The Effect of Concussions in Professional Sports with a Focus on the National Football League: A Meta-analysis

By Kerri Neville

Abstract:

This study reviews what concussions are, how they affect the brain, and how professional sports, specifically the NFL, put athletes at risk of obtaining traumatic brain injuries. To find this the reasoning behind why concussions are more prevalent in the NFL and the different ways a concussion could happen during different plays to specific positions are examined as well. The long-term effects that concussions have on athletes is permanent and life-threatening, as athletes are getting stronger and faster each year, concussions have been on an upward trend. Revealing the social and physical effects of concussions on professional athletes is a needed meta-analysis that has not been done, there are a lot of studies about concussions in the NFL that reveal different information. By researching this topic and bringing similar data and information from published studies together, there is a stronger report that reveals the truth. This study opens a light to the dangers of football, and sports in general, and provokes a change in the professional sporting policies.

Introduction:

Contact sports have been under scrutiny for endangering athletes. In particular, the National Football League has been in an ongoing class-action lawsuit that is fighting for serious change in the professional football league. Football, along with other contact sports, put athletes at a higher risk for concussions. Concussions are caused by a force to the head that makes that brain rapidly shake. These traumatic brain injuries are extremely serious and a proven to cause life-altering brain damage which can shorten your lifespan. While active athletes are able to receive medical care from the NFL, retired athletes struggle with medical bills and do not receive the proper care that they deserve. NFL athletes put their life's at-risk playing football professionally, the amount of concussions is rising with long-term dangerous and deadly results. Looking into why concussions are growing and why more retired athletes are dying with concussion related illnesses is being investigated in this meta-analysis.

Objective

Concussions are a dangerous injury due to the effects they have. Every concussion is different, symptoms such as headaches, drowsiness, and memory loss may occur right away, or it may take a few days to show up. If a concussion is not fully recovered the results could be fatal (Centers for Disease Control and Prevention, 2017). Repeated brain trauma causes the loss of brain tissue which can result in a disease called chronic traumatic encephalopathy (CTE). Bennet Omalu discovered this disease in 2005 while researching an autopsy of a retired NFL

ledged. Symptoms of CTE include cognitive impairment, mood disorders, parkinsonian

symptoms, severe depression, and dementia. Currently there is no cure for CTE and the only

way to be diagnosed is postmortem. CTE has been found in the brains of 110 out of the 111 NFL

athletes researched. That means that 99% of NFL athletes examined have this devastating,

personality altering disease (Moran, 2017).

Concussions are caused by a significant force to the head, in the sport of football each

play offers multiple opportunities to be hit by a force. This makes football one of the leading

sports in concussions. However, this has always been a part of the game. In recent studies it is

shown that over the years, concussions have become more frequent (J.M. Noble, 2013).

Looking into why concussions have become more frequent relies on the definition of force.

According to Newton, force equals to mass multiplied by acceleration. Each NFL athlete is

required to pass physical fitness testing during their try-out for a team, this is called the NFL

combine. Each athlete's scores are open to the public. Using the record of height and weight to

find the body mass index of each athlete, and the 50-meter sprint as the acceleration factor,

overall force of an NFL athlete can be found.

The body mass index (BMI) of a person indicates how much body fat they have. In

athletes, a higher BMI may not indicate a higher fat content but instead the amount of muscle

in their bodies. Although having more muscle is not considered unhealthy compared to having

more fat, however, muscle is still considered mass. When you have a higher BMI, it is shown

that you will have a longer recovery process when obtaining a concussion (YM Lee, 2016). While

calculating the BMI of athletes, it was found that the majority of athletes are considered obese.

Having a BMI over 30 is considered obese. Most positions have an average BMI of over 30. The

average BMI of NFL athletes in 2017 was 31.11. Throughout the years, the BMI scores per position have not changed drastically (Appendix 1) but are still in dangerously high levels that require more recovery time for concussions.

The speed of an athlete in the NFL is determined through the combine test called the 40-yard dash. This is a timed event where the athletes run 40 yards as quickly as possible. This is a good measurement for the acceleration variable to discover force. The average speed of this test has been decreasing throughout the years. This means that the athletes have been getting faster. This is proven through an analysis of variance. The ANOVA test results (Appendix 2) scored a p-value of <2e-16 which makes this test statistically significant with certainty that the means of speed have changed throughout the years (Appendix). To find the acceleration, the change in velocity must be determined. Velocity equals distance divided by time. When the distance remains constant and the time decreases, velocity increases. Since the change in velocity is increasing (Appendix 3), and the time to complete is decreasing, acceleration increases.

Since there is an increase in acceleration and a constant in mass, the overall force of NFL athlete's increase. Since there is an increase in force over time in the NFL, athletes are now at an increased risk in obtaining concussions than ever before. An increase in force means that there is an increased amount of concussions in the NFL. Due to the evidence that proves an increase in the amount of possible concussions, the next step is finding what happens to athletes after they get these concussions.

Method

A meta-analysis is a type of research paper that uses data from multiple research papers to determine similarities. This is a strong type of research that is beneficial because it removes falsified information. If multiple research papers conclude to similar outcomes, the stronger that research becomes. This is done through a series of data collection and analysis among multiple articles (Arindam Basu, 2017). The NFL tends to attest that the sport does not cause concussions and they are not responsible for the later in life medical issues. This is suspicious and could be providing incorrect information about concussions to the public, which could be putting the health of athletes at risk. This analysis should get to the bottom of how concussions are affecting athletes in the NFL.

While beginning a meta-analysis, the first step is to define a question to investigate. Knowing that there is limited information about specific athletes and their health conditions, due to the Health Insurance Portability and Accountability Act (HIPAA), this question has to be broad. Only general statistical facts about concussions and separate statistical facts about specific positions can be examined. Due to those factors, the question posed is; What is the effect of concussions on National Football League athletes?

The research consisted of looking for NFL concussions articles, along with CTE experiments, and NFL concussion policies. This step requires basic research discover by reading the titles of various papers. From the search, 509 papers with titles that meet the criteria were discovered.

From the 509 papers that were discovered, the articles were narrowed down based on content and reliability. Skimming the abstracts of these articles determined the most suitable

research to use for the meta-analysis. There are now only 19 papers eligible to further investigate through this meta-analysis. Of those 19 papers that aligned with our research question, 5 were scientific research-based papers that contained information based on similar populations. It is important that the population sample is compatible between articles so results can be combined.

Results

The projects were split up into separate studies. One was a meta-analysis to see if concussions caused depression in the future. The other was finding if concussions cause a decrease in cognitive ability in the future. Through the calculation of odds ratio, you can track differences in the data findings for each research paper. Since each paper used the same population, retired NFL players, you can compare the results to measure accuracy. Odds ratio compares the positive outcomes to the negative outcomes in each study. Specifically, it compares the amount of people with and without depression based on if they had or did not have a concussion while playing in the NFL. This properly weighs each analysis based on the sample size, since all of the papers have different sample sizes.

There are 5 research articles in the comparison for becoming depressed after retiring the NFL. An odds ratio of less than one means that the research displays a correlation between concussions and depression, anything over one means the opposite. Each of the 5 articles had an odds ratio of less than .371. This means that the research heavily leans towards the fact that

concussions lead to depression later in life. Appendix 4 displays a graph showing how much these studies agree with each other.

There are 4 research articles that compare the decrease of cognitive ability and concussions. All of the research indicates that concussions do in fact lean toward. The highest odds ratio was .748 which still leans towards the fact that concussions lead to a future decrease in cognitive ability. Appendix 5 displays a graph that shows the results of each article's odds ratio.

Discussion

Ever since Dr. Bennet Omalu began researching the effects of concussion in the NFL, the league has been trying to cover up the severity of medical issues football causes. Omalu was the founder of CTE, a disease that is caused by constant head trauma. Patients who are found to have CTE experience mood changes, like depression, and cognitive disfunction. Through the meta-analysis it is found that there is a significant amount of information linking concussions with depression and cognitive disfunction. The fact that there are multitudes of retired NFL athletes that are depressed and have a decrease in cognitive ability, there could be multitudes of these athletes with CTE, a deadly disorder. Since CTE can currently be found solely by postmortem autopsy, there is no way of telling if they have CTE. Due to this, there is also no known cure or aid for these people.

Instead of the NFL putting money towards CTE research to help their retired athletes get help before they fall victim to CTE, the NFL only funds research projects for concussion

detection and reduction. Although those are also good causes to be researching, it does not care for past athletes, it only benefits the current players.

The league actively denies the existence of CTE. The scientists that the NFL hired for research attempt to disprove her research. They called her research speculative and tried to get research published that downplayed how concussions impact athletes (Union of Concerned Scientists, 2017). There is also proof that the NFL made a scientific journal that would discuss how concussions do not occur in football. "The league used that journal, which some researchers would come to ridicule as the 'Journal of No NFL Concussions,' to publish an unprecedented series of papers, several of which were rejected by peer reviewers and editors and later disavowed even by some of their own authors" (Fainaru-Wada, 2014).

The NFL settled in a lawsuit that cost the league $765 million. This settlement involved 4500 retired athletes that had long-term effects of brain injuries acquired while playing in the NFL (Fortunato, 2015). "The NFL did not have to admit any guilt in the settlement" (Futterman & Clark, 2013). Although retired athletes got settlement money to help with their medical bills, it made a small dent in the NFL's success. The league is a huge industry and still need to find ways to improve the livelihoods of retired athletes.

Conclusion

Concussions are a serious health condition that are leaving retired athletes with long-term effects. With the discovery of CTE, concussions are even leading to death. Due to the effects of depression and a decrease in cognitive function, the livelihood of NFL players post-career is diminished. Instead of figuring out how to make the livelihood of the retired played

better, the NFL tries to diminish the severity of concussions. Since the NFL is only funding

concussions prevention projects, athletes that are already affected are not receiving the

treatment they deserve. The NFL should put more money into funding projects that can

prevent the development of CTE along with finding a way to diagnose before death. As athletes

are evolving, the sport should evolve as well to keep athletics safe, and healthy.

References

Alosco, Michael L., et al. "Utility of providing a concussion definition in the assessment of
      concussion history in former NFL players." *Brain injury* 31.8 (2017): 1116-1123.

Amen, Daniel G., et al. "Impact of playing American professional football on long-term brain
      function." *The Journal of neuropsychiatry and clinical neurosciences* 23.1 (2011): 98-
      106.

Bachynski, Kathleen E., and Daniel S. Goldberg. "Time out: NFL conflicts of interest with
      public health efforts to prevent TBI." *Injury Prevention* 24.3 (2018): 180-184.

Basu, Arindam. "How to conduct meta-analysis: a basic tutorial." (2017).

Casanova, M. P. E., and P. Madeline. "The Fall of the Gladiators: Wives' Tales of Concussion
      Reporting and (Possible) Progressive Neurodegenerative Disease in NFL Players." *The
      Qualitative Report* 24.1 (2019): 1-23

Casson, Ira R., et al. "Twelve years of National Football League concussion data." *Sports
      health* 2.6 (2010): 471-483

Didehbani, Nyaz, et al. "Depressive symptoms and concussions in aging retired NFL
      players." *Archives of Clinical Neuropsychology* 28.5 (2013): 418-424

"Facts About Concussion and Brain Injury." *BrainLine*, 28 Mar. 2019,
      https://www.brainline.org/article/facts-about-concussion-and-brain-injury.

Fainaru-Wada, Mark, and Steve Fainaru. *League of denial: The NFL, concussions, and the battle
      for truth*. Three Rivers Press (CA), 2014.

Fortunato, John A. "The advocacy and corrective strategies of the National Football League:

Addressing concussions and player safety." *Journal of Conflict Management* 3.1 (2015): 7-21.

Frazier, Grant. "Using Your Head: A Different Approach to Tackling The NFL's Concussion Epidemic." *Harvard Journal of Sports & Entertainment Law* 10.2 (2019).

Guskiewicz, Kevin M., et al. "Recurrent concussion and risk of depression in retired professional football players." *Medicine and science in sports and exercise* 39.6 (2007): 903.

Hart, John, et al. "Neuroimaging of cognitive dysfunction and depression in aging retired National Football League players: a cross-sectional study." *JAMA neurology* 70.3 (2013): 326-335

Kerr, Zachary Y., et al. "Nine-year risk of depression diagnosis increases with increasing self-reported concussions in retired professional football players." *The American journal of sports medicine* 40.10 (2012): 2206-2212.

Lee, Young M., et al. "Obesity and neurocognitive recovery after sports-related concussion in athletes: a matched cohort study." *The Physician and sportsmedicine* 44.3 (2016): 217-222.

Noble, J. M., & Hesdorffer, D. C. (2013). Sport-related concussions: a review of epidemiology, challenges in diagnosis, and potential risk factors. *Neuropsychology review*, *23*(4), 273-284.

Normand, Sharon-Lise T. "Meta-analysis: formulating, evaluating, combining, and reporting." *Statistics in medicine* 18.3 (1999): 321-359.

Omalu, Bennet I., et al. "Chronic traumatic encephalopathy in a National Football League player." *Neurosurgery* 57.1 (2005): 128-134.

Ruth, Dave, et al. "BU Researchers Find CTE in 99% of Former NFL Players Studied." *Boston University*, 26 July 2017, http://www.bu.edu/articles/2017/cte-former-nfl-players.

Schwarz, Alan. "Dementia risk seen in players in NFL study." *The New York Times* (2009).

Weir, David R., James S. Jackson, and Amanda Sonnega. "National football league player care foundation study of retired NFL players." *Ann Arbor: University of Michigan Institute for Social Research* (2009).

Yengo-Kahn, Aaron M., et al. "Concussions in the National Football League: a current concepts review." *The American journal of sports medicine* 44.3 (2016): 801-811.

Zhang, Yanjie, et al. "Long-term cognitive performance of retired athletes with sport-related concussion: a systematic review and meta-analysis." *Brain sciences* 9.8 (2019): 199.

Appendix

Appendix 1:
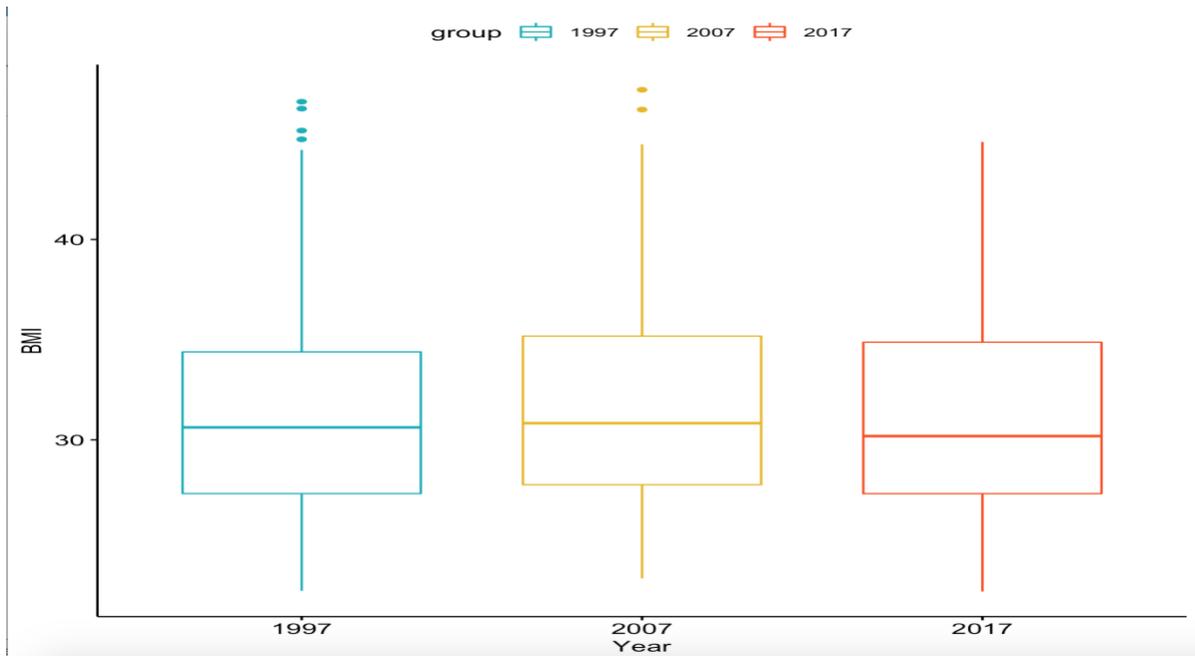
Appendix 2:

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> summary(aov(yarddash$YARDDASH~yarddash$YEAR))
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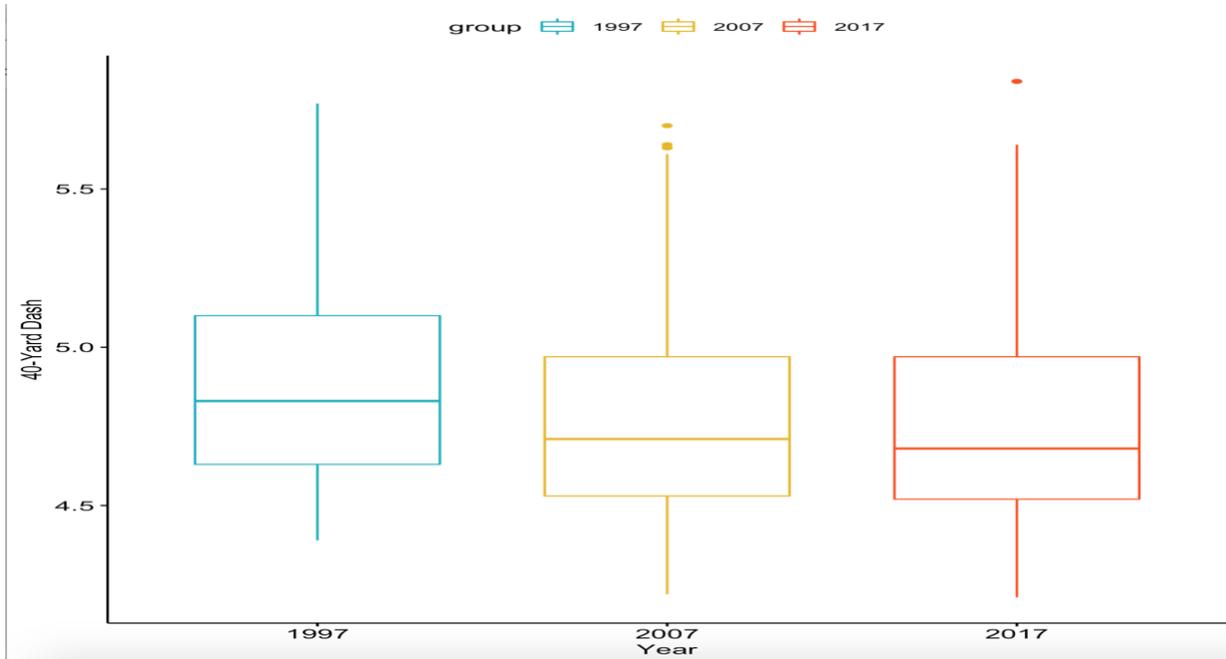
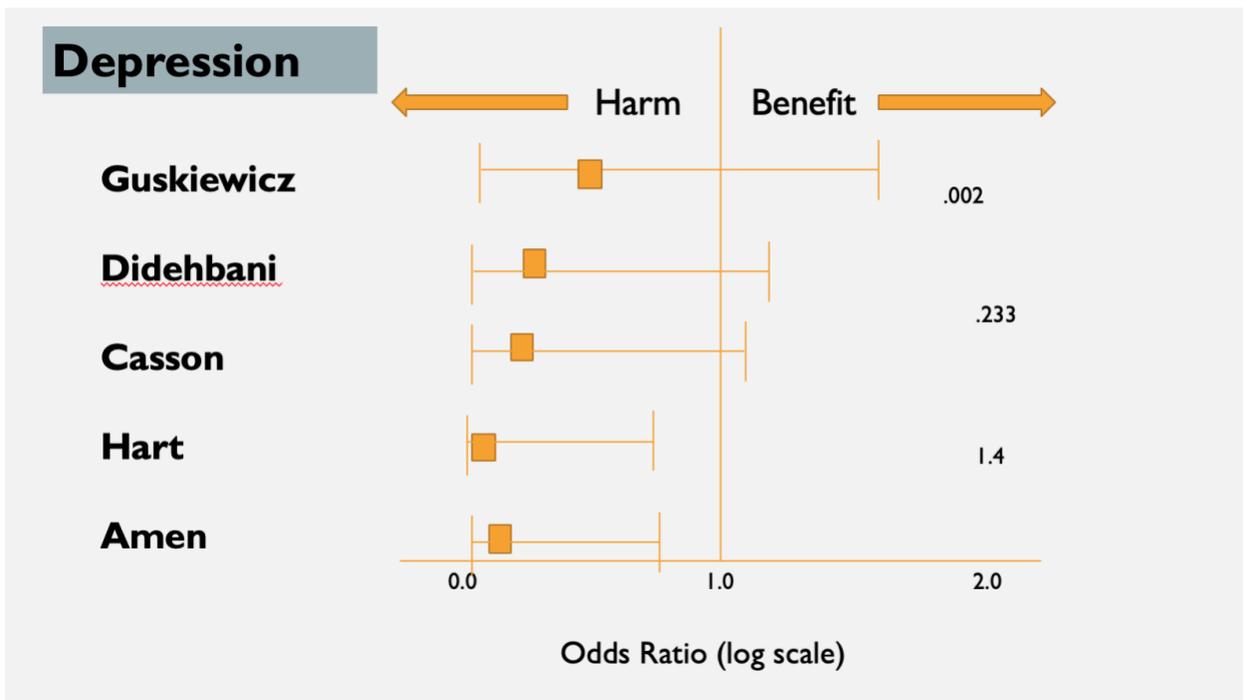|	Df	Sum Sq	Mean Sq	F value	Pr(>F)
yarddash$YEAR	1	5.9	5.918	66.72	4.02e-16 ***
Residuals	4560	404.5	0.089		

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Appendix 3:

Appendix 4:

Appendix 5: