

# **Sports Helmet Impacts and their Relationship to Traumatic Brain Injury**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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## **Introduction**

The topic of safety surrounding tackle football has been a long-standing conversation in America dating back to the early 20<sup>th</sup> century. For a sport that is loved by many, the dangers of football have prompted some parents to vow that their kids will never play football. In America, children start playing sports at around 6 years old (Anzilotti, 2019). To start a contact sport at 6 years old and continue that throughout youth sports up until college or professionally, is subjecting a person to over a decade of tackles and potential brain damage. According to University of Pittsburgh Medical Center (UPMC) concussion statistics, approximately 300,000 sports-related concussions per year are from football with 5 out of 10 concussions going unreported or undetected (UPMC, 2023). To protect against possible traumatic head injuries, football equipment, specifically helmets, has evolved to adapt to the physicality of the game. Other changes throughout the game include rule changes and assessing the impact of different playing surfaces. This paper will help assess some of the health consequences of football, equipment effectiveness, and playing surfaces which begs the question of what is being done to make football safer for upcoming generations.

To answer the previous question, the use of journal articles, previous research, and data analysis will be used to explore where safety measures have been improved and where they fall short. Through literature review, this paper will employ a sociotechnical analysis of the main impacts associated with helmets and the community they aim to protect. A great source of this information comes from the NFL (National Football League) itself which has accessible information on injury data and updated rule changes. With the NFL being the highest level that football is played, it is important that set the precedent for player safety as it influences NCAA football all the way down to youth football leagues. Other sources will be used to dive deeper into

the technology behind helmets, playing surfaces, and injuries. The theoretical framework that suits this research is Actor-Network Theory (ANT) to define the relationships between the many actors that make NFL player safety possible. Actor-Network Theory is a theoretical framework in which the networks and relationships between actors/human interaction are constantly shifting and being influenced by others (Rodger, 2009). The book *No Game for Boys to Play* (Bachynski, 2019) helps identify numerous roles, especially sporting goods manufacturers, that have a major effect on the safety of football. A lot of actors contribute to player safety, some of which include the National Football League (NFL), helmets, helmet designers/manufacturers, rules and regulations, medical professionals, fan bases, and the players.

### **Background and Significance**

The ‘concussion crisis’ is a term that dates back to the early 1900s and was meant to characterize the commonality of concussions and the physicality of American Football. This term is still popular today as the NFL has been considered to be in a concussion crisis since the 1990s. The concussion statistics for the NFL continue to increase or stay within an average year after year. A lot of these concussions come from helmet-to-helmet or helmet-to-ground impacts. Concussions and other traumatic head injuries (THI) have the potential to have lasting negative health impacts on these athletes and with sports starting at such a young age, it puts a lot more athletes at risk for multiple head injuries throughout their playing careers. With a consistent history of head injuries, a sport like football should explore every way possible to protect the people that generate massive revenue for the sport.

Football is a game played on all levels with the NFL being particularly popular in the United States. Even though hard hits and traumatic injuries have always been a part of the sport, more attention is drawn to them when fans and spectators have easier access. With increasing

access to social media and technology, such as instant replays, these hard hits are more commonly being plastered across the internet. It isn't uncommon to see a few hard hits in a week on an app like Instagram or Twitter. An accumulation of these videos brings on the cause for public concern that stems beyond medical professionals. A recent example of this was Tua Tagovailoa, quarterback for the Miami Dolphins (Staff, 2023). In September 2022, Tagovailoa was in the spotlight due to a head injury suffered in a game on the 25<sup>th</sup> and then proceeded to play on the 29<sup>th</sup> where he was sacked and laid motionless on the field, later being diagnosed with a concussion. The clips of him being hit were going viral on Twitter along with the concern from the public about his health. This situation led to an investigation of medical staff and an almost immediate modification in concussion protocol (Staff, 2023).

Concussions have been shown to be the leading cause of Chronic Traumatic Encephalopathy (CTE) which is a progressive brain condition caused by repeated blows to the head and repeated concussions (Gardner et al., 2013). The repetition of these blows over a long period of time can lead to mental conditions such as depression, dementia, and other erratic behaviors. Some sufferers of CTE have gone on to commit suicide due to erratic behaviors masked as CTE. Traumatic head injuries (THI) can affect athletes at any age and the accumulation of THI can lead to lasting neurological issues. In Eaton (2020), the legal limitations for CTE lawsuits are defined and explained a statute of limitations that I disagree with for CTE cases. Since CTE is a condition that cannot be diagnosed until death, how can one pinpoint the specific head injury that caused the condition? A recent case that got a lot of attention included Aaron Hernandez, the NFL, and almost reached the NCAA and Florida State University, the college he attended. Aaron Hernandez was a former New England Patriots tight end, convicted murderer, and sufferer of Chronic Traumatic Encephalopathy (Benson, 2017). In April of 2017, Hernandez committed

suicide in his prison cell and an examination of his brain revealed one of the most severe cases of CTE seen in a 27-year-old. Hernandez showed symptoms of CTE when he was alive with violent, erratic behavior associated with the degenerative brain disease. After his death, Aaron Hernandez's estate filed a lawsuit against the NFL claiming that they knew that repeated traumatic head injuries could lead to brain disease yet didn't do enough to protect him. This case brought a lot of attention to CTE and the effects it has on football players while playing and in retirement.

With all that being said, what is being done to reduce the risk of traumatic head injuries in football? Is it enough?

## **Literature Review**

The most important piece of equipment in football is the helmet. Helmets are the piece of equipment that protect and shield players from several different types of impacts including helmet-to-helmet, helmet-to-body, and helmet-to-ground. To ensure how effective a helmet is, Collelo et al. (2018) acknowledges the helmet safety-rating system that was developed in 2011 and used this system to accumulate data on about 1000 NFL players from the 2015-16 and 2016-17 season. The data showed that a wide range of helmets that varied in safety ratings were used, concluding that players that wore a lower safety-rated helmet were more likely to experience a concussion than those that wore a higher safety-rated helmet. Furthermore, it was noted that players that suffered a concussion during the 2015 season did not opt to change to a higher safety-rated helmet in the following season. Collelo et al. (2018) did a great job using the safety-rating system to support their claim of making the NFL mandate that players wear a high-rated helmet to reduce concussions. Published in the Journal of Neurotrauma, this journal article about assessing NFL policy regarding types of helmets allowed on the playing field provides relevant data to support the effectiveness of helmet types for player safety. To further support the effect of wearing a newer,

higher-ranked football helmet versus an older, lower-ranked helmet, Diekfuss et al. (2021) completed pre and post-season imaging of high school football athletes in which about half wore a high-ranked helmet during the season while the other half wore a low ranked helmet. The data yielded that wearing a higher-ranked helmet is effective in preserving the white matter, which is found in deeper tissues of the brain, from traumatic head impacts. The purpose of this journal article, published in the *Annals of Biomedical Engineering*, is to evaluate the effectiveness of helmet designs with newer technology compared to older helmet models. Unlike Collelo et al. (2018), this article offers the effects for a different demographic which can be argued that it has less control over player safety due to less sophisticated resources compared to the NFL.

Another factor that contributes to head injuries in football is the surface on which the game is played. A review article published in the *Journal of American Academy of Orthopedic Surgeons* (AAOS) offered good insight into the effects of synthetic playing surfaces on the health of athletes. Since the emergence of artificial playing surfaces, research has been done to assess their impact on athletic performance. Data has shown that artificial surfaces, such as turf, produce greater potential for concussions (Drakos, 2013). This source provides an extensive history on artificial surfaces along multiple injury areas including foot/ankle, skin infection, carcinogenic risk, and concussion. Drakos et al. (2013) states that although player-to-player contact is the most common source of concussions, contact with the playing surface accounts for about 15.5% of concussions. This source provided reliable information regarding the role of playing surfaces on concussions and offered broad knowledge of other injuries that are heightened on artificial playing surfaces. To counter Drakos et al. (2013), a source that gave more insight into natural grass fields was needed. In an article published in *The Journal Trauma: Injury, Infection and Critical Care*, research was done to compare an indoor artificial turf practice field, an artificial turf field in a domed

stadium, and an outdoor grass practice field. According to Naunheim et al. (2002), the results of this research showed that the hardest surface was the artificial turf field in the domed stadium compared to the indoor artificial turf and the outdoor grass field. This source provided a comparison of three different surfaces unlike Drakos et al. (2013) which focused on two. A downside about this source and sources similar is that they aren't as relevant to today's sporting climate due to the research being done dating back 20 years.

Lastly, rule changes are important in regulating and protecting the safety of athletes by implementing a feature that has to be followed by everyone. The targeting rule was erected in response to the ongoing issue of concussions. According to Nfl.com (2018), over 50 rule changes have been made since 2002 to reduce the risk of injuries and other potentially dangerous tactics that players tend to do. In addition to this, Staff (2023), states the modification of NFL concussion protocol to enhance the safety of players. The NFL itself is a good source for data that comes from football being played at the highest level. It is also reliable for rule changes being made in real-time, especially in response to high-profile situations. The targeting rule forbids initiating contact with the crown of a helmet and targeting defenseless players in the head and neck area (Westermann, 2016). This source did well at explaining the targeting rule and the problem it intended to solve while addressing the unintended effects of a possible increase in injuries to the lower extremities of athletes.

## **Results**

After reviewing literature and previous research regarding helmets, playing surfaces, and rule changes, each actor has contributed to increased safety in their own ways. The main improvement noted for helmets is the newer, higher-rated helmet models that have emerged over the years. These helmets have shown positive results in concussion feedback but show a lack in applicability without it being a league-mandated requirement (Collelo, 2018). The safety rating system, implemented in 2011, is a great tool being used to assess the safety and reliability of new helmets and their effectiveness on the field, contributing to an increase in player safety. Each source also revealed different areas in which helmet impacts are tested in relation to brain injuries. These methods ranged from testing white-matter pre and post-season to documenting the number of concussions received by a player in a specific helmet that season and seeing if they opt for a safer helmet next season or not. Extensive research, design, and manufacturing have gone into making helmets, the first line of protection, as safe as possible.

Assessing the playing surface that football is played on in relation to helmets and traumatic head injuries seems to be an area that can use more research. Going through sources, there was no consistent consensus on whether grass playing fields are definitely safer than artificial turf when it comes to concussions. An important aspect to keep in mind when assessing a playing surface is the material that lies under it. Artificial turf fields can be put in over material such as gravel, concrete, geotextile mats, or a crushed rock base. Different materials contribute to different abilities to absorb the shock that a player would experience when hitting the ground. To help the issue, it is suggested that impact testing be done regularly on these surfaces (Drakos, 2013). Notable research performed by Naunheim et al. (2002) showed that the artificial turf field within a domed stadium produced the highest peak Gs for impacts compared to an outdoor grass field and an artificial indoor turf field. This can be applied to the NFL's current makeup in assessing teams

practice and playing surfaces and how they may contribute to concussion statistics. The sources gathered on playing surfaces and their effects on the health of athletes showed conflicting opinions on what is considered the safest. As a result of this, it might be suggested that more research should be conducted to form a comprehensive conclusion on if grass playing surfaces have less of an impact on helmet-to-ground contact than artificial playing surfaces. It is noted that despite the risk of injury that may come with playing on artificial surfaces, they remain attractive to athletes and administrators due to their durability, relative ease of maintenance, and the potential for multiple uses (Drakos, 2013).

The NFL has shown the ability to make modifications to concussion protocol in a prompt manner. As mentioned before, following the investigation into the handling of Tua Tagovailoa's back-to-back head injuries, the NFL terminated the unaffiliated neurotrauma consultant involved in the initial concussion check and proceeded to update the concussion protocol. Specifically, the update will rule out players who exhibit gross motor instability regardless of any possible contributing factors (Staff, 2023). Decisions like this have proven to be made with the safety of the player in mind with a more observable change being the erection of the "targeting" rule, which also punishes the player to not only protect players but also deter repeated offense. The targeting rule makes the player think in real time about how they are going into a potential tackle.

Through an extensive literature review, the relationship between sports helmets and traumatic head injuries were able to be identified and defined by focusing on three main actors: helmets, playing surfaces, and rule changes. By breaking down these actors, literature review helped identify the multiple parties affected by traumatic brain injuries and how over the years, the sport has changed to accommodate the increasing physicality. The sociotechnical implications of this research show that it takes multiple actors to reach the common goal of making football

safer, from the technology behind the helmets to the opinions of medical professionals, along with the current and future well-being of the players. The question of safety in regard to football impacts individuals, specifically athletes, on a personal, community, and organizational level. By connecting these actors to each other, it is clear that all of their roles intertwine and have a profound influence on player safety. Broader implications for this literature review include recognizing the shortcomings of player safety that are evident in the current climate of the NFL, NCAA, and amateur football leagues in order to make the game safer. This literature review can also lead researchers in their prospective specialty, whether that be the science behind playing surfaces, helmets, or brain injuries, to collaborate with the common goal of safety in mind. Collaboration fosters creativity which can lead to new technologies to improve player safety. Lastly, improving player safety in football can lead to changes in other sports with similar equipment or physicality.

## **Conclusion**

By assessing the relationship between helmet safety and traumatic head injuries in football, it allows for the reevaluation of safety standards, equipment, and playing surfaces. The overall safety of athletes, amateur and professional, is important to ensure the progression of the sport. The area that is experiencing the most progress is helmet designs and manufacturing to make newer, high-ranked helmets that should be mandated league-wide so that the baseline standard for helmets is of high quality. Addressing the new rules implemented to protect players allows us to recognize the benefits and the downsides of new rules despite adverse reactions that may come from the players. Playing surfaces remain an area that should be explored more in order to have a better contribution to the concussion crisis. In reference to helmets and playing surfaces, looking at these actors on a more structural level can help researchers, medical professionals, and helmet

manufacturers alike to improve the structure of helmets and playing fields to promote a safer sporting experience.

Helmets themselves only account for a fraction of the concussion crisis and cannot solely be relied on for a decline in statistics. By including the makeup of football fields and their contribution to the concussion crisis, it allows for a more thorough look into factors that contribute to helmet impacts that cause concussions. Overall, the standards implemented by the NFL should work in the best interest of player safety and that begins with addressing multiple actors contributing to the current concussion crisis. Throughout this paper, what is being done to reduce the risk of traumatic head injuries in football has been made clear, but is it enough? There is always more that can be done and it seems like researchers are doing a lot of work to keep up with the increasing physicality of football in order to ensure the safety of players at all levels.

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