Integrative Review: Head Injury and Violence in Football Players

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Integrative Review Part II: Head Injury and Violence in Football Players

American football, created as a hybrid of rugby and soccer, has been dangerous from the beginning. In the late 1890s, it was not uncommon to read newspaper headlines of players dead on the field. In 1906, physicians at Harvard College even published an article standing against the sport, particularly highlighting the risk of "concussion of the brain" (Harrison, 2014).

Since that time, the world has recognized the risk of head injury that is associated with American football. When the National Football League (NFL) was started in 1920, the league utilized soft leather helmets as protection against concussion. The NFL has continuously worked on improvements in protective head gear, progressing from soft to hard leather, to plastic helmets, adding face masks in 1962, air pockets in 1970, and polycarbonate shells in the 1980s. They continue to improve helmets through their Head, Neck, and Spine Committee (National Football League, 2015).

More recently, football players seem to be in the spotlight for committing violent crimes. O.J. Simpson was charged with murder and convicted of robbery at gunpoint. Alonzo Spellman terrorized a commercial flight, forcing an emergency landing. Ray Lewis was indicted for murder (USA Today, 2015).

The purpose of this integrative review is to explore the relationship between head injury and violence in football players. The hypothesis is that some of the violent behavior seen in football players is caused by head injury (to include concussion, traumatic brain injury, and chronic traumatic encephalopathy). If this hypothesis is correct, it will have implications for nursing, medicine, the criminal justice system and football programs across America. Any predictor for violence that can be identified will lead to new prevention strategies. A specific cause for violence such as head injury could open up many convicted criminal cases for re-investigation. Violent offenders could suddenly be released from blame due to their head injury. In addition, football leagues will need to work even harder to prevent

head injury in football players of all ages. The guiding question for this integrative review is: Does head injury in football players contribute to violence later in life?

Search Strategies

In order to locate research on the topic, Google Scholar, PubMed, Ovid, and Medline were consulted, limited to the English language. All three key terms "violence," "head injury," and "football" failed to return results when used together. "Head injury" and "football" yielded many results. "Head injury" was also replaced with "concussion," "traumatic brain injury," and "chronic traumatic encephalopathy," which also yielded results with football. The combination of "violence" and "head injury" (with the same synonyms) also returned numerous results. There were no research articles relating football and violence. (It should be noted that when a non-scholarly search is performed online, there are numerous writings on the topic. However, it seems that the professional research community has not yet connected the two terms for scientific progress.)

Initially, results were limited to data within the past five years. However, this did not produce as many articles as expected. Since the purpose of this review is to describe a relationship that has existed for over a hundred years, it was decided that older research connecting head injury to violence would likely still be valid. Therefore, articles were accepted from the past fifteen years.

Google Scholar produced numerous articles with the various combinations of search terms. Since this search engine pulls data from across the globe with any hint of connectivity to the terms, most of these articles were not truly related to the topic and not suitable for review. PubMed, however, limited the search to less than one hundred articles with either the combinations of head injury and violence or football and head injury. After selection of articles from search engines, references within each article were reviewed, which lead to several more articles that were fit for inclusion.

In order to fill the gap left by researchers who have not specifically connected football and violence, articles were selected that can lead the astute reader to connect the two terms. First, articles were selected which confirm the well-established fact that football can cause head injuries. (There were no articles disputing this argument). Next, articles were selected that study the relationship between head injuries and violence. If playing football can cause specific head injuries, and those types of head injuries can separately be shown to contribute to violence, then one can logically conclude that football-related head injuries can also contribute to violence.

In the end, fifteen articles were chosen for review. These articles were the only full-text pieces that directly described the relationships between the terms searched. Articles were only discarded if they did not contribute to the purpose of this review.

Summary of Research

The articles included can be divided into two main themes. The first set of articles focus on research that shows the association between playing American football and the rates of head injury, including concussions, traumatic brain injury (TBI), and chronic traumatic encephalopathy (CTE). These authors consistently found playing football to be a risk factor for head injury. Each heading below reflects the title of the article reviewed.

Head Impact Exposure in Youth Football. The objective of this study was to quantify the number of head impacts that occur per football player in the youth population. The researchers attached accelerometer array equipment to the helmets of seven players age seven to eight years old. A total of 748 impacts were measured during the season (to include both games and practices), which averages to 107 impacts per player (Daniel, Rowson, & Duma, 2012). These results are significant in that they reveal the high frequency of head impacts, each of which has the potential to cause head injury. As

youth football players are a much larger population than collegiate or professional players, it is especially important to focus on head injury prevention at this level.

Head Impact Exposure in Collegiate Football. The purpose of this study was to quantify head impacts in the collegiate football player population. A total of 286,636 head impacts were recorded for 314 players over three seasons (Crisco, Wilcox, Beckwith, Chu, Duhaime, Rowson, Duma,Maerlender, McAllister, & Greenwald, 2011). In order to compare this to the previous article in youth players, this author divided the total of impacts by the players and seasons, to get an average of 304 head impacts per season, per player. In addition, this study revealed that although quarterbacks in collegiate football have the most severe levels of impacts, defensive linemen, offensive linemen, and line backers have the most frequent head impacts (Crisco, et al, 2011). In regards to the overall topic of head injury and violence, these findings lead this author to wonder if any of these positions (most severe QBs or more frequent DL, OL, and LBs) are more associated with violence over the others.

Frequency and Location of Head Impact Exposures in Individual Collegiate Football Players. The researchers of this study aimed to find not only the frequency of head impacts, but also the location of the impact in collegiate players. There were 188 players studied from three college teams. Their helmets were equipped with the Head Impact Telemetry (HIT) system to measure impact exposure. They found that a player can have as many as 1400 head impacts in one season. In addition, the highest percentage of impacts occurred at the front of the helmet. Furthermore, the average number of impacts per game was three times higher than impacts per practice (Crisco, Fiore, Beckwith, Chu, Brolinson, Duma, McAllister, Duhaime, & Greenwald, 2010). This study helps us to quantify the risk of head injury associated with playing football.

Incidence of Concussion during Practice and Games in Youth, High School, and Collegiates. These authors take the topic to the next level by looking not at the number of head impacts that can

potentially lead to injury, but at the number of head injuries themselves. Specifically, this study focuses on concussions per level of player: youth, high school, and collegiate. “N” is measured as an “athlete season,” taken from 2012 and 2013 football seasons. There were 4,092 youth, 11,957 high school, and 4,305 college athlete seasons studied. Data on concussions was entered by the athletic trainer for each team in the Sports Injury Monitoring System. Results indicated that concussions accounted for 9.6% of all youth injuries, 4.0% of high school, and 8.0% of all college injuries. In addition, the authors found that at all age levels, concussion rates were significantly higher in games than in practice sessions (Dompier, Kerr, Marshall, Hainline, Snook, Hayden, & Simon, 2015). These results reveal a large number of head injuries occurring each year as the result of American football. Based on their numbers, the authors estimate that as many as 182,000 players nationwide sustain a concussion annually (Dompier, et al, 2015). Despite all of the progress that has been made in helmet development over the years, these results point to the significant need for head injury prevention in modern football.

Participation in Pre-High School Football and Neurological, Neuroradiological, and Neuropsycholocial Findings in Later Life. The authors of this study sought to discover if earlier age of exposure to playing football would increase the risk of neurocognitive impairment later in life. They studied forty five retired National Football League (NFL) players under the age of sixty by taking a demographic history, MRI scans, and completing several instruments such as the Beck Depression Inventory, Mini-Mental State Evaluation (MMSE), and the Wechsler Adult Intelligence Scale. They analyzed the results with multiple regression models. These results indicated that there was not an association between earlier age of start and neurocognitive impairment in retired NFL players (Solomon, Kuhn, Zuckerman, Casson, Viano, Lovell, & Sills, 2016). However, it is important to note than any NFL player would likely have years of experience with the game, as the NFL usually requires collegiate experience, and collegiate teams usually require high school experience. Future research should replicate the study in various populations and take into account the number of years playing the game.

Chronic Traumatic Encephalopathy in Athletes. The last article regarding head injury caused by football exposure is a case study of forty seven confirmed cases of Chronic Traumatic Encephalopathy (CTE) in athletes, only one of which was a football player, (McKee, Cantu, Nowinski, Hedley-Whyte, Gavett, Budson, Santini, Lee, Kubilus, & Stern, 2009). CTE is brain damage caused by smaller, repetitive blows to the head. Diagnosis can only be confirmed upon autopsy (Gavett, Stern, & McKee, 2011). Of the forty seven cases in the McKee, et al, study, thirty two cases experienced personality or behavior changes, thirteen experienced irritability, and twenty two experienced aggression and/or violence as a result of the CTE. Specifically, the football player (case number one of forty seven) initially exhibited changes memory & speech, followed by personality/behavior changes, agitation, cognitive changes, memory loss, dementia, movement abnormalities, and Parkinsonism (McKee, et al, 2009). The significance of this article is that it not only confirms that the brain can be damaged from repetitive closed head injuries (such as the repetitive head impacts experienced by football players), but also that these damages can specifically lead to personality changes in a majority of cases and aggression/violence in almost half of the cases studied.

This article serves as an introduction to the next half of the studies reviewed. The following articles show the impact that head injury can have on the brain. They investigate the relationship between head injury and violent crime. This research will establish that the presence of head injury is a risk factor for violence later in life.

The Association between Mild Traumatic Brain Injury History and Cognitive Control. The authors Pontifex, O'Connor, Broglio, and Hillman (2009) assessed cognitive control in individuals with (N=30) and without (N=36) a history of concussion. Instruments included performing a cognitive control task while recording electroencephalographic (EEG) activity. Data was analyzed with one-way ANOVA. Findings indicated that mTBI history was associated with deficits in task performance and neuroelectric

measures of cognitive control (Pontifex, et al, 2009). The limitation of this article for clinical practice is that the task chosen was not indicative of how the deficit would impact the participants' daily functioning.

Association of Interpersonal Violence with Self-Reported History of Head injury. Stoddard and Zimmerman (2011) studied 850 youth over eight years into young adulthood in order to investigate interpersonal violence in those with head injury compared to those without head injury. Data was collected through sixty minute face to face interviews and follow-up paper and pencil questionnaires, and reviewed with one-way analyses of variance and multivariate regression analyses. After controlling for other significant factors (race, gender, drug & alcohol use, & violence observation in past), the authors found that head injury was a predictor for interpersonal violence (Stoddard & Zimmerman, 2011).

Brain Injury and Violent Crime. Turkstra, Jones, and Toler (2003) begin their article by acknowledging that there is an association between traumatic brain injury (TBI) and crime, which has been believed to be caused by damage to the frontal lobe in the brain. They hypothesize that the prevalence of TBI will be higher in subjects who have criminal conventions than those in a control group. They compared 20 African American males with violent crime convictions to 20 African American males with no convictions of violent crime. Oral and written questionnaires were administered and logistic regression performed as an analysis of data. Results showed no significant difference in the presence of TBI among the two groups, but the authors did note that the violent criminal group had more severe injury than the non-violent group (Turkstra, et al, 2003). Although these results contribute knowledge to the link between head injury and violence, there are several significant limitations to note. Results do not have high generalizability due to the small sample of only African Americans, which in general have a higher rate of crime than the majority of Americans.

Blows to the Head during Development can Predispose to Violent Criminal Behaviour. The authors of this study hypothesize that "individuals predisposed to violent behavior sustained, on multiple occasions, blows to the head during their development, resulting in neurological damage" (Leon-Carrion and Ramos, 2003). Forty-nine male prisoners from a single penitentiary in Spain were divided into two groups of those that had committed violent crimes (N=36) and those who had committed white collar, non-violent crime (N=13). During individual interviews the participants completed an epidemiological questionnaire. Reliability of the instrument was high and factor analysis was used to ensure validity. Findings indicate that both groups had behavioral and learning problems while at school with no significant difference, so this alone was not predictive of violent behavior. However, when added with previous non-treated head injury, the three part combination was the highest predictor for violent type of crime (Leon-Carrion and Ramos, 2003). The authors did not study whether or not treatment of the head injury at the time of the event changed the risk. Therefore, this is a direction that should be pursued in future research.

Association of Traumatic Brain Injury with Criminality in Adolescent Psychiatric Inpatients in Northern Finland. Luukkainen, Riala, Laukkanen, Hakko, and Rasanen (2012) chose a sample of 508 psychiatric inpatients in Northern Finland. They aimed to discover whether TBI in childhood would predict early-onset criminality. Data was collected from national registries: the Finnish Hospital Discharge Register for diagnosis of TBI, and the Finnishish Legal Register Center for criminal acts committed at age 15 and later. Logistic regression analysis and Pearson's Chi-Square tests were performed with the data. The results indicate that 53.8% of TBI patients had a history of criminality, whereas only 14.7% of adolescents without TBI showed criminality. The likelihood of a patient with TBI committing a violent crime was 5.9-fold as compared to those without TBI, after controlling for gender, age, family type, and employment status of parents (Luukkainen, et al, 2012). The strength of this study is that the registries cover all of Finland, therefore including all cases of hospital-treated TBI. Therefore,

this study fills the gap left by the previously reviewed article “Blows to the Head during Development can Predispose to Violent Criminal Behaviour,” which only investigated non-treated TBI.

Risk of Violent Crime in Individuals with Epilepsy and Traumatic Brain Injury. This study used the Swedish population registers from 1973 to 2009 to examine the relationships between epilepsy (N=22,947) and traumatic brain injury (N=22,914) with that of violent crime (defined to include homicide, assault, robbery, arson, sexual offense, and threats or intimidation). They case matched individuals from the same database without epilepsy and without TBI as control groups (N=229,118). Power calculations were performed. Findings indicated that although there was no association between diagnosis of epilepsy and committing a violent crime, there was a significant (5.8%) risk increase for violent crime in those with diagnosed TBI as compared with the general population. They state that 9% of those diagnosed with TBI had violent convictions after diagnosis (Fazel, Lichtenstein, Grann, & Langstrom, 2011). The strength of this study is the large sample size and use of nation-wide data.

Traumatic Brain Injury in a County Jail Population. These authors began their research by interviewing sixty nine inmates to determine presence of TBI. Participants were then narrowed into twenty five with TBI and twenty five without TBI (control group) to compare cognitive and emotional differences. Results showed that 87% of all subjects interviewed (N=69) reported a history of TBI. The group with TBI had higher anger and aggression scores, poorer cognitive performance, and a higher prevalence of psychiatric diagnosis as compared to the control group (Slaughter, Fann, & Ehde, 2003).

Self-Reported Traumatic Brain Injury in Male Young Offenders. The next article investigates the rate of self-reported TBI in male youth offenders in the United Kingdom. One and eighty six offenders age 11 to 19 were individually interviewed face to face, administered the Index for Violence Offending (IVO), and given £4 for participating. ANOVA data analysis showed a significant effect, with 65.1% of offenders reporting a TBI in their lifetime. The authors concluded that greater number of TBI was

associated with greater number of convictions (Williams, Cordan, Mewse, Tonks, & Burgess, 2010). Limitations include no use of medical records and no control group. However, the authors cite several older studies with similar conclusions, which is strength and support for their work.

Self-Reported Traumatic Brain Injury and Postconcussive Symptoms in Incarcerated Youth. The last study identifies its purpose as defining the relationship between the frequency and severity of self-reported TBI and post-concussion symptoms (PCS) in incarcerated youth. The authors quote previous research that states the prevalence rate of any TBI in offenders to be between 65 and 87%, and uses this as their motivation for continued research on the topic. A between-subjects design was used to study 61 male juvenile offenders age 16-18 years. Respondents were interviewed and administered the Rivermead Post-Concussion Symptoms Questionnaire (RPSQ) and an Index of Violent Offending (IVO). Analysis of variance was used on the data. Results indicated that 72.1% of offenders reported any head injury in their lifetime, with 41% of all offenders reporting loss of consciousness associated with the worst of their head injuries. It was found that 88.5% of all participants had at least one violent offense conviction. These results were significant to report TBI as a predictor for violent offense convictions (Davies, Williams, Hinder, Burgess, & Mounce, 2012).

Tabular Presentation of the Research

The table in Appendix A shows a complete list of articles reviewed by author with design, sample, analysis, findings, strengths, and limitations.

Research Synthesis

Common Findings. The first six articles describe the relationship between playing football and head injury. All of the articles agree that head injury is a risk of playing football, and most of the articles aim to describe which positions and age groups pose the greatest risk of injury. The last nine studies

explore the relationship between head injury and violence. All but one of these articles connected head injury with an increased risk for violence. The one study that did not show significant results in this area was a poorly designed study due to lack of generalizability.

The purpose of this piece is to examine the relationship between football related head injuries and violent crime in football players. Although though there is no research on this exact topic, this text has examined multiple studies that show that playing football is clearly a risk factor for head injury. In addition, many articles cited have shown that multiple types of head injury can be considered risk factors for violence. Therefore, it is reasonable to conclude that head injuries obtained while playing football can also be considered risk factors for violence in those players.

Theoretical and Conceptual Issues. The articles presented in this piece were conducted in the fields of biomedical engineering, athletic training, pediatric medicine, sports medicine, neuropathology, neuropsychology, and psychiatry. There were no studies available in the field of nursing. Therefore, no individual study was designed with nursing theory in mind. However, the information discovered by the many contributors will be very useful to nurses in the future. Nurses should have no trouble using this data within the context of their chosen theory.

The best example of this is Mary Jane Smith and Patricia Liehr's Story Theory. These theorists argue that at some points, the raw numerical or physiological data is most urgent, but at other times the person's story is more urgent (Smith & Liehr, 2010). Consider the case of an individual with severe TBI who commits murder. The fact of the situation is that the individual committed murder, which may lead many individuals to condemn that person to prison. However, the nurse using Story Theory may form a timeline to discover that the individual never had violent tendencies until after the brain injury. That nurse may determine that the violence is a result of an illness, and therefore may decide that treatment

would be more beneficial than imprisonment. Without the full story, the fate of this individual would be very different.

Another nurse may prefer to operate under Myra Levine's Conservation Model. In this model, the nurse's role is to promote adaptation and maintain wholeness. The nurse uses the principle of conservation, which seeks a balance of energy within the unique biological capabilities of the individual (Schaefer, 2010). A nurse using this theory would interpret the presented research and understand that an individual with a TBI may no longer function at his/her previous level. This nurse would care for the client by promoting adaptation to the new situation. For example, if a client with a TBI is prone to violence, the nurse may help that client identify triggers for anger and tools that may be used to reduce that anger.

Operational Definitions. It is most important to understand the uses of the terms "head impact" and "traumatic brain injury" or TBI, as they are used frequently in the research. The term "head impact" is used in the first three articles. All three articles use this term to indicate any blow to the head, with varying degrees of intensity. Their purpose is to establish that head impacts are a risk for head injury. There are several types of head injuries used in the subsequent articles. Two of those are concussions and chronic traumatic encephalopathy. Both of these are medical terms with one accepted medical definition. The last, and most frequently used, type of head injury is "traumatic brain injury." This is the term used in seven of the nine articles that associate head injury as a risk factor for violence or violent crime.

A search of ICD 10 codes for "traumatic brain injury" revealed the following options: S06 Intracranial injury, S06.0 Concussion, S06.1 Traumatic cerebral edema, S06.2 Diffuse traumatic brain injury, S06.3 Focal traumatic brain injury, S06.4 Epidural hemorrhage, S06.5 Traumatic subdural hemorrhage, S06.6 Traumatic subarachnoid hemorrhage, S06.8 Other specified intracranial injuries, and

S06.9 Unspecified intracranial injury (World Health Organization, 2016). This reveals many possible options for use of the term TBI. In according with this, most of the articles leave the term open to include many types of head injury. Several of the articles (Luukkainen, et al, 2012; Davies, et al, 2012;) specify that TBI can include concessions and other head injuries. Williams, et al, (2010) preferred to study TBIs that specifically experienced loss of consciousness with the injury. Others (Stoddard, et al, 2011; Turkstra, et al, 2003; Leon-Carrion, et al, 2003) simplified matters by studying any and all head injury as associated with violence.

Instruments. The most commonly used instrument among the studies for measuring head impact exposure was the HIT system, which is specifically designed to measure head accelerations (Crisco, et al, 2010; Crisco, et al, 2011). This instrument has a high reliability rating. Two of the studies (Fazel, et al, 2011; Luukkainen, et al, 2012) used national databases of injury and crimes, which not only had excellent reliability, but led to a large sample size from the entire countries' populations (Finland and Sweden).

In almost all of the studies, data on history of TBI was self-report. Authors did not consult medical records, but relied on the sample participants to recall whether or not they had ever had a head injury. There are no reliability scores available for this method of data collection in any of the studies. Schofield, Butler, Hollis, and D'Este examined this subject in 2011, with their paper entitled "Are Prisoners Reliable Survey Respondents? A validation of self-reported traumatic brain injury (TBI) against hospital medical records." The study asked 200 prisoners to report on their history of TBI and compared the responses against their medical records. One hundred and sixty four participants reported a total of 420 separate TBI events. The prisoners went to the hospital (resulting in a reviewable medical record) for 156 of these events. They found that 70% of these reported TBIs were confirmed in medical records.

The authors concluded that prisoners were generally accurate in their self-report of TBIs (Schofield, Butler, Hollis, & D'Este, 2011)

Conclusion

While it cannot be concluded that playing football is an exclusive cause of violence, these articles do show that head injury may be one risk factor in violence. This outcome may have implications for prevention of head injury during football games and practices, for clinicians as it shows greater necessity for immediate treatment of the injury, and for the legal system as it brings to question the guilt of someone who commits acts of violence due to the injury.

This review clearly identifies gaps in the research and the need for future work in the area. The first major gap is lack of specific articles connecting football related head injury and violence. Individual case studies should be performed to see if any of the NFL players with violent convictions can be connected with previous brain injury. Studies with control groups are needed in order to determine if football-related head injury is specifically a risk factor for violence. Identifying risks for violence may prevent future crimes. It is hoped that this piece will contribute towards closing this gap.

Secondly, nurses should be participating in the discussion on this topic. There were currently no articles in nursing that were appropriate for this study, either in football head impacts or in violence caused by head injury. Nurses should join the conversation by providing new research and discovering ways to alter their care in order to meet the needs of the violent TBI patient. One methodology by which this gap and the previous gap could be closed is by nurses conducting a simple descriptive study connecting the number of football player convictions for violent crimes. This could be performed using USA today's NFL arrest database as an initial starting point, with follow-up on each violent case listed (USAToday, 2015).

Finally, research should be performed to study the level of guilt that should be associated with an individual that suffers from TBI and commits a violent crime. In order to research this, a self-awareness scale may need to be developed, as none were available on a precursory search on Google Scholar. The nurse should compare awareness of criminal actions of those with TBI as compared to those without TBI in order to justify future legal actions.

There are serious legal implications that could arise from the findings of this article. It would be unethical for readers to waive guilt of the individual without first researching the violent person's motivations and self-awareness. This piece has shown a clear connection between head injury and violent crime, but it is not able to comment on the individual's awareness of his crimes. This author recommends that each individual be intensely studied on a case by case basis by educated clinicians and legal authorities.

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