Concussion Awareness Effects on NFL Concussions

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Outline:

1. Introduction
    - Introduce and elaborate on the research question
        - How the awareness of concussions has changed over time and whether those changes have had any effect on the concussion rate.
    - Address prior research on the topic
        - At least 2 to 3 sources
        - *Chronic traumatic encephalopathy: The dangers of getting "dinged"*, Lakhan, Kirchgessner
        - *Chronic traumatic encephalopathy in football players*, Mez, Daneshvar, Kiernan
    - State the significance of the research
        - State what differentiates your research
        - Focusing on the relationship between NFL concussion awareness and the NFL concussion rate
    - Transition into the rest of the paper
2. Data and methods
    - Introduce the goal of the data
    - Introduce the sources of the data
        - *Twelve Years of National Football League Concussion Data*, 2001 through 2006
        - *Reported NFL Concussions Up 34 Percent Since 2008*, 2008
        - *NFL sees spike in reported concussions*, 2009
        - *2010 NFL Concussion Report (End of Regular Season)* and *2011 Concussion Report – End of Regular Season*, 2010 and 2011
        - *NFL Concussions: The 2012-13 Season In Review* and *NFL Concussions: The 2013-14 Season In Review*, 2012 and 2013
        - *NFL: Concussions down 25 percent in 2014*, 2014
        - *Epidemiology of Concussion in the National Football League, 2015-2019*, 2015 through 2019
        - *Injury Data Since 2015*, 2020 through 2022
    - Explain the methodology used to gather the data
        - Explain how the data for the word frequency will be collected (Python Script)
    - Explain the organization of the data
        - Explain how the NFL concussion data will be organized in the spreadsheet
        - Explain how the data for the word frequency will be organized in the spreadsheet
    - Limitations and Potential Errors of Data
        - Address the ESPN paywall for some articles
        - The potential issues with the keywords
3. Results
    - Summarize the results
    - Provide Descriptive Statistics of the results
        - Including mean, median, etc

- Analyze the Results
    - Conduct a correlation test
    - Provide a formal report of the correlation test
    - The relationship between the change of concussion awareness to the concussion rate in the NFL
- Explain the significance of the results
- Describe each table and graph
    - Yearly Data Table
    - Monthly Word/Phrase Frequency graph
    - Yearly Concussions graph
    - Yearly word/phrase frequency graph

4. Discussion
    - Summary of the results
    - Interpret the results
        - Interpret what the correlation between the concussion related words/phrases in NFL ESPN articles and the number of concussions in the NFL suggests
    - Discuss importance of results to the research question
5. Conclusion and future directions
    - Answer the question research question
        - Base answer around Results
    - Introduce ideas for future research
    - Discuss limitations
        - Concussion Data
        - Text Files

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Abstract:

This research analyzes the change of frequency in which concussions and other closely related words and phrases are mentioned within all ESPN, NFL related articles published within the regular season of the NFL from 2003 through 2022; and compares that data to the number of concussions occurring within the regular season of the NFL from 2003 through 2022. From the comparison of the data gathered on NFL concussions from 2003 through 2022 and the data collected on the word frequency of concussions and other related words and phrases, we will be able to determine if an increase or decrease in NFL concussion awareness has had an impact on the number of concussions in the NFL.

The NFL is renowned as a physical league which in part comes from the nature of American football. Current and former NFL players have suffered devastating effects because of multiple concussions. The intensity associated with playing football at the top-level leads to players suffering multiple concussions throughout their professional careers, ultimately their health being the most impacted.

Gathering and analyzing the data on the number of concussions in the NFL was a crucial first step in determining the interpretation of the question. Gathering and analyzing data on aspects that could indicate the awareness emphasized on concussions in the NFL was an essential secondary group of data to gather and analyze to better understand the question at hand. The word frequency in which concussions and other similar words and phrases appear throughout all the ESPN articles published relating to the NFL will serve as a measure of the emphasis and awareness placed on concussions in the NFL. From the comparison of the two data sets, a clear understanding of the effects of concussion awareness on the NFL concussion rate will be able to be determined.

The data on the ESPN, NFL related articles demonstrates a substantial increase in concussion awareness in the NFL. The correlation test demonstrated a significant moderate relationship between the frequency of concussion related words/phrases in all NFL ESPN articles and the number of concussions in the NFL.

The data and analysis derived from the research demonstrated that there was a considerable change in concussion awareness in the NFL and that the increased concussion awareness had a significant impact on the number of concussions reported in the NFL.

Concussion Awareness Effects on NFL Concussions

Introduction:

The NFL is renowned as a physical league which in part comes from the nature of American football. As a result of the physicality of the sport, players sustain various injuries of ranging severity. The frequent occurrences of these injuries have contributed to them being widely accepted as they are now the norm within the NFL. Injuries revolving around head trauma are the most concerning type of injury commonly sustained by players in the NFL.

Current and former NFL players have suffered devastating effects because of multiple concussions. The intensity associated with playing football at the top-level leads to players suffering multiple concussions throughout their professional careers, ultimately their health being the most impacted. Concussions are a significant cause of major head injuries, including Chronic Traumatic Encephalopathy (CTE), which is known to impact the overall wellness of current and former NFL players especially relating to their mental health. CTE is known to cause abnormal behavior among individuals who suffer from the brain condition, including decline of memory and cognition, suicidal behavior, poor impulse control, and aggressiveness (Lakhan, Kirchgessner). A study published by the *Journal of the American Medical Association* examined the brains of former now, deceased National Football League players. It revealed that 110 of 111 or 99% of the players studied developed CTE (Mez, Daneshvar, Kiernan). However, despite CTE being a prominent effect of concussions, there are many more negative effects of concussions apart from CTE, which not much is known relating to the long-term effects on players' health.

This research will analyze how the awareness of concussions has changed over time and whether those changes have affected the concussion rate. To determine the change in concussion awareness over time, the frequency in which concussions and other closely related words and phrases are mentioned within articles will be determined and gathered throughout a specific period. From the comparison of the analysis of the data relating to the change of concussion awareness in the NFL and the number of concussions throughout a certain period, a clear conclusion will be able to be determined on the relationship between the data. Leading to the conclusion that will provide greater depth into the relationship between the change in concussion awareness and the effect on the concussion rate in the NFL.

Data and Methods

Gathering and analyzing the data on the number of concussions in the NFL was a crucial first step in determining the interpretation of the question. Concussion data for the NFL, between the six-year intervals of 1996 through 2001 and 2006 through 2007, was gathered from the publication *Twelve Years of National Football League Concussion Data* (Casson, Viano, Powell, Pellman), published in *Sports Health.* Concussion data for the NFL for 2008 was gathered from the article *Reported NFL Concussions Up 34 Percent Since 2008,* published by *CBS News*. Concussion data for the NFL for 2009, was gathered from the article *NFL sees spike*

in reported concussions, published by *ESPN.* Concussion data for the NFL, for 2010 and 2011, was gathered from the articles *2010 NFL Concussion Report (End of Regular Season)* and *2011 Concussion Report – End of Regular Season,* both published by *The Concussion Blog*. Concussion data for the NFL for 2012 and 2013 was gathered from the article *NFL Concussions: The 2012-13 Season In Review* and *NFL Concussions: The 2013-14 Season In Review,* both published by *PBS: Frontline.* Concussion data for the NFL for 2014 was gathered from the article *NFL: Concussions down 25 percent in 2014,* published by *Sports Illustrated.* Concussion data for the NFL, between the five-year interval of 2015 through 2019, was gathered from the publication *Epidemiology of Concussion in the National Football League, 2015-2019* (Mack, Solomon, Covassin, Theodore, Cardenas, Sills), published in the journal *Sports Health.* Concussion data for the NFL in 2020 through 2022 was gathered from an *NFL: Health and Wellness* publication, *Injury Data Since 2015.* NFL concussion data was only gathered for the NFL regular season; the data did not include pre-season and playoff concussions. The NFL concussion data was then organized into a singular spreadsheet, which divided the number of concussions per year from 2003 to 2022. Additionally, the data was also organized by month.

Gathering and analyzing data on aspects that could indicate the awareness emphasized on concussions in the NFL was an essential secondary group of data to gather and analyze, to better understand the question in hand. The word frequency in which concussions and other similar words and phrases appear throughout all the ESPN articles published relating to the NFL will serve as a measure of the emphasis and awareness placed on concussions in the NFL.

All ESPN articles relating to the NFL from 2003 through 2022 were accessed through the *ESPN NFL Football News Archive.* All the articles for every month of the NFL regular season (September, October, November, December, January) from 2003 through 2022 were then placed into a singular text file corresponding to each month in every year. The few dozen articles per month under paywall were not considered and, therefore, not part of the analysis. Each text file was then analyzed through a Python script. This Python script focused on converting a large text file into a string. Following this, all punctuation from the string was removed. Additionally, all the words in the string were converted to lowercase. Finally, the Python script counted the word frequency in which the keywords and phrases appeared within each text file.

Python Libraries: os.path, Pandas, Matplotlib.

Keywords and Phrases: concussion/s, brain/s, head trauma, head, headache/s, nausea, dizziness, post-concussion, brain injury, trauma, CTE, TBI, brain damage.

Issues relating to the keywords and phrases that could have led to inaccurate data include that some keywords and phrases may be mentioned within an article and counted towards the frequency count. However, the article may not have used the keyword or phrase in the context of concussions and other related injuries.

After gathering the word frequency count for each month of every year from 2003 through 2022, this data was placed into a spreadsheet that separated the total count by months and years. From the comparison of the two data sets, a clear understanding of the effects of concussion awareness on the NFL concussion rate will be able to be determined.

Results:

Year	Number of Articles	Word/Phrase Frequency Total	Percent Increase/Decrease
2003	3325	1138	
2004	2013	741	-34.89
2005	2365	755	1.89
2006	2943	967	28.08
2007	3387	1144	18.30
2008	3711	1277	11.63
2009	3772	1947	52.47
2010	3956	1444	-25.83
2011	3627	1543	6.86
2012	4330	1852	20.03
2013	3511	1119	-39.58
2014	3509	1601	43.07
2015	4946	2585	61.46
2016	3930	1465	-43.33
2017	4235	2109	43.96
2018	3906	1656	-21.48
2019	3699	1389	-16.12
2020	3968	1857	33.69
2021	3811	1326	-28.59
*2022	3183	1374	3.62
Total	72127	29289	115.23

Figure 1: Yearly Data

* Data for 2022 was only collected from the start of the NFL season in September through early November

Descriptive Statistics
(2003 – 2022)

Number of Articles
Mean: 3606.35
Median: 3705
Maximum: 4946
Minimum: 2013

Word/Phrase Frequency
Mean: 1464.45
Median: 1416.50
Maximum: 2585
Minimum: 741

Figure 1 demonstrates the number of ESPN NFL related articles published between 2003 through 2022. Additionally, figure 1 displays the total word/phrase frequency for every year. Finally, figure 1 demonstrated the percent increase or decrease of the concussion related words/phrases frequency in all ESPN NFL related articles from 2003 through 2022, demonstrating an overall total increase of 115.23%. This data can be inferred to demonstrate a substantial increase in concussion awareness in the NFL.

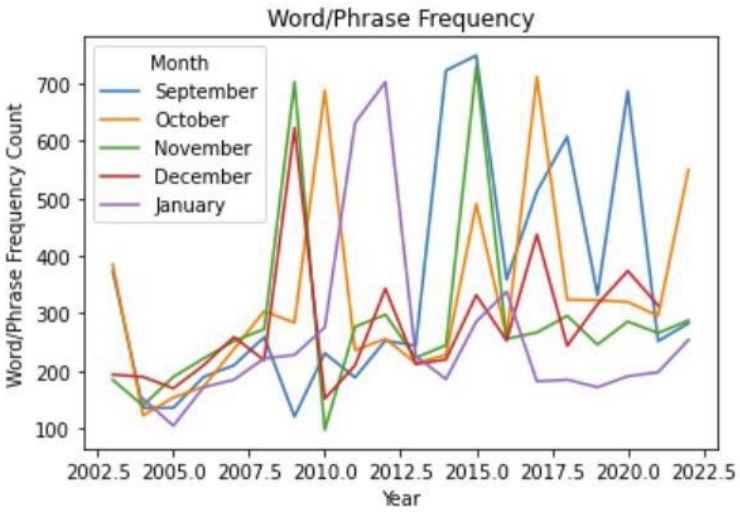

Figure 2: Monthly Word/Phrase Frequency

Figure 2 demonstrates the word/phrase frequency in all NFL ESPN articles for each month in every year. The corresponding year is demonstrated along the x-axis, while the y-axis demonstrates the word/phrase frequency count. The word/phrase frequency for each month from 2003 through 2022 is highlighted by its corresponding color. The data demonstrate significant absurd and unpredicted fluctuations; this could have resulted from the unequal number of ESPN NFL related articles published each year, as demonstrated by Figure 1, and or the unequal concussion related words and phrases mentioned throughout articles in differing years and or months.

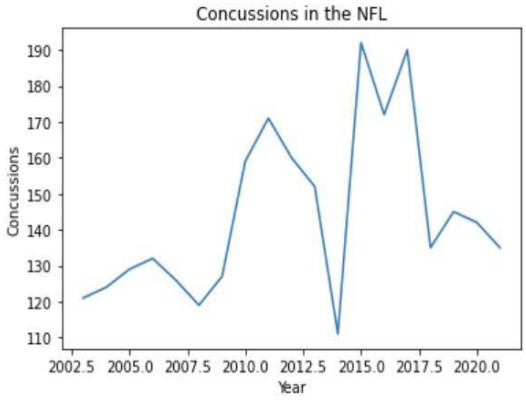

Figure 3: Yearly Concussions

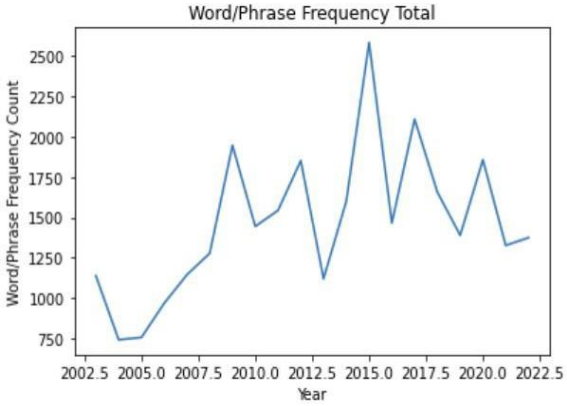

Figure 4: Yearly Word/Phrase Frequency

Figure 3 demonstrates the yearly number of concussions from 2003 through 2020. The year is demonstrated along the x-axis and the number of concussions is demonstrated along the y-axis

Both figure 3 and figure 4 demonstrate their maximums near 2015, additionally, both figure 3 and figure 4 demonstrate dramatic downturns around 2012-2013, suggesting a relationship between the two figures. From the comparison of both figure 3 and figure 4, a slight resemblance between the fluctuations of the two graphs is demonstrated.

Correlation: Number of Concussions and Word/Phrase Frequency:

A correlation test was conducted to determine if a correlation between the concussion related words/phrases in NFL ESPN articles and the number of concussions in the NFL was present.

R-Value: 0.62
P-Value: 0.0050
Degrees of Freedom: 17

$r\ (17) = 0.62,\ p > 0.001$

The *r* value of 0.62 for the correlation coefficient tells us that there is a significant moderate relationship between the frequency of concussion related words/phrases in NFL ESPN articles and the number of concussions in the NFL. However, this correlation is not perfect, as *r* is not equal to 1.

Discussion

The correlation test demonstrated a significant moderate relationship between the frequency of concussion related words/phrases in all NFL ESPN articles and the number of concussions in the NFL. This would suggest that the overall emphasis and awareness placed on concussions and other related injuries directly fluctuates with the number of concussions each year within the NFL.

The naïve ideal outcome for the correlation test is that there was no significant relationship between the frequency of concussions and other related words/phrases and the number of concussions in the NFL, especially where the data demonstrated an increase in concussion awareness, as demonstrated by an increase in concussion related words/phrases in figure 1, and a decrease in NFL concussions. This is because this outcome would suggest that increased concussion awareness has directly led to decreased concussions and other related injuries in the NFL. This outcome may have resulted from increased concussion awareness, leading to increased research on concussions and other related injuries, which in turn could be directly utilized to innovate and improve current technology and equipment used to prevent and treat concussions by teams in the NFL.

However, the correlation test outcome demonstrates that there is a moderate strong relationship between the frequency of concussion related words/phrases in all NFL ESPN articles and the number of concussions in the NFL. Additionally, through analyzing the word/phrase frequency data and the number of NFL concussions in the NFL from 2003 through 2022, the overall trend demonstrates a slight increase in the number of concussions. This outcome suggests

certain factors associated with increased concussion awareness have led to an increase in the number of concussions reported in the NFL. Additionally, this outcome could be derived from concussion awareness directly impacting increased individuals' greater understanding of concussions. This includes the increased understanding of guidelines in accurately diagnosing concussions and the lowering of the threshold to diagnose a concussion to ensure player safety, which in part could create the perception of increased concussions in the NFL throughout the years. (NBC Sports)

Conclusion and Future Research:

The data and analysis derived from the research demonstrated that there was a considerable change in concussion awareness in the NFL and that the increased concussion awareness had a significant impact on the number of concussions reported in the NFL. This data can be used and utilized by multiple parties with the goal of increasing everyone's knowledge of concussions by bringing awareness to the topic to benefit not only individuals associated with the NFL but everyone with some association with football at all levels.

Limitations associated with this research included the fact that there was no singular standalone database to acquire data on concussions and other related injuries in the NFL, which is accessible by the public, slowing the process of data acquiring for this study and other future studies related to this topic. Additionally, the process of acquiring and organizing all the ESPN NFL related articles was repetitive and tedious, which resulted in extensive time dedicated to this process. Applying a better methodology in acquiring all the ESPN NFL related articles could have been used to expedite the process. Furthermore, this process left a slight room for error as the keywords used to analyze the text files needed to consider the context of the articles, potentially greatly swaying the data and leading to inaccurate results.

Ideas for future research associated with concussion awareness include looking at the relationship between increased concussion awareness and the impact, if any that it has had on an individual's willingness to be involved with football. This study could be a great way to understand if severe injuries like concussions might deter individuals from becoming involved in football. This could be of immense importance, especially as the sport seeks to expand its reach nationally and internationally. Another potential future research is interpreting the long-term effects of the recent increase in concussion awareness on conditions like CTE. Dividing CTE data by centuries and analyzing further changes in concussion awareness over time could reveal the effectiveness of increased concussion awareness in preventing devastating conditions like CTE.

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