physical aggression, which have been shown to increase after mTBI and may be secondary to neuropsychological and emotional deficits including decreased inhibition and increased frustration (Alderman, 2003; Roy et al., 2017). Substance use, mood disorders, and aggression prior to mTBI have also been shown to be predictive factors of post-mTBI associated aggression (Tateno et al., 2003). With growing interest in identifying aggression as a possible risk factor for mTBI, Mosti et al. (2018) showed that individuals with intermittent explosive disorder (IED) are more likely than those without to have a history of mTBI and that other- and self-directed aggression increased as a function of mTBI history in a community sample. These findings are supported by growing neuroimaging findings of those affected by mTBI. Work by Epstein et al. (2016) showed that those with a history of mTBI showed cortical thinning of the right orbito-frontal cortex compared with those without history of mTBI, and Kraus et al. (2007) added evidence of fractional anisotropy with limited white matter functioning in the fronto-temporal-occipital brain regions as a finding common in those with history of mTBI.

While recent work has focused on aggression and impulsivity in relation to mTBI, relatively little work has been done to investigate the relationship between personality disorders (PD) and associated personality traits with mTBI. It is estimated that the prevalence of PD in a community sample may range from 4% to 15% (Coid et al., 2006; Samuels et al., 2002), but this is likely an underestimate given that a majority of individuals with PD do not access care for their PD traits (Bender et al., 2001). It is clear, however, that having any PD diagnosis carries an increased risk of negative outcomes including suicide, mood disorders, and psychotic disorders (Björkenstam et al., 2016; Keown et al., 2002; Skodol et al., 1999). The link between PD and violence and aggression has also been investigated, with particularly strong evidence for antisocial PD (ASPD), borderline PD (BPD), and narcissistic PD (NPD) showing increased rates of violent behavior in the general population (Kolla et al., 2017; Lambe et al., 2018). Any PD diagnosis, particularly ASPD and BPD, has also been found to have higher prevalence rates in groups previously shown to have higher rates of aggression and violence such as prisoners and domestic violence offenders (Green & Browne, 2020; Player, 2017). Despite existing evidence showing a relationship between aggression and mTBI, as well as aggression and PD, there remains a gap in understanding of the direct relationship between PD and mTBI.

The goal of this study was to examine the relationship between history of mTBI and PD in a large community research sample. We hypothesized that (a) participants with any PD diagnosis would be more likely to have a history of mTBI and (b) participants with any cluster B personality diagnosis, specifically ASPD and BPD, would be more likely to have a history of mTBI than those with other PD diagnoses and traits.

METHODS

Participants

This study enrolled and evaluated 1456 adult participants as part of a larger program designed to examine correlates of personality-related, aggressive, and impulsive behavior. Participants were recruited via advertisements in the media, newspaper, and through public service announcements. Recruitment specifically targeted individuals who struggle with psychosocial difficulty related to one or more psychiatric conditions, as well as those who do not suffer from any psychiatric conditions. Each

individual subject provided informed consent to participate in the study, which was reviewed and approved by the Institutional Review Board.

Assessment for PD

Study design and assessment was completed using similar criteria to Mosti et al. (2018) with modification to include additional analyses of PD diagnoses in relation to mTBI. PD diagnoses were made according to DSM-5 criteria. This process utilized information gathered from a clinical psychiatric interview according to the Structured Interview for DSM Diagnoses (SCID, First & Gibbon, 2004) for syndromal (formerly Axis I) disorders and the Structured Interview for DSM-IV Personality (formerly Axis II) Disorder (Pfohl et al., 1997). Other available clinical data were also used, with final diagnoses determined via best-estimate consensus procedures utilizing expertise from research and clinical psychiatrists and psychologists as described by Coccaro et al. (2012). Populations of participants who were excluded from this study based on information obtained during the structured clinical interview include individuals with the following: intellectual disability, history of substance use disorder, history of any bipolar disorder, and history of any psychotic disorder.

Assessment for history of mTBI

For the sake of this assessment and in line with guidelines from the American Congress of Rehabiliation Medicine, mTBI was defined as an acute brain injury associated with mild and brief neurological symptoms including but not limited to disorientation, dizziness, loss of consciousness lasting no longer than 30 min, and post traumatic amnesia (PTA) lasting no more than 24 h following injury (American Congress of Rehabilitation Medicine [ACRM], 1993). Individuals with loss of consciousness following mTBI of greater than 30 min were excluded from this study. History of mTBI was collected using self-reported data throughout the course of the diagnostic assessment interview described previously. This structured interview contained a majority of elements listed in the Ohio State University TBI-ID (Corrigan & Bogner, 2007), although not all given that the timing of its release occurred during data collection for this study.

Group assignment and demographics

Following the structured interview and exclusionary criteria assessment, 1189 individuals were determined to have no history of mTBI and were subsequently grouped as "no mTBI"; 267 individuals were found to have history of mTBI with about half (135) having loss of consciousness lasting less than 30 min.

Statistical analysis and data reduction

Chi-square, t test, and logistic regression were performed as appropriate. All reported analyses were adjusted for age, sex, ethnicity, and socioeconomic status. A two-tailed alpha value of 0.05 was used to denote statistical significance.

RESULTS

Demographic characteristics of study participants

The most notable demographic difference between the three groups was in biological sex, with the mTBI group having a greater proportion of males compared with the No mTBI group. Otherwise, the groups displayed a marginal difference in age, with the mTBI group being modestly older than the No mTBI group. The groups did not differ in terms of ethnicity or in SES scores (Table 1).

TABLE 1 Demographic characteristics of study participants

	No mTBI ($N = 1189$)	mTBI ($N = 267$)	p
Age[a]	34.2 ± 11.0	36.2 ± 10.8	$=0.030$
Gender (% male)[b]	41.3%	58.1%	<0.001
Race (% White)[b]	53.8%	62.2%	$=0.173$
SES score[a]	43.5 ± 12.8	43.2 ± 12.6	$=0.733$

Abbreviations: mTBI, mild traumatic brain injury; SES, socioeconomic status.
[a]p from ANOVA.
[b]p from Chi-square test.

Relationship between any PD and history of mTBI

Study participants with PDs represented a higher proportion of those with history of mTBI. The adjusted odds ratio for this comparison with the control group was 1.92 (95% CI: 1.44–2.55, $p < 0.001$) (Table 2).

Relationship between PD diagnoses and history of mTBI

Only study participants with a Cluster B PD diagnosis demonstrated a significant association with history of mTBI (odds ratio: 1.95 [95% CI: 1.38–2.75], $p < 0.001$). Subsequent analyses of the four Cluster B PD diagnoses

revealed that only ASPD (2.75 [95% CI: 1.64–4.61], $p < 0.001$) and BPD (1.82 [95% CI: 1.26–2.71], $p < 0.01$) demonstrated a significant association with history of mTBI. Given the relation of Cluster B traits to mTBI, post hoc analysis examined specific PD-associated traits. Within ASPD, "rule-breaking" (ASPD Criterion 1: 1.82 [95% CI: 1.43–2.32], $p < 0.001$) and "aggression and irritability" (ASPD Criterion 4: 1.27 [95% CI: 1.06–1.52], $p < 0.01$) were uniquely related to history of mTBI. Within BPD, only "anger dysregulation" (BPD Criterion 8: 1.23 [95% CI: 1.04–1.45], $p < 0.001$) was uniquely related to history of mTBI. Between these three ASPD/BPD traits "rule-breaking" (ASPD Criterion 1: 1.58 [95% CI: 1.29–1.94], $p < 0.001$) and "anger dysregulation" (BPD Criterion 8: 1.23 [95% CI: 1.05–1.43], $p < 0.012$) were uniquely associated with history of mTBI (Table 3).

DISCUSSION

The most important finding from this study is that any PD diagnosis is a significant risk factor for history of a mTBI. When considering diagnoses by cluster, only Cluster B PD diagnoses are significantly associated with a history of mTBI with only AsPD and BPD diagnoses significantly associated with a history of mTBI. These findings support our hypothesis that individuals with PD,

TABLE 2 Relationship between personality disorder and history of mTBI

	No mTBI (N = 1189)	All mTBI (N = 267)
Any PD (N = 689)	532 (77.2%)	157 (22.8%)
No PD (N = 767)	657 (85.7%)	110 (14.3%)

Note: Chi-square = 17.29, df = 1, $p < 0.001$.
Abbreviations: mTBI, mild traumatic brain injury; PD, personality disorder.

TABLE 3 Relationship between personality disorder and history of mTBI

	No mTBI (N = 1189)	mTBI (N = 267)	*p*	Odds ratio	CI
PD (N = 689)	532 (44.7%)	157 (58.8%)	<0.001	1.76	[1.35, 2.31]
No PD (N = 767)	657 (55.3%)	110 (41.2%)			
Cluster A Dx (N = 95)	70 (5.9%)	25 (9.4%)	0.054	1.65	[1.03, 2.66]
No Cluster A Dx (N = 1367)	1119 (94.1%)	242 (90.6%)			
Cluster B Dx (N = 296)	216 (18.2%)	80 (30%)	<0.001	1.93	[1.43, 2.60]
No Cluster B Dx (N = 1160)	973 (81.8%)	187 (70%)			
Cluster C Dx (N = 170)	117 (14.9%)	53 (19.9%)	0.051	1.42	[1.01, 2.00]
No Cluster C Dx (N = 1226)	1012 (85.1%)	214 (80.1%)			
ASPD (N = 94)	56 (4.7%)	38 (14.2%)	<0.001	3.36	[2.17, 5.19]
No ASPD (N = 1362)	1133 (95.3%)	229 (85.8%)			
BPD (N = 223)	163 (13.7%)	60 (22.5%)	0.001	1.82	[1.31, 2.54]
No BPD (N = 1233)	1026 (86.3%)	207 (77.5%)			
NPD (N = 90)	69 (5.8%)	21 (7.9%)	0.207	1.39	[0.834, 2.30]
No NPD (N = 1366)	1120 (94.2%)	246 (92.1%)			
Histrionic PD (N = 24)	18 (1.5%)	6 (2.2%)	0.423	1.50	[0.588, 3.80]
No histrionic PD (N = 1432)	1171 (98.5%)	261 (97.8%)			

Abbreviations: ASPD, antisocial personality disorder; BPD, borderline personality disorder; Dx, diagnosis; mTBI, mild traumatic brain injury; NPD, narcissistic personality disorder; PD, personality disorder.

specifically AsPD and BPD, are at greatest risk for mTBI compared with those without these diagnoses.

Based solely on these data, we cannot ascertain that the presence of PDs and their associated traits led participants to situations in which they were more likely to sustain an mTBI. However, traits common to many PDs including impulsivity and aggression have been shown to manifest early in life (Tremblay, 2014), which may lead to individuals placing themselves in situations in which sustaining mTBI is more likely. These findings also support prior evidence that individuals with AsPD and/or BPD traits are more likely to exhibit disregard for rules and for anger dysregulation (ACRM, 1993; Coccaro et al., 2012; First & Gibbon, 2004; Pfohl et al., 1997), which then leads to higher rates of mTBI. Neuroimaging evidence may also provide supporting evidence for a link between PD and mTBI. A reduction in grey matter found in the dorsolateral prefrontal cortex (DLPFC) has been shown in subjects with BPD compared with healthy controls, and this region has also been shown to have less activation during cognitive control of aggression in subjects with BPD (New et al., 2009; Sala et al., 2011). A broad range in DLPFC deficits have also been seen in individuals diagnosed with ASPD compared with individuals without this diagnosis (Dolan & Park, 2002). Chen et al. (2008) showed that in a sample of athletes with history of mTBI, functional MRI studies revealed reduced activation in the DLPFC relative to a group of controls without history of mTBI. Data from our study, while not providing direct evidence of this link, support the notion that certain neurobiological deficits may play a role in both PDs and mTBI.

This study has several strengths, including the large participant sample that allowed for a powerful analysis through validated clinical research interviews. The sample also provided an opportunity to study large groups of individuals both with and without self-reported history of mTBI, thus creating substantial experimental and control groups for statistical analysis. The makeup of the population was also significant in that it likely represents a true community sample, as recruitment and advertising for the study were completed in diverse environments not limited to clinical settings. Future work studying specific populations, such as athletes, would be beneficial in determining differences in associations within population subgroups. One limitation of the study is that the context of each injury was not recorded, although most participants reported that their injury occurred during a motor vehicle accident or athletic activity. Despite the lack of timing, context of injury, and information about recurrent mTBI, it was known that none of the participants experienced more than a mild TBI or LOC greater than 30 min. Additionally, this study investigated mTBI only and did not include data about moderate and severe TBI, both of which would be interesting areas of further investigation.

CONCLUSION

Individuals with any PD diagnosis are significantly more likely to have a history of mTBI compared with individuals who do not have a PD diagnosis. Presence of any Cluster B PD diagnosis, particularly AsPD and BPD, was independently associated with increased rates of history of mTBI. These findings support the hypothesis that individuals with PDs are at greater risk for mTBI compared with those without PDs. It is likely that traits associated with certain PDs, such as "disregard for rules" and "anger dysregulation," place affected individuals in circumstances in which mTBI is more common. Evaluation for the presence of PD, and of specific associated traits, should include screening questions about history of mTBI. Such expanded clinical assessments would allow for a more complete evaluation of patients who may fall within the subgroups presented in this study and more focused clinical care.

CONFLICT OF INTEREST
Dr. Coccaro reports being a consultant to and being on the Scientific Advisory Boards of Azevan Pharmaceuticals, Inc. and of Avanir Pharmaceuticals, Inc., and being a current recipient of a grant award from the NIMH. Dr. Moley and Dr. Norman report no conflicts of interest regarding this work.

ETHICS STATEMENT
This study had ethical approval granted by the Institutional Review Board (IRB) of the Biological Sciences Division of the University of Chicago (Protocol #10375). Each subject signed the informed consent document reviewed and approved by this IRB, before taking part in this study.

REFERENCES
Alderman, N. (2003). Contemporary approaches to the management of irritability and aggression following traumatic brain injury. *Neuropsychological Rehabilitation*, *13*(1–2), 211–240. https://doi.org/10.1080/09602010244000327

American Congress of Rehabilitation Medicine (ACRM). (1993). Definition of mild traumatic brain injury. *The Journal of Head Trauma Rehabilitation*, *8*, 86–87. https://doi.org/10.1097/00001199-199309000-00010

Bender, D. S., Dolan, R. T., Skodol, A. E., Sanislow, C. A., Dyck, I. R., McGlashan, T. H., Shea, M. T., Zanarini, M. C., Oldham, J. M., & Gunderson, J. G. (2001). Treatment utilization by patients with personality disorders. *American Journal of Psychiatry*, *158*(2), 295–302. https://doi.org/10.1176/appi.ajp.158.2.295

Björkenstam, C., Ekselius, L., Berlin, M., Gerdin, B., & Björkenstam, E. (2016). Suicide risk and suicide method in patients with personality disorders. *Journal of Psychiatric Research*, *83*, 29–36. https://doi.org/10.1016/j.jpsychires.2016.08.008

Brent, D. A., & Max, J. (2017). Psychiatric sequelae of concussions. *Current Psychiatry Reports*, *19*(12), 108. https://doi.org/10.1007/s11920-017-0862-y

Carroll, L. J., Cassidy, J. D., Holm, L., Kraus, J., & Coronado, V. (2004). Methodological issues and research recommendations for mild traumatic brain injury: The WHO collaborating Centre task force on mild traumatic brain injury. *Journal of Rehabilitation Medicine*, *43*, 113–125. https://doi.org/10.1080/16501960410023877

Chen, J. K., Johnston, K. M., Petrides, M., & Ptito, A. (2008). Neural substrates of symptoms of depression following concussion in male athletes with persisting postconcussion symptoms. *Archives of General Psychiatry*, *65*(1), 81–89. https://doi.org/10.1001/archgenpsychiatry.2007.8

Coccaro, E. F., Nayyer, H., & McCloskey, M. S. (2012). Personality disorder-not otherwise specified evidence of validity and consideration for DSM-5. *Comprehensive Psychiatry*, *53*(7), 907–914. https://doi.org/10.1016/j.comppsych.2012.03.007

Coid, J., Yang, M., Tyrer, P., Roberts, A., & Ullrich, S. (2006). Prevalence and correlates of personality disorder in Great Britain. *The British Journal of Psychiatry*, *188*(5), 423–431. https://doi.org/10.1192/bjp.188.5.423

Corrigan, J. D., & Bogner, J. (2007). Initial reliability and validity of the Ohio State University TBI identification method. *The Journal of Head Trauma Rehabilitation*, 2007, *22*, 318–329. https://doi.org/10.1097/01.HTR.0000300227.67748.77

Dean, P. J., ONeill, D., & Sterr, A. (2012). Post-concussion syndrome: Prevalence after mild traumatic brain injury in comparison with a sample without head injury. *Brain Injury*, *26*(1), 14–26. https://doi.org/10.3109/02699052.2011.635354

Dolan, M., & Park, I. (2002). The neuropsychology of antisocial personality disorder. *Psychological Medicine*, *32*(3), 417–427. https://doi.org/10.1017/S0033291702005378

Epstein, D. J., Legarreta, M., Bueler, E., King, J., McGlade, E., & Yurgelun-Todd, D. (2016). Orbitofrontal cortical thinning and aggression in mild traumatic brain injury patients. *Brain and Behavior: A Cognitive Neuroscience Perspective*, *6*(12), e00581. https://doi.org/10.1002/brb3.581

First, M. B., & Gibbon, M. (2004). *Structured clinical interview for DSM-IV Axis I disorders (SCID)*. Psychiatric Institute, Biometrics Research.

Gardner, R. C., & Yaffe, K. (2015). Epidemiology of mild traumatic brain injury and neurodegenerative disease. *Molecular and Cellular Neuroscience*, *66*, 75–80. https://doi.org/10.1016/j.mcn.2015.03.001

Green, K., & Browne, K. (2020). Personality disorder traits, trauma, and risk in perpetrators of domestic violence. *International Journal of Offender Therapy and Comparative Criminology*, *64*(2–3), 147–166. https://doi.org/10.1177/0306624X19826516

Harmon, K. G., Drezner, J., Gammons, M., Guskiewicz, K., Halstead, M., Herring, S., Kutcher, J., Pana, A., Putukian, M., & Roberts, W. (2013). American medical Society for Sports Medicine position statement: Concussion in sport. *Clinical Journal of Sport Medicine*, *23*(1), 1–18. https://doi.org/10.1097/JSM.0b013e31827f5f93

Hoge, C. W., McGurk, D., Thomas, J. L., Cox, A. L., Engel, C. C., & Castro, C. A. (2008). Mild traumatic brain injury in US soldiers returning from Iraq. *New England Journal of Medicine*, *358*(5), 453–463. https://doi.org/10.1056/NEJMoa072972

Humphreys, I., Wood, R. L., Phillips, C., & Macey, S. (2013). The costs of traumatic brain injury: A literature review. *ClinicoEconomics and Outcomes Research: CEOR*, *5*, 281.

Hutchison, M. G., Di Battista, A. P., McCoskey, J., & Watling, S. E. (2018). Systematic review of mental health measures associated with concussive and subconcussive head trauma in former athletes. *International Journal of Psychophysiology*, *132*, 55–61. https://doi.org/10.1016/j.ijpsycho.2017.11.006

Karr, J. E., Corson, N. A., & Garcia-Barrera, M. A. (2014). The neuropsychological outcomes of concussion: A systematic review of meta-analyses on the cognitive sequelae of mild traumatic brain injury. *Neuropsychology*, *28*(3), 321–336. https://doi.org/10.1037/neu0000037

Kay, T., Newman, B., Cavallo, M., Ezrachi, O., & Resnick, M. (1992). Toward a neuropsychological model of functional disability after mild traumatic brain injury. *Neuropsychology*, *6*(4), 371–384. https://doi.org/10.1037/0894-4105.6.4.371

Keown, P., Holloway, F., & Kuipers, E. (2002). The prevalence of personality disorders, psychotic disorders and affective disorders amongst the patients seen by a community mental health team in London. *Social Psychiatry and Psychiatric Epidemiology*, *37*(5), 225–229. https://doi.org/10.1007/s00127-002-0533-z

Kolla, N. J., Meyer, J. H., Bagby, R. M., & Brijmohan, A. (2017). Trait anger, physical aggression, and violent offending in antisocial and borderline personality disorders. *Journal of Forensic Sciences*, *62*(1), 137–141. https://doi.org/10.1111/1556-4029.13234

Kraus, M. F., Susmaras, T., Caughlin, B. P., Walker, C. J., Sweeney, J. A., & Little, D. M. (2007). White matter integrity and cognition in chronic traumatic brain injury: A diffusion tensor imaging study. *Brain*, *130*(10), 2508–2519. https://doi.org/10.1093/brain/awm216

Lambe, S., Hamilton-Giachritsis, C., Garner, E., & Walker, J. (2018). The role of narcissism in aggression and violence: A systematic review. *Trauma, Violence & Abuse*, *19*(2), 209–230. https://doi.org/10.1177/1524838016650190

Mosti, C., & Coccaro, E. F. (2018). Mild traumatic brain injury and aggression, impulsivity, and history of other-and self-directed aggression. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *30*(3), 220–227. https://doi.org/10.1176/appi.neuropsych.17070141

New, A. S., Hazlett, E. A., Newmark, R. E., Zhang, J., Triebwasser, J., Meyerson, D., Lazarus, S., Trisdorfer, R., Goldstein, K. E., Goodman, M., Koenigsberg, H. W.,

Flory, J. D., Siever, L. J., & Buchsbaum, M. S. (2009). Laboratory induced aggression: A positron emission tomography study of aggressive individuals with borderline personality disorder. *Biological Psychiatry*, *66*(12), 1107–1114. https://doi.org/10.1016/j.biopsych.2009.07.015

Pavlov, V., Thompson-Leduc, P., Zimmer, L., Wen, J., Shea, J., Beyhaghi, H., Toback, S., Kirson, N., & Miller, M. (2019). Mild traumatic brain injury in the United States: Demographics, brain imaging procedures, health-care utilization and costs. *Brain Injury*, *33*(9), 1151–1157. https://doi.org/10.1080/02699052.2019.1629022

Pfohl, B., Blum, N., Zimmerman, M., et al. (1997). *Structured Interview for DSM-IV Personality Disorder: SIDP, 1997*. American Psychiatric Press.

Player, E. (2017). The offender personality disorder pathway and its implications for women prisoners in England and Wales. *Punishment & Society*, *19*(5), 568–589. https://doi.org/10.1177/1462474516672883

Prince, C., & Bruhns, M. E. (2017). Evaluation and treatment of mild traumatic brain injury: The role of neuropsychology. *Brain Sciences*, *7*(8), 105. https://doi.org/10.3390/brainsci7080105

Rockhill, C. M., Fann, J. R., Fan, M. Y., Hollingworth, W., & Katon, W. J. (2010). Healthcare costs associated with mild traumatic brain injury and psychological distress in children and adolescents. *Brain Injury*, *24*(9), 1051–1060. https://doi.org/10.3109/02699052.2010.494586

Roy, D., Vaishnavi, S., Han, D., & Rao, V. (2017). Correlates and prevalence of aggression at six months and one year after First-time traumatic brain injury. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *29*, 334–342. https://doi.org/10.1176/appi.neuropsych.16050088

Sala, M., Caverzasi, E., Lazzaretti, M., Morandotti, N., de Vidovich, G., Marraffini, E., Gambini, F., Isola, M., de Bona, M., Rambaldelli, G., d'Allio, G., Barale, F., Zappoli, F., & Brambilla, P. (2011). Dorsolateral prefrontal cortex and hippocampus sustain impulsivity and aggressiveness in borderline personality disorder. *Journal of Affective Disorders*, *131*(1–3), 417–421. https://doi.org/10.1016/j.jad.2010.11.036

Samuels, J., Eaton, W. W., Bienvenu, O. J., Brown, C. H., Costa, P. T., & Nestadt, G. (2002). Prevalence and correlates of personality disorders in a community sample. *The British Journal of Psychiatry*, *180*(6), 536–542. https://doi.org/10.1192/bjp.180.6.536

Skodol, A. E., Stout, R. L., McGlashan, T. H., Grilo, C. M., Gunderson, J. G., Shea, M. T., Morey, L. C., Zanarini, M. C., Dyck, I. R., & Oldham, J. M. (1999). Co-occurrence of mood and personality disorders: A report from the collaborative longitudinal personality disorders study (CLPS). *Depression and Anxiety*, *10*(4), 175–182. https://doi.org/10.1002/(SICI)1520-6394(1999)10:4<175::AID-DA6>3.0.CO;2-2

Slaughter, B., Fann, J. F., & Ehde, D. (2003). Traumatic brain injury in a county jail population: Prevalence, neuropsychological functioning and psychiatric disorders. *Brain Injury*, *17*, 731–741. https://doi.org/10.1080/0269905031000088649

Snell, D. L., Hay-Smith, E. J. C., Surgenor, L. J., & Siegert, R. J. (2013). Examination of outcome after mild traumatic brain injury: The contribution of injury beliefs and Leventhal's common sense model. *Neuropsychological Rehabilitation*, *23*(3), 333–362. https://doi.org/10.1080/09658211.2012.758419

Spinos, P., Sakellaropoulos, G., Georgiopoulos, M., Stavridi, K., Apostolopoulou, K., Ellul, J., & Constantoyannis, C. (2010). Postconcussion syndrome after mild traumatic brain injury in Western Greece. *Journal of Trauma and Acute Care Surgery*, *69*(4), 789–794. https://doi.org/10.1097/TA.0b013e3181edea67

Tateno, A., Jorge, R. E., & Robinson, R. G. (2003). Clinical correlates of aggressive behavior after traumatic brain injury. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *15*(2), 155–160. https://doi.org/10.1176/jnp.15.2.155

Tremblay, R. E. (2014). Early development of physical aggression and early risk factors for chronic physical aggression in humans. *Current Topics in Behavioral Neurosciences*, *17*, 315–327. https://doi.org/10.1007/7854_2013_262

Trudeau, D. L., Anderson, J. M., Hansen, L. M., Shagalov, D. N., Schmoller, J., Nugent, S., & Barton, S. (1998). Findings of mild traumatic brain injury in combat veterans with PTSD and a history of blast concussion. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *10*(3), 308–313. https://doi.org/10.1176/jnp.10.3.308

Vasterling, J. J., Verfaellie, M., & Sullivan, K. D. (2009). Mild traumatic brain injury and posttraumatic stress disorder in returning veterans: Perspectives from cognitive neuroscience. *Clinical Psychology Review*, *29*(8), 674–684. https://doi.org/10.1016/j.cpr.2009.08.004

Voss, J. D., Connolly, J., Schwab, K. A., & Scher, A. I. (2015). Update on the epidemiology of concussion/mild traumatic brain injury. *Current Pain and Headache Reports*, *19*(7), 32. https://doi.org/10.1007/s11916-015-0506-z

Williams, W. H., Mewse, A. J., Tonks, J., Mills, S., Burgess, C. N. W., & Cordan, G. (2010). Traumatic brain injury in a prison population: Prevalence and risk for re-offending. *Brain Injury*, *24*(10), 1184–1188. https://doi.org/10.3109/02699052.2010.495697

Williams, W. H., Potter, S., & Ryland, H. (2010). Mild traumatic brain injury and postconcussion syndrome: A neuropsychological perspective. *Journal of Neurology, Neurosurgery & Psychiatry*, *81*(10), 1116–1122. https://doi.org/10.1136/jnnp.2008.171298

Yue, J. K., Cnossen, M. C., Winkler, E. A., Deng, H., Phelps, R. R. L., Coss, N. A., Sharma, S., Robinson, C. K., Suen, C. G., Vassar, M. J., Schnyer, D. M., Puccio, A. M., Gardner, R. C., Yuh, E. L., Mukherjee, P., Valadka, A. B., Okonkwo, D. O., Lingsma, H. F., Manley, G. T., & TRACK-TBI Investigators. (2019). Pre-injury comorbidities are associated with functional impairment and post-concussive symptoms at 3-and 6-months after mild traumatic brain injury: A TRACK-TBI study. *Frontiers in Neurology*, *10*, 343. https://doi.org/10.3389/fneur.2019.00343