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The Relationship Between Concussion and Violent Criminal Behavior in Professional Football Players

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THE RELATIONSHIP BETWEEN CONCUSSION AND VIOLENT CRIMINAL BEHAVIOR IN PROFESSIONAL FOOTBALL PLAYERS

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by

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THE RELATIONSHIP BETWEEN CONCUSSION AND VIOLENT CRIMINAL BEHAVIOR

IN PROFESSIONAL FOOTBALL PLAYERS

This dissertation, by Sarah Jeanne Boucher, has
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Antioch University New England
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ABSTRACT

THE RELATIONSHIP BETWEEN CONCUSSION AND VIOLENT CRIMINAL BEHAVIOR IN PROFESSIONAL FOOTBALL PLAYERS

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This dissertation explored the relationship between head injury and violent crime among professional football players. This study was particularly focused on determining if the frequency or severity of head injury was related to the severity of violent crime among National Football League (NFL) football players. Additionally, this study explored possible differences in violence severity and concussion history among offensive and defensive positions. Based on information gathered from publicly available archival databases, sixty-three participants were placed into four groups based on their concussion and violent crime histories. Pearson correlations were conducted to determine the relationship between concussion history and violent crime severity. Independent Sample *t*-Tests were also completed to determine any significant difference in violence severity among participants with and without concussion history; as well as to determine any significant difference in concussion history among participants with and without a violent criminal history. Chi-square analyses were conducted to examine the relationship between National Football League (NFL) position and concussion history, as well as history of violence. An ANOVA was used to compare career lengths of the participants in the four study groups. Results suggest no significant relationship between concussion severity or concussion frequency and the severity of violent crime in participants. Participants with a concussion history but no violent criminal history had significantly longer

NFL careers compared to participants in each of the other groups. Although a relationship was not identified in this study, further investigation into the negative outcomes of repetitive head injuries remains crucial. Limitations of the present study are discussed, and recommendations are made for future research. This dissertation is available in open access at AURA (https://aura.antioch.edu) and OhioLINK ETD Center (https://etd.ohiolink.edu).

Keywords: repetitive concussion, head trauma, violent crime, professional football, contact sports

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THE RELATIONSHIP BETWEEN CONCUSSION AND VIOLENT CRIMINAL BEHAVIOR IN PROFESSIONAL FOOTBALL PLAYERS

Introduction

Research has linked long-term negative effects to multiple concussions and serious head trauma. One potential impact of concussions that has been raised, but remains unclear, is the relationship between head trauma and violent criminal behavior. Therefore, the question of whether repeated head traumas are associated with an increase in violence and criminal behavior in athletes in contact sports is unanswered. Using archival data from publicly available databases, this dissertation explored the relationship between repetitive head traumas and violent criminal behavior in professional football players by examining whether head trauma frequency or severity was related to violent crime severity among professional football players.

Concussions and Head Traumas are Common in Contact Sports

Every year approximately 1.6 to 3.8 million sports-related concussions and brain injuries occur in the United States, with 10% of all contact sport athletes sustaining concussions every year (Brain Injury Research Institute [BIRI], n.d.). Individuals that participate in contact sports are especially at risk for concussion. Athletes in contact sports tend to make violent body contact whether during blocking, fighting, or tackling their opponents, increasing opportunities for severe body hits to the head or body that cause their head to snap back and forth. While most symptoms subside after a few days of rest, concussions and other brain injuries can produce serious long term negative consequences. An individual is at especially high risk for negative outcomes given repeated head injury (Stamm et al., 2015; Mez et al., 2017; Muth, 2018). Due to their high exposure, athletes in contact sports such as football may be more likely to experience the potential long-term effects of concussions.

A traumatic brain injury (TBI) is an injury to the head that impacts and changes how the brain functions. This type of injury occurs from an insult to the head from an outside source, such as a hit to the head or a penetrating injury (e.g., gunshot; Centers for Disease Control and Prevention [CDC], n.d.). Each TBI is different, leading outcome prediction and treatment to be based on severity. Though there are various classification systems to rate the severity of concussions, an injury to the brain is often classified as mild, moderate, or severe. Each system utilizes different criteria to determine the severity of a head trauma, however, the length of loss of consciousness (LOC), presence of post-traumatic amnesia (PTA), as well as presence and length of symptoms are taken into account when diagnosing a TBI. A mild TBI (mTBI), also known as a concussion, does not typically result in gross structural damage to the brain, but rather, leads to differing levels of temporary altered mental status (e.g., confusion, LOC; Galgano et al., 2017). Concussion symptoms are typically short-term and subside after a few days or weeks. A moderate or severe TBI is diagnosed if an individual experiences prolonged periods of altered mental status following a trauma to the head. For instance, an individual that experiences more than 30 minutes but fewer than 24 hours of LOC following head trauma, would be classified as having a moderate TBI. A severe TBI is diagnosed if an individual losses consciousness for more than 24 hours following a head trauma (Carlson et al., 2009; CDC, n.d.).

The most common brain injuries in contact sports are concussion and subconcussive impacts. Both involve a hit to the head that causes the brain to shake violently against the skull (Muth, 2018). While concussion (mTBI) symptoms typically subside after a few days or weeks, an individual with a history of multiple or repeated concussions (mTBIs) may experience longer recovery and more severe symptoms (CDC, n.d.; Galgano et al., 2017). Concussion symptoms can include headache, nausea, fatigue, confusion or difficulties with memory, sleep disturbance,

alteration in mood, and temporary gait issues (CDC, n.d.; Muth, 2018). Subconcussive impacts are another type of mild head trauma that do not result in the observable signs and symptoms typically associated with concussions (Baugh et al., 2012; Muth, 2018). As such, they typically go unreported or undetected. Nevertheless, both concussive and subconcussive impacts negatively affect the brain. Over time, they have been found to damage connections in the brain, suppress brain function, and contribute to mood and behavior problems later in life (Muth, 2018).

Repeated Brain Injuries Have Serious Short and Long-term Consequences

Concern is growing about the long-term adverse consequences of repeated concussion and head trauma in athletes who play contact sports such as football, boxing and hockey. Long-term effects of concussions may include memory loss, anger, impulsivity, severe medical disability, damage to brain tissue, and can even lead to death (McKee et al., 2014). Studies have identified second-impact syndrome (SIS), juvenile head trauma syndrome, catastrophic sudden death, and Chronic Traumatic Encephalopathy (CTE) as conditions that can occur as a result of multiple concussions and head trauma (Martini et al., 2017; McKee et al., 2014). SIS occurs after an athlete sustains a mild to a severe concussion and later receives an additional blow to the head before symptoms from the initial concussion subside (McKee et al., 2014). SIS can result in coma, cerebral edema, and brain herniation. Juvenile head trauma syndrome is a minor craniocerebral trauma that is typically associated with severe, sometimes fatal, cerebral edema and coma (McKee et al., 2014). Post-concussive syndrome (PCS) is diagnosed when symptoms of an acute concussive injury persist for more than three months. An individual suffering from PCS may exhibit symptoms such as loss of consciousness, amnesia, as well as sleep

disturbances, behavioral changes, cognitive impairment, somatic symptoms, and cognitive or emotional symptoms (McKee et al., 2014).

Another potential outcome of multiple head traumas is CTE, which has become a highly publicized topic due to its prevalence among National Football League (NFL) players. CTE is a neurodegenerative disease that is believed to be caused by multiple concussions, subconcussive hits, and repetitive blows to the head (Lehman, 2013; McKee et al., 2014; Stein et al., 2015). CTE has been found to lead to cognitive decline, dementia related symptoms, emotional dysregulation, and behavioral problems (Lindsley, 2017; McKee et al., 2009). Symptoms of CTE do not generally begin to appear until years after the head impact(s). A recent study from the Boston University CTE center tested 202 brains of former football players from across all levels of play and diagnosed 177 (87%) with CTE (Mez et al., 2017). Of those diagnosed, 110 of 111 (99%) former NFL players were found to have CTE, while "three of 14 high school brains (21%), 48 of 53 college brains (91%), nine of 14 semiprofessional brain (64%), and seven of eight brains from the Canadian Football League (88%)" were diagnosed with CTE (Mez et al., 2017, p. 360). The inability to diagnose CTE antemortem leads athletes to suffer through their lives with symptoms without a proper diagnosis.

The most severe outcome associated with multiple concussions and head trauma is catastrophic sudden death. According to the 30-year U.S. National Registry of Sudden Death in Young Athletes, 1,827 deaths in athletes aged 21 and younger occurred between the years of 1980—2009. Of those sudden deaths, 261 (14%) were due to head and neck trauma (McKee et al., 2014). Catastrophic head and neck injuries can lead to skull fractures, subdural hematoma, epidural hematoma, ruptured vertebral artery with subarachnoid hemorrhage, SIS, and juvenile head trauma syndrome (McKee et al., 2014).

Repetitive hits to the head can lead to widespread deposits of tau protein tangles (also known as tau neurofibrillary tangles [NFTs]), lesions, and atrophy to multiple key regions of the brain including the cerebral cortex, temporal lobes, thalamus, mammillary bodies, and the brain stem (Lindsley, 2017; Mez et al., 2017). These brain alterations are characteristics of the neurodegenerative disease CTE. There are four stages of CTE (stage I, stage II, stage III, stage IV) that are based on the level of degeneration of brain tissue and the accumulated tau protein deposits, with stage IV being the most severe. Dissection of brain tissue is required to identify the extent of deposits of microscopic tau protein tangles and the atrophy of brain tissue to determine the stage of CTE. Moore et al. (2015) found that frontal-alpha asymmetry was related to reported depression and anxiety, while beta-asymmetry alterations were related to anger and aggression, suggesting that certain brain alterations may be associated with specific clinical symptoms.

Repetitive head traumas also lead to emotional, cognitive and behavioral changes (Baugh et al., 2012), including depression, anxiety, and suicidality (Finkbeiner et al., 2016). Guskiewicz et al. (2007) investigated the relationship between concussions and clinical depression among retired NFL athletes, by distributing a general health survey and the SF-36 to over 3,500 athletes to assess the athletes' current health and their daily functioning (Guskiewicz et al., 2007). The study found that athletes that suffered from more frequent concussions were more at risk for depression later in life (Guskiewicz et al., 2007). Specifically, athletes that had experienced one to two concussions in their life were 1.5 times more likely to develop depression compared to athletes with no concussion history, while those who had three or more concussions were three times more likely to develop depression (Guskiewicz et al., 2007). Additionally, Kerr et al. (2012), studying the same population nine years later, found that 3% of athletes that had not

experienced a concussion reported a depression diagnosis, while 26.8% of athletes that reported ten or more concussions reported a depression diagnosis (Kerr et al., 2012). These studies establish a relationship between concussion and depression, suggesting that individuals that experience more frequent concussions may be at an increased risk for depression.

Repeated Concussions and Head Trauma can Lead to Poor Executive Functioning

Executive functions are a set of mental abilities that facilitate attention, memory, organization, planning, problem solving, and emotion regulation (Takeuchi et al., 2013). Executive functioning is associated with the prefrontal cortex (PFC). Damage to this area has been found to lead to executive dysfunction (Hartikainen et al., 2010; Takeuchi et al., 2013). Executive functioning is influential in all facets of an individual's life including behavioral choices. While mTBI is often associated with disturbances in various neurocognitive functions, the most profound deficits have been seen in domains of executive functioning, processing speed, delayed memory, and verbal fluency (Belanger et al., 2005).

Trauma to the head has been associated with increased risk for memory issues, attention, and concentration difficulties as well as slowed processing speed, impulsivity, and other executive functioning deficits (Hehar et al., 2015; Hinton-Bayre et al., 1999; McKee et al., 2014). Following a concussion, individuals may experience executive dysfunction, impulsivity and aggression (Finkbeiner et al., 2016), all of which influence behaviors and the decision-making process. When these abilities are hindered, individuals tend to struggle to control their impulses and make poor choices. Poor executive functioning also impacts irritability, carelessness, and rigidity (Lezak et al., 2012). Additionally, athletes that suffer from multiple concussions experience emotional lability, explosive outbursts, and suicidal ideation (Maroon et al., 2015; Mez et al., 2017; Stern, 2017).

Seichepine et al. (2013) investigated behavioral changes in college and professional football players with histories of concussions compared to healthy individuals. The Behavior Rating Inventory of Executive Functioning (BRIEF) was utilized to measure the behavioral changes of the participants. The study found that when compared to healthy individuals, athletes that had suffered concussions demonstrated impairment in seven areas of executive functioning: inhibition, shifting, emotional control, the ability to initiate tasks, working memory, planning and organizing, and task monitoring (Seichepine et al., 2013).

Poor Executive Functioning has Been Linked to Criminal Behavior

The association between prefrontal brain damage and antisocial behavior has been supported by neuroimaging indicating dorsolateral dysfunction in individuals with antisocial behaviors, impaired social functioning, and criminal behavior (Raine & Yang, 2006). Additionally, impulsivity has been found to be related to antisocial behaviors, violence, and crime. Research also suggests that impulsivity is a major contributing factor to the personality structure of crime (Foroozandeh, 2017).

Poor executive functioning skills and poor emotional control are risk factors for criminal behavior (Seruca & Silva, 2016). One study found that offenders performed worse in mental flexibility and planning measures when compared to nonoffending populations (Seruca & Silva, 2016). It appears that criminal offenders have poor decision-making skills and exhibit poor impulse control. Executive functioning impairments affect both behavior and cognitive abilities. Dysfunction in an individual's executive abilities can include difficulty with planning actions, can cause exclusivity, impulsivity and erratic behavior (Seruca & Silva, 2015).

Additionally, Barbosa and Monteiro (2008) compared inmate performance on the Behavioral Assessment of the Dysexecutive Syndrome (BADS) to a control population. The

BADS is a battery of assessments that examine an individual's executive functioning abilities. When compared to the control subjects, inmates' performance was worse overall and across most domains, indicating impaired executive function (Barbosa & Monteiro, 2008).

Violent crimes are associated with poor inhibitory control and impaired updating ability (Cruz, 2016). Cruz (2016) compared 52 violent and 47 nonviolent high security inmates to 48 controls without a criminal history. Participants were required to undergo a semi-structured interview; a mild cognitive impairment screening; neuropsychological testing that focused on executive functioning; and self-report measures of psychopathy, aggression, and impulsivity (Cruz, 2016). Inmates were found to have higher levels of aggression and psychopathy. Their performance also revealed impaired inhibition and difficulty with updating information (Cruz, 2016). Athletes that have experienced concussions seem to exhibit similar executive dysfunction and emotional lability as individuals that have committed crimes.

Traumatic Brain Injury has Been Linked to Aggression

Evidence of a strong connection between TBI and aggression has also been seen, with occurrences of verbal aggression, temper outbursts, and disinhibition increasing following reported TBI (Dyer et al., 2006; Hall et al., 1994). Of men referred for evaluation due to marital violence, 61% had a reported history of severe TBI (Rosenbaum & Hoge, 1989). Additionally, as previously stated, in a study examining death-row inmates, all 15 had suffered a severe TBI prior to their crime (Lewis et al., 1986). Overall, inmates with a history of TBI had higher measures of anger and aggression when compared to inmates that do not have a history of TBI.

In support of the connection between TBI and aggression, a study that examined 270 Vietnam Veterans with frontal lobe TBI found that 60% of Veterans reported very mild forms of aggression, while 20% experienced overt aggression, and 14% endorsed using physical violence

(Grafman et al., 1996). Research also suggests that the increased aggression seen following TBI can be chronic and occur after long periods of time. For example, in studies examining a population of 228 participants with a history of TBI ranging from moderate to severe, 25% of the population reported experiencing high levels of aggression after five years (Baguley et al., 2006; Brooks et al., 1986).

Higher Rates of Traumatic Brain Injury Reported Among Incarcerated Offenders

Research has suggested that TBI can lead to behaviors that may be associated with criminal behavior, such as impulsivity, dysfunction to an individual's ability to regulate their emotions, as well as leading to individuals experiencing aggression, apathy, and violence (Baguley et al., 2006; Brower & Price, 2001; Bufkin & Luttrell, 2005; Farrer & Hedges, 2011). However, there has been large variability in the lifetime TBI prevalence rates reported among incarcerated offenders. For instance, a TBI prevalence rate of 4.7% was found among a Brazilian sample of 2,820 forensic patients (Crespo de Souza, 2003). In contrast, a study of 15 United States death row inmates reported a 100% prevalence of a severe TBI history (Lewis et al., 1986). Additionally, a meta-analysis conducted in 2010 found a 60.3% prevalence for TBI in offending populations (Shiroma et al., 2010). These research findings suggest high lifetime prevalence of TBI in incarcerated individuals.

Higher rates of TBI prevalence have also been found in incarcerated individuals compared to the general population. Farrer and Hedges (2011) conducted a meta-analysis of 24 studies to further examine the association between TBI and incarceration. In this study, they pooled studies that reported lifetime TBI prevalence among incarcerated populations and compared them to the estimated lifetime TBI prevalence in the general population. Though prevalence of TBI can be high within the general population, in comparison, incarcerated

individuals have a significantly higher lifetime prevalence of TBI (Farrer & Hedges, 2011). Results also suggested that criminal behavior increased following TBI. One study included within the meta-analysis reported that 7% of individuals that experienced severe TBI became involved in the legal system within one year following their injury, with this rate increasing to 31% in the five years following head injury (Brooks et al., 1986). Similarly, Hall et al. (1994) found that 24% of individuals committed crimes within two years following TBI. Of note, these crimes are not exclusive to violent crimes.

We Know Little About the Relationship Between Repetitive Head Trauma and Violence

While the scholarly evidence indicates that multiple concussions and serious head trauma are linked with long-term negative effects, and some research has found presence of a TBI history in adult offender and prisoner populations, the relationship of concussions to violent criminal behavior is still unclear. Therefore, the question of whether repeated head traumas are associated with an increase in violence and criminal behavior in athletes in contact sports, such as football, is unanswered. Knowing more about this potential relationship could be helpful to athletes in contact sports as it would lead to further awareness of additional detrimental effects that could occur following repetitive hits to the head. For NFL players, the results of this study could lead to further emphasis on player safety and available support to players that could help minimize or manage the long-term consequences of their head trauma history.

Is Repeated Head Trauma Associated With an Increase in Violent Criminal Behavior in Professional Football Players?

The purpose of this study is to explore the relationship between repeated head trauma and violent criminal behavior among athletes in contact sports. The research question is: Is repeated head trauma associated with a professional football player's risk for violent criminal behavior?

Method

This study used a quantitative design to investigate the relationship between the frequency and severity of concussions and head trauma and violent criminal behavior in NFL football players. Archival data were utilized to measure each variable. The predictor variables were the frequency and severity of concussions/head trauma incidents. The dependent variable was the severity of violent criminal behavior. Analyses were completed to determine if there was a relationship between violent crime severity in NFL players with and without a concussion. Analyses were also completed to determine if there was a relationship between concussions severity in NFL players with and without a history of violent crime.

Participants

NFL players were selected to participate in this present study. Participants were players that were active NFL roster members (not just the practice squad) for at least one year between the years of 2009 to 2020. A total of 63 NFL players were randomly selected to participate in the study. Players were designated as part of one of four groups: head trauma history and violent criminal history, head trauma history with no violent criminal history, no head trauma history and violent criminal history, and no head trauma history and no violent criminal history.

Measures

Publicly available databases were used in this study. The databases were available on the web and located through a Google search. The variables utilized in this study included demographic information such as current status (retired or active), years played in the NFL, and position played. This information was gathered from the NFL player directory available on the NFL website (NFL, 2021). The predictor variables were the total number of concussions/head trauma injuries and concussion/head trauma severity. The criterion variable used were the

severity of violent crimes. The data for each variable were collected through two archival databases that have been selected for this study.

The total number of concussions/head trauma and severity of concussions/head trauma was gathered from the NFL Injury Reports database (Pro Football Reference, 2021). NFL teams are required to release weekly injury status on each player on their active roster. The weekly reports indicate the type of injury, and that designation must remain on each report until the player is cleared by the team physician. After experiencing a hit to the head, players may receive a concussion diagnosis or be designated with a head trauma. According to the NFL's concussion policy, a player is diagnosed with a concussion if their score on the Sports Concussion Assessment Tool-5 (SCAT 5; Echemendia et al., 2017) is lower than their baseline assessment score. Players may also be diagnosed with a concussion if the team doctor notes abnormalities following the injury based on their knowledge of the player (NFL, 2018; Seifert, 2017). For the purpose of this study, all classifications of concussion, head trauma, and "head" designations listed in the injury report database were included. Severity of concussions/head trauma was operationalized as the total number of weeks players missed due to that injury designation. Frequency of concussions/head traumas was recorded on a ratio scale, based on the number of concussions/head traumas that a player suffered. The number of concussions/head traumas only included those that have been reported by the NFL.

The NFL Player Arrest database (USA Today, 2018) was utilized to gather the criminal history of each player. The arrest records included the crime that the player was charged with, when the incident occurred, the status of the case, as well as the outcome and punishment. The crimes included in the variable of "total number of violent crimes" were assault, vehicular assault, battery, sexual battery, sexual assault/rape, murder, attempted murder, and domestic

violence. This variable was based on a ratio scale, and the severity of the violent crime was recorded. The severity of each crime was operationalized based on the type of violent crime a player committed. The severity of crime was recorded according to a rating scale that was based on the Crime Severity Scale (CSI) that was created in Canada. The CSI was created to track the changes in the level of severity of crime in Canada and within that index, all crimes are assigned a weight based on their seriousness (Canadian Centre for Justice Statistics, 2009). Higher weights are given to more serious crimes. The weights given to any type of criminal offense is based on the incarceration rate and the average length of the prison sentence for the specific criminal offense. Offenses that are more severe tend to be punished by incarceration at time of conviction and the most serious crimes generally receive longer prison sentences (Canadian Centre for Justice Statistics, 2009). The rating scale used in this study, that was used based on Canada's CSI, rated crimes from a one to eight, with eight being the most severe crime. Table 1 includes a breakdown of the rating given to each crime. Given the difference in crime classification in the United States and Canada, the description of a participant's crime was utilized to assign a severity rating. For example, no specific severity rating was designated for domestic violence; however, occurrences of domestic violence were rated by the description of the crime provided in the USA Today NFL Player Arrest Database (2018). Only crimes that occurred after the first concussion/head trauma suffered during a player's NFL career were included in the dataset.

Table 1

Crime Severity Ratings

Crime	Rating
Murder	8
Attempted Murder	7
Sexual Assault 3/Rape	6
Sexual Assault 2	5
Assault 3	4
Sexual Assault 1/Sexual Battery	3
Assault 2/Vehicular Assault	2
Assault 1/Battery	1

Procedure

This study used archival data for all variables for each participant. To begin, NFL players with a history of violent crime between the years of 2009 to 2019, with cases that have been resolved with some form of punishment (either via guilty verdict or plea deal) were randomly identified from the USA Today Arrest Database (2018). After being selected, each potential participant's injury report history was examined on the Pro Football Reference database to record their NFL concussion/head trauma history. For participants that were deemed to have a violent criminal history and a history of concussion/head trauma, only crimes that occurred after their first identified NFL concussion/head trauma were included.

To compile a comparison group, NFL players were selected through random searches of the Pro Football Reference database (Pro Football Reference, 2021). After selecting 32 NFL players, their injury report history was examined to identify how many concussions/head traumas they experienced and how many weeks they missed due to those injuries. Potential participants were then searched for through the USA Today Arrest Database (2018). Participants that were found to have violent crimes were not included in this comparison group.

Once all participants were identified and their violent criminal history and their concussion/head trauma history were recorded, a search of the NFL's player directory on the NFL website was conducted to gather information regarding their position, their status in the NFL (retired or active), and the length of time spent in the NFL (NFL, 2021).

Analysis

A Pearson Product-Moment Correlation was conducted to estimate the strength of the linear relationship between severity of violent criminal behavior and the occurrence and severity of concussion/head traumas. In addition, an Independent Samples *t*-Test was completed to determine if there is a difference in violent crime severity in NFL players with and without a concussion. An Independent Samples *t*-Test was also completed to determine if there was a different in concussions severity in NFL players with and without a history of violent crime. A chi-square analysis was conducted to determine if there was a relationship between position played (defensive position vs. offensive position) and the occurrence of concussion, as well as the occurrence of violent crime. A p-value of .05 will be utilized for all statistical significance testing.

Results

Descriptive Statistics

Of the 63 participants, all players were male. With regard to ethnicity, 77% were Black or African American (49), 15% were White (10), <1% were Hispanic (3) and Pacific Islander (1). With regard to NFL position played, 56% played defensive positions (35 participants) and 44% of participants played offensive positions (28 participants). The average years played in the NFL for all participants was 8.1 years. Table 2 provides demographic information and sample size for the three study groups.

Table 2

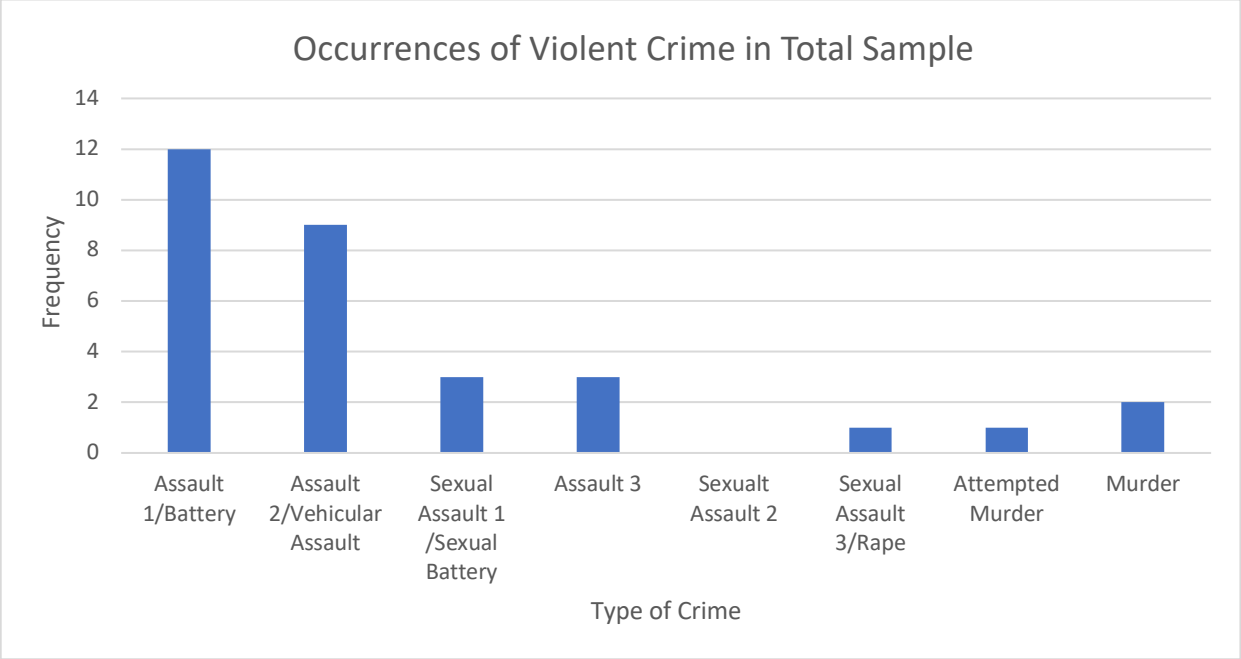
Group Characteristics

	Concussion & Violence	No Concussion & Violence	Concussion & No Violence	No Concussion & No Violence
n	16	15	13	19
Mean Years in NFL	7.4	6.7	10.9	7.7
Offensive Position: Total(%)	4 (25%)	6 (40%)	10 (77%)	8 (42%)
Defensive Position: Total(%)	12 (75%)	9 (60%)	3 (23%)	11 (58%)

Within the total sample, the most common violent crime that was committed was assault 1/battery, with the second most frequent being assault 2/vehicular assault. The least common violent crime committed was sexual assault 2. Figure 1 provides the frequency of each type of violent crime committed by the total sample.

Figure 1

Occurrences of Violent Crime Committed by Total Sample



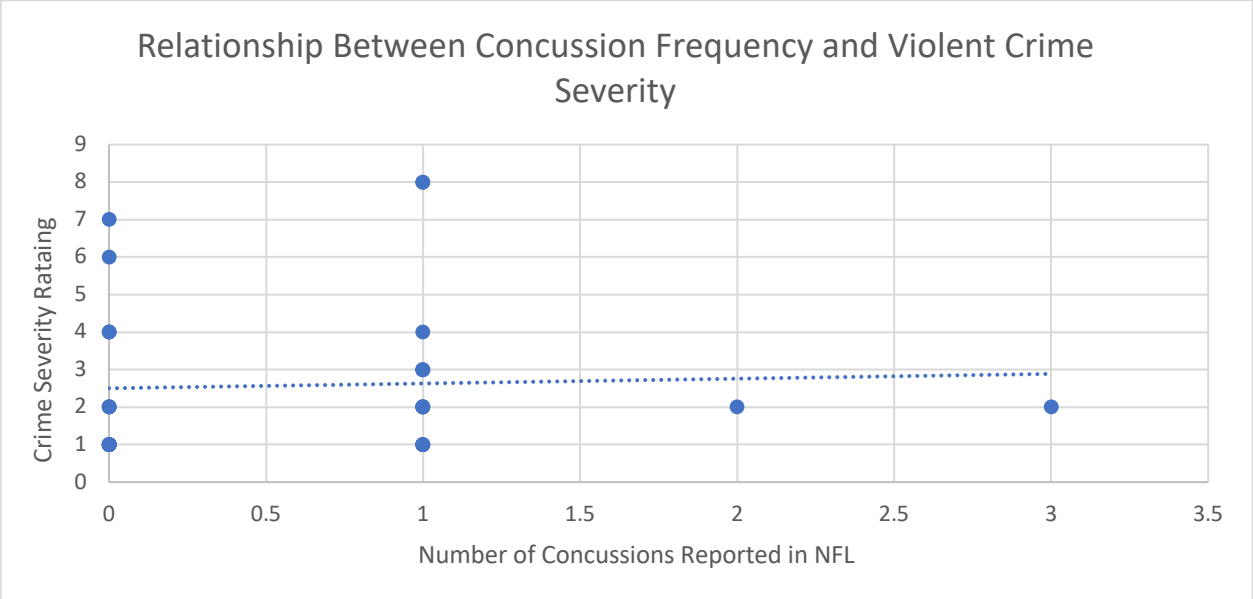
Relationship Between Concussion History and Violent Crime Severity

Regarding the severity of concussions, participants in the concussion and violence group missed an average of 2.6 weeks due to concussions (*SD* = 3.34, range 1–12). The participants in the concussion and no violence group missed an average of 3.6 weeks due to concussion (*SD* = 4.39, range = 0–17). There was no significant difference between the groups with regards to the average weeks missed due to concussion (t (22) = -0.67, p = .51). Examining the severity of violent crime, participants in the concussion and violence group had an average severity of crime rating of 2.8 (*SD* = 2.20, range = 1–8), with two participants receiving the crime severity rating of 8 for murder. Participants from the no concussion and violent crime group had an average severity of crime rating of 2.3 (*SD* = 1.99, range = 1–7), with one participant receiving a crime severity rating of 7 for attempted murder.

A Pearson product-moment correlation coefficient was computed to determine the relationship between the frequency of concussions and the severity of violent crime. There was no significant correlation between the two variables ($r = 0.04, n = 31, p = 0.81$). A scatterplot summarizes the results in Figure 2.

Figure 2

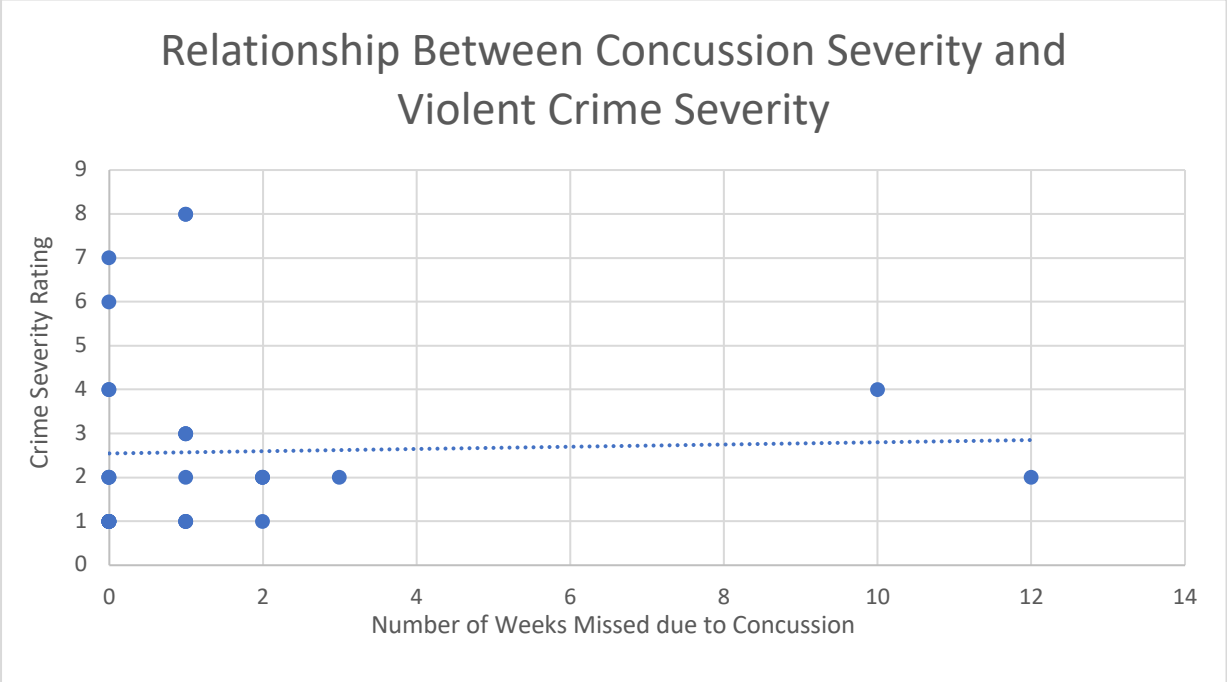
Relationship Between Frequency of Concussion and the Severity of Violent Crime



A Pearson product-moment correlation coefficient was computed to determine the relationship between severity of concussions and the severity of violent crime. There was no significant correlation between the two variables ($r = 0.03, n = 31, p = 0.57$). A scatterplot summarizes in the results in Figure 3.

Figure 3

Relationship Between Severity of Concussion and the Severity of Violent Crime



Concussion Versus No Concussion: Violent Crime Severity Difference

An Independent Sample *t*-Test was completed to determine if there was a significant difference between violent crime severity in participants with and without concussion histories. There was no significant difference between the 16 participants with a concussion and violent crime history compared to the 15 participants with no concussion history but a violent crime history (t (29) = -0.64, p = .53).

Violent Crime Versus No Violent Crime: Concussion History Difference

An Independent Sample *t*-Test was completed to determine if there was a significant difference between concussion severity in participants with and without a history of violent crime. There was no significant difference in concussion severity between the 31 participants with violent crime history compared to the 32 participants with no violent crime history (t (60) = -0.15, p = .88).

An Independent Sample *t*-Test was completed to determine if there was a significant difference between concussion frequency in participants with and without a history of violent crime. There was no significant difference in concussion frequency between the 31 participants with violent crime history compared to the 32 participants with no violent crime history (t (50) = -0.54, p = .59).

NFL Position Differences

A chi-square test of independence was performed to examine the relationship between NFL position and the presence of concussion history. The relationship between these variables was not significant, X^2 (1, N= 63) = 0.32, p = 0.57. There was no significant relationship between whether a participant was an offensive or defensive player and if they had a concussion history.

A chi-square test of independence was performed to examine the relationship between NFL position and their perpetration of violent crime. The relationship between these variables was not significant, X^2 (1, N= 63) = 3.67, p = 0.55. There was no significant relationship between whether a participant was an offensive or defensive player and if they committed a violent crime.

NFL Career Length Differences

A one-way ANOVA was conducted to compare the career lengths for participants in the concussion and violent history, concussion and no violent history, no concussion and violent history, and no concussion and no violent history groups. There was a significant difference in NFL career length, F(3,59) = 5.41, p = .002. Post hoc comparisons using the Tukey HSD test indicated that the concussion and no violence group (M = 10.9, SD = 3.25) was significantly different then the concussion and violence group (M = 7.4, SD = 3.39). Significant differences were also seen between the concussion and no violence group (M = 10.9, SD = 3.25) and the no concussion and violence group (M = 6.7, SD = 2.31), as well as a significant difference between

the concussion and no violence group ($M = 10.9$, $SD = 3.25$) and the no concussion and no violence group ($M = 7.7$, $SD = 2.79$). In other words, the concussion and no violence group differed significantly from the other three groups on length of career using an alpha level of $p = .05$. No other posthoc tests were significant.

Discussion

The purpose of this study was to explore the relationship between repeated concussions/head trauma and violent criminal behavior among NFL athletes, specifically, examining whether repetitive concussions increase a contact sport athlete's risk for violent criminal behavior. I hypothesized that there would be a positive relationship between repetitive concussions causing head trauma and violent crime, meaning that players with more frequent concussions/head traumas would have a history of more severe violent crimes. Additionally, I hypothesized that more serious concussions and head traumas would increase an individual's risk for violent crime.

The findings of this study do not support these hypotheses. There was no relationship seen between the frequency of head trauma and violent crime. There was also no relationship seen between the severity of concussions/head trauma and violent crime. The findings of this study suggest that, at least for this present cohort, neither the frequency nor the severity of concussions was related to the severity of violent crime. Prior research has found that concussions can cause executive dysfunction, impulsivity, emotional lability, explosive outbursts and aggression (Finkbeiner et al., 2016; Seichepine et al., 2013), all of which have been found to be risk factors for criminal behavior (Foroozandeh, 2017; Seruca & Silva, 2016). Though separate studies have found similar patterns of executive dysfunction in violent offenders and athletes (Cruz, 2016; Seichepine et al., 2013), concussion history and violent crime were not

found to be related in the current study. Though defensive players in the sample had more occurrences of violent crime, there was no significant relationship between offensive and defensive positions and the occurrence of violent crime or the presence of a concussion history.

A significant difference in length of NFL career was noted between the concussion and no violence group and the two groups with violent history (concussion and violence; no concussion and violence), as well as the group of participants with no concussion and no violence history. Within this study, players with a history of concussion and no violent criminal history had the longest average NFL career. Interestingly, participants that had a history of violent crime, both those with and without a concussion history, were noted to have shorter NFL careers compared to participants that did not have a history of violent crime. Players with a violent history had various professional career lengths, possibly due to the punishment they were given based on their crime, with some players being able to return to play in the NFL, while others who committed more serious crimes (e.g., murder) were not able to return due to their lengthy prison sentences.

Of note, the most frequent violent crimes committed by the NFL players in this present study were assault 1 and battery and assault 2, both of which included several occurrences of domestic violence. This finding was consistent with data reported by Morris (2014), who found that the most common violent crimes resulting in arrest among NFL players were assault and domestic violence.

Although not statistically significant, some of the other directional differences might warrant further research. For example, one interesting finding was that nonsignificantly more defensive NFL players were noted to have a violent criminal history than offensive. This finding

may be suggestive of the amount of contact and aggressiveness the various positions require or experience.

Additionally, though not surprising given the fame of most NFL players, observations of the USA Today NFL Player Arrest Database (2018), revealed numerous plea agreements, settlements between victim and offender, and many cases that were not prosecuted with charges being dropped. These occurrences raise the question of how the privilege of fame and wealth impact outcomes within the criminal justice system. This is also relevant to the current study, as violent crime was only included if there was a punishment outcome, and NFL players that had criminal cases that were dismissed or resolved by settlement were not included. Cases that were settled by plea agreement, specifically if they involved some level of punishment, were included.

The current study focused solely on concussions and head traumas suffered during a participant's NFL career and possible injuries that occurred prior to their professional career were not included. Given that a large majority of professional NFL players begin playing football at an early age and likely experienced some level of head trauma prior to their professional career, the lack of incorporation of these data in this study likely minimized the potential to find relationship for this population. Additionally, subconcussive hits are not reported by the NFL, therefore, the estimation of subconcussive hits a player experiences in their NFL career could not be included in this current study. Subconcussive impacts are a type of mild head trauma that do not result in the observable signs and symptoms of concussions and often go unreported and undetected (Baugh et al., 2012; Muth, 2018). Nevertheless, subconcussive impacts can have long-lasting impacts, such as damaging connections in the brain, suppressing brain function, and contributing to mood and behavior problems later in life (Muth, 2018).

In addition to the present study not including information prior to a participant's NFL career, information for after their NFL career is also not included. The databases used in this study did not include information regarding concussion history or violent offenses after a player was no longer active in the NFL. This leaves out any possible occurrences of violent crimes that occurred after they left or retired out of the databases used in this study. The current study also only includes violent crimes and no other instances of violence that may have occurred. It is possible that professional athletes commit violent acts that are not reported or that they are not charged with crimes that occur or committed crimes other than those included in the database.

Additionally, due to the possibility of confounding factors, it is difficult to generalize the study to other NFL players and the general population. For instance, the data used, solely looked at concussions and head traumas suffered during participants' NFL careers and violent offenses that occurred after a reported NFL concussion. The data did not account for other risk factors, such as childhood upbringing, socioeconomic status, race, predisposition to aggression, or other factors that could be related to violence risk. Additional factors that were not controlled for in the current study that may influence violent risk include hyperactivity/attention deficits or learning disorders, involvement with substance use, low intelligence, deficits in social cognitive or information-processing abilities, high emotional distress, antisocial traits, low parental involvement in childhood, poor family functioning, low commitment to school and school failure, as well as exposure to violence in the home or in the community (e.g., gangs, domestic violence; CDC, 2020).

The present study did not account for the inherently aggressive nature of a contact sport like football, and how they may be related to an individual's personality outside of that sport. Research has suggested that athletes tend to have a more positive attitude towards violence

compared to their nonathlete counterparts (Forbes et al., 2006). Men who participate in organized sports exhibit more aggressive behaviors both in athletic and nonathletic contexts, and their propensity towards aggression and violence may be influenced by the masculine social norms that are established on sports teams (Boeringer, 1999; Coulomb-Cabagno & Rascle, 2006; Forbes et al., 2006; Koss & Gaines, 1993; Sonderlund et al., 2014; Steinfeldt et al., 2012).

The present study has several limitations, several of which are related to issues discussed above. To begin, the reporting of participants' concussion history was possibly impacted by several factors including inaccurate reporting of concussion symptoms by players to avoid missed play, incomplete reporting by NFL teams, and the lack of tracking of subconcussive hits. Additionally, the present study solely included NFL injury data and did not incorporate head trauma suffered prior to a player's NFL career or injuries that occurred outside of NFL play (practice or game). Another limitation was the small sample size utilized in this study. The power of the data was decreased due to the small size. The present study did not lend consideration to other risk factors for violence. The present study also relied solely on archival data that were not based on information collected directly from the participants. Due to the lack of direct involvement from participants, personality measures, self-report measures, and information about injury or crime history was not utilized or corroborated by the individuals.

Future Research

Though this present study did not find a relationship between concussion history and violent crime in NFL players, additional examination will be essential to further investigate a possible link between these factors. To answer the research question at hand, whether repetitive concussions increase the risk for violent crime, future research should include lifetime concussion history as well as inclusion of estimated subconcussive impacts an individual has

experienced. Further, although difficult to determine, examining individual violent behavior histories including violent acts that were not prosecuted and those committed after a player's NFL career ends may also be valuable. Further control for other variables that could impact a person's risk for violence is also recommended for future research.

An additional avenue for continued research that may be fruitful is investigating the role individuals' first exposure to football plays on the relationship between head trauma history and violence to understand developmental factors in this relationship. Possible differences between player position as a variable in head trauma history and violence is another area for possible investigation.

If future research does uncover a relationship between repetitive head trauma and violence, comparison to other contact sports (e.g., boxing, mixed martial arts, ultimate fighting, hockey, rugby) would further contribute to the head trauma literature. It would also be interesting to examine how personal attitudes and tendencies toward aggression in such sports is related to violence in the context of multiple head traumas. Further research should be completed with more controls in place to determine a relationship between these factors to further inform possible negative long-term consequences of repetitive heads traumas.

Conclusion

The goal of the present study was to contribute to and expand the current literature on potential detrimental effects that could occur following repetitive hits to the head. Specifically, this study explored the relationship between frequency and severity of concussions/head trauma and violent crime and whether concussion/head trauma was related to increased risk for violent crime in professional football players. However, the results from the current study did not find a

significant relationship between frequency or severity of concussion/head trauma and violent crime.

Previous research has found high prevalence rates of TBI in incarcerated individuals as well as connections between TBI and behaviors associated with crime (e.g., aggression, emotional liability, disinhibition, violence, impulsivity). The goal of the present study was to examine if similar patterns could be noted in a sample of NFL players; however, there was no relationship between concussion and violent crime in the present sample. While this present study does not support the relationship between TBI and violence, it does warrant further investigation.

Although there was no relationship seen in the current study, further research is needed given the various limitations of this study. Furthermore, the lack of relationship seen between repetitive concussions and violence in NFL players does not decrease the importance of focusing on head trauma in athletics. There should be increased emphasis on player safety as well as increased support available to players and their families to help minimize or manage any potential long-term consequences of the injuries and head trauma experienced during their professional football careers. Recently, the NFL has been placed under increased scrutiny given the reported prevalence of CTE among professional football players. This has increased the NFL's attention to both prevention and management of concussions and brain health. However, there continue to be large holes in the present concussion policy, including the lack of documentation and monitoring of subconcussive hits. There also continues to be concern regarding the accuracy of reported concussions and the complete reporting of such injuries by players and teams. It is essential for continued research to investigate potential long-term consequences of repetitive concussion and TBI, including potential associations with increased

risk for violence, and to consider essential policy changes within various organizations, including the NFL, as well as better informed treatment for the general public as well. Though we know repetitive concussion and severe TBI can have long-term consequences, more clarity can be gained from research, which can lead to ensuring proper treatment and increased quality of life following such injuries.

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