The Prevalence of Depression and Concussions in a Sample of Active North American Semi-Professional and Professional Football Players

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Background: Concussive events frequently occur in high impact sports such as North American football. The long term effects of concussive events on physical and psychological wellbeing are the focus of ongoing research. The purpose of this study was to determine if concussive events increase the incidence of depression in active semi-professional and professional North American football players.

Methods: An anonymous online survey was sent to 200 players to collect the following self-reported data: position played, years played, number of concussions sustained and subsequent depressive symptoms using the Center for Epidemiologic Studies Depression (CESD-R) scale. An independent T-test was used to determine differences in the number of concussive events in those with CESD-R scores < 16 vs. ≥ 16, where scores ≥ 16 are indicative of a depressed state. Likewise, an independent T-test was used to compare CESD-R scores between players with ≥ 3 concussions vs. ≤ 2.

Results: Individuals with a CESD-R score ≥ 16, sustained a significantly greater number of concussions (3.8 vs. 1.6) than those who scored < 16 ($p < 0.001$). Further analysis also revealed significantly higher CESD-R scores in players who had sustained ≥ 3 concussions (24.0 vs. 15.6) than those with ≤ 2 ($p < 0.05$).

Conclusion: Within the parameters of this study, players that were classified as depressed had sustained significantly more concussions compared to those who were not classified as depressed. Further, multiple concussive events (≥ 3) appears to increase symptoms of depression.

Key Words: Football, Concussion, Depression, CESD-R

INTRODUCTION

In the sporting community, and especially North American football (football), a new importance has been placed on properly diagnosing and treating concussion injuries as a result of evidence indicating that these mild traumatic brain injuries can have lasting neurological effects which may lead to degenerative diseases such as early Alzheimers and Parkinson's syndrome as well as symptoms of depression [1,2]. On an annual basis football-related concussions alone occur to an estimated 43,200 to 67,200 athletes [3]. Professional football players in the National Football League (NFL) sustained a total of 758 concussions during the 2002-2007 seasons [4] with 152 players having sustained multiple concussions [5]. Recently Baron et al. [6] observed

in retired NFL football players (n = 2,552), a 5-fold increase in prevalence of mild cognitive disorders and a threefold increase in prevalence of significant memory problems in players who experienced three or more concussions verses those who sustain fewer than three concussions [6]. Although unable to establish cause-effect, Baron et al. [6] did provide additional evidence supporting the association between multiple concussions and increased risk of neurodegenerative diseases.

Casson et al. [7] recently found from a sample of retired NFL players (n = 45) that 32 had sustained three or more concussions and of these players, 13 were found to have suffered from depression. In a similar study Didenbani et al. [8] examined depression symptoms and concussions in retired NFL players. The results indicated that there was a significant positive relation between number of sustained player concussions and cognitive depressive symptoms. It should be noted, in the two aforementioned studies [7,8] that the Beck Depression Inventory (BDI-II) was used to assess depression at the time of the study, hence reflecting current state or symptoms of depression, providing little temporal information regarding the relationship of depression and concussion.

Schwenk et al. [9] examined depression and pain in retired NFL players. The results indicated that retired NFL players experienced symptoms of depression at levels consistent with the general population. The instrument used to assess depressive symptoms at the time of the study was the PHQ-9, a screening questionnaire known for a significant rate of false positives [10,11].

An additional pair of recent studies have focused on concussion and depression symptoms in retired NFL players [1,12]. The initial study by Guskiewicz at al. [1] focused on the relationship of concussion and being diagnosed with depression in retired NFL players (n = 2552). The results of the study indicated that players who had sustained 1-2 concussions were 1.5 times more likely to be diagnosed with depression than players who had not sustained a concussion. Further, players who reported ≥3 concussion were 3 times more likely to be diagnosed with depression then players who had not sustained a concussion. The purpose of the second study by Kerr et al. [12] was a nine-year follow up to the Guskiewicz at al. [1] report which attempted to pro-

spectively determine the effects of concussion occurrence on clinical diagnosis of depression in retired NFL players (n = 1044). During the 9-year study period 106 players reported being diagnosed as clinically depressed. Additionally, the results of the study indicated that there was a strong dose response relationship between the number of self-reported concussions and 9-year clinical diagnosis of depression.

It should be noted that in the two aforementioned studies [1,12] that the method of determining depression occurrence was based on the investigators asking the players "Have you ever been told by a physician or health care professional that you had/have any of the following conditions?" Where one of the conditions enquired about was depression [12]. The researchers in these studies did not state who the health care professional was (general practitioner or psychiatrist, etc.). There is lack of consensus between how psychiatrists and general practice (GP) physicians diagnose depression [13] where the majority of patients with depression are treated by GP physicians [14]. The lack of shared understanding between psychiatrists and GP physicians regarding the diagnosis of depression is beyond the scope of this manuscript. However what is important is that there is a clear lack of inter-rater reliability regarding the diagnosis of depression and an issue that must be kept in mind when attempting to interpret the results of the studies in question [1,12]. Further confounding the issue of clinical depression diagnosis has to do with the explosion of individuals diagnosed with depression during the time frame of the Guskiewicz at al. [1] and Kerr et al. [12] studies [15]. The clinical diagnosis of depression among Medicare patients increased by 100% between 1992-95 and 2002-05 [16]. According to Dowrick [15], this increase in depression diagnosis rates is not due to GP's improved ability to identify depression disorders but rather a result of "medicalising of unhappiness", a likely outcome of the broadening of depressive disorders introduced by the DSM-IV [17].

Psychology based research has fallen under considerable scrutiny given the poor rate of reproducibility, a "defining feature of science" [18]. A study published in Science in august of 2015 [18] indicated that in attempt to replicate 100 experimental and correlational psychology studies that only 36% of the replicant studies demonstrated significant

results compared to 97% of the original studies that had reported significant results. Given the limitations of the studies expressed above and concerns of poor replication of psychology research in general, we felt that the potential relationship between concussions and depression in professional football players warrants continued investigation.

Therefore, the purpose of this study was to assess the difference in average number of concussive events among active professional and semi-professional football players meeting criteria for clinically significant depression vs non-clinically significant depression using the Center for Epidemiologic Studies Depression scale (CESD-R) [19]. Where depression is defined as a CESD-R score of 16 or greater. Further, a secondary purpose was to investigate the CESD-R scores between players with ≥3 concussions with those having sustained ≤2 concussions. It was hypothesized that if the relationship between concussion and depression suggested by prior research robustly exits [1,7,8,12], then it would be supported by the results of the current study.

MATERIALS AND METHODS

1. Participants

The sample population for this study was active semi-professional and professional football players. All participation was voluntary and all participants read the informed consent prior to answering any research questions. The recruitment of semi-professional player-participants was conducted in two leagues: The Western Washington Football Alliance (WWFA) and Pacific Football League (PFL). Professional player-participants were recruited from various NFL teams. Only current football players were recruited.

1) Instruments

A web-based Qualtrics Survey was used to question participants on the following: league (Professional or Semi-Professional), position played, years played, if a concussion has ever been sustained and if so, and how many. If the participant answered "no" to having ever received a concussion, the survey was terminated and the participant was excluded from further questioning and subsequent data analysis. If the participant responded "yes", they were then asked to answer a number of questions from the Center for

Epidemiologic Studies Depression (CESD-R) Scale [19], which consists of 20 closed-ended survey questions in which participants answer questions by choosing one of four response options: 0) rarely or none, 1) some or little of the time, 2) occasionally or a moderate amount, 3) most or all of the time. Example questions include: "I felt depressed" or "I felt happy". Results are calculated using a 0-3 scoring system and individual question scores are totaled (0-60 possible). Score classifications are as follows: 0 no depression exists; 1-16 little or no depression and not clinically significant; 17-49 mild depression; 50-60 major depression. CESD-R questions were asked within the context of how the participant felt in the days and weeks after a concussive event. The CESD-R scale has been reported to be a valid instrument, with high reliability (0.85-0.95), when compared to other measures of depression [20].

2. Procedures

The current study and the participant informed consent document were approved by the University Institutional Review Board (IRB) as being in accordance with the ethical standards of human experimentation (institutional and national) and with the Helsinki Declaration of 1975 (as revised in 2008). All participants read the IRB approved electronic informed consent document; consent was given by clicking an "agree" tab which then linked the participant to the survey. All responses were anonymous with no identifying information attached to any portion of the survey results. Semi-Professional and Professional football players were recruited via two methods. Semi-Professional players were contacted through a social media site with a letter containing information about the topic, the research procedures and information regarding the voluntary and anonymous nature of study participation. Professional players were contacted via personal connections of the Principle Investigator (PI). The PI contacted former or current NFL players whom he had a personal connection/acquaintance with. These individuals were given informative recruitment letters to hand out to interested current NFL players. In order to participate in the study, players must have sustained at least one concussion. Within the context of the present study the term "concussion", is defined as a direct blow to the head, face, or neck with an "impulsive force transmitted to the

head that may result in neuropathological changes and may or may not involve a loss of consciousness" [21]. Players that chose to participate were given a link to the Qualtrics Survey regarding their past concussion history and the CESD-R scale.

3. Statistical analyses

An independent t-test was used to find if players who scored ≥16 on the CESD-R test had incurred a greater number of concussions compared with those who scored <16. An independent t-test was also used to determine if those who have a history of three or more concussions scored higher on the CESD-R survey compared to players who have sustained two or fewer concussions. Level of significance for all tests was set at $p < 0.05$. Descriptive statistics and frequency tables were calculated and generated via Qualtrics software program, all inferential statistical calculations were conducted using Microsoft Excel 2013.

RESULTS

A total of 51 participants agreed to take the survey. However, do to the inclusion criteria (~a concussive event), only 35 of the 51 willing participants were eligible to take the surveys. Eight of the 35 eligible participants did not finish the surveys. Hence the data provided below is based on a participant pool of n = 27. Participant demographics and position played can be found in Table 1.

The 27 participants who previously sustained one or more concussion(s) were asked to complete the 20 question CESD-R form. Of the 27 participants, the mean CESD-R scores can be found in Table 2. Players who scored ≥16 (n = 16) on the CESD-R survey incurred a significantly greater number of concussions compared with those who scored <16 (n = 11) (p = 0.0004). Players with a history of three or more concussions scored significantly higher on the CESD-R survey when compared to players that had a history of two or less (p = 0.03), see Tables 2 and 3.

After reviewing the data (histograms), we were concerned that the assumptions of normality and equal variance might be in question, noting that the independent t-test is robust in regards to these assumptions [22]. As such, additional statistical analyses (Welch's t-test) that accommodate for the aforementioned violation of assumptions were carried out as recommended by McDonald [22]. The results of the Welch's t-tests were as follows: the players who scored ≥16 (n = 16) on the CESD-R survey incurred a significantly greater number of concussions compared with those who scored <16 (n = 11) (p < 0.001), and the players with a history of three or more concussions scored significantly higher on the CESD-R survey when compared to players that had a history of two or less (p < 0.001). Hence, confirming is initial statistical analysis.

Table 1. Demographics of participants by group

	Professional	Semi-Professional
Participants	5	46
Participants with Concussion	2	25
Age (Years)	26.6 ± 3.3	25.9 ± 5.1
Concussion Range	4 ± 2	2.6 ± 4.1
Years Playing	10	10.9 ± 8.1
Offense		
Wide Receiver	1	7
Running Back	0	4
Quarterback	0	4
Defense		
Defensive Line	1	9
Linebacker	0	7
Safety	0	5

Note[1]: Professional football player, Semi-Professional football player.
Note[2]: Some Semi-Professional football players were multi-position.

Table 2. *CESD-R scores: 2 or fewer concussions vs. 3 or more concussions*

	2 or fewer concussions (n = 16)	3 or more concussions (n = 11)
Average CESD-R Score	15.6	24.0*
N scoring CESD-R ≥16	5	11

Note: CESD-R score ≥16 is criteria for clinical depression, *Significantly greater: p = 0.03.

Table 3. Average number of Concussions: CESD-R Score 16 or greater vs. less than 16

	CESD-R score ≥16 (n = 16)	CESD-R score <16 (n = 11)
Average number of concussions	3.8*	1.6

*Significantly greater: p = 0.0004.

DISCUSSION

The purpose of this study was to investigate if the number of concussive events leads to an increased prevalence of depression in active professional and semi-professional North American football players. The results of the studied sample indicate that professional and semi-professional football players who experience a greater number of depressive symptoms have also suffered a greater number of concussive events. This is evidenced in our study in that those who met the CESD-R criteria for clinical depression had sustained a significantly greater number of concussive events. Furthermore, players that had a concussion history of three or more also scored significantly higher on the CESD-R survey. We also explored the direct relationship between concussive events and the CESD-R survey score (Pearson correlation $\sim r$) which yielded a significant positive moderate relationship ($r = 0.37$, $p < 0.05$) [23]. This moderate positive relationship between concussive events incurred and the CESD-R survey score was independent of years played. Of particular concern is the fact that 100% of the participants that experienced 3 or more concussive events were assessed as clinically depressed per the CESD-R survey. In contrast, the lifetime prevalence of major depression among US male adults has been estimated to be 12.7% [24].

Previous results corroborate the present findings. Guskiewicz et al. [1] reported that NFL players with a history of three or more previous concussions were three times more likely to be diagnosed with depression, and those with a history of one or two previous concussions were 1.5 times more likely to have been diagnosed with depression, compared to those who reported no concussive events. Results of the Guskiewicz et al. study [1] as well as the present suggest that football players with three or more concussions are at a significantly increased risk of being diagnosed with clinical depression compared to those with limited or no prior concussion history. In a 9-year follow-up study to the Guskiewicz et al. [1] report, Kerr et al. [12] documented a strong dose-response relationship between depression diagnosis and self-reported concussions in retired NFL players. Didehbani et al. [8] also reported a positive significant association between the number of self-reported lifetime con-

cussions and depression in retired NFL players as measured by the BDI-II total scores ($r = 0.43$, $p < 0.05$), a statistic closely matching the results of the current study.

Casson et al. [7] examined chronic brain damage in retired NFL players which included the BDI-II inventory in order to evaluate if there was a relationship between depression and concussions. The results indicated that of the n = 45 players who participated in the study, 32 of 45 ($\approx 71\%$) had experienced ≥ 3 concussions. Thirteen of the 32 ($\approx 41\%$) were assessed with some level of depression per BDI-II inventory criteria (BDI-II ≥ 14). According to the authors [7], "evidence in this study does not support the contention that a career in the NFL is causally related to later-life depression". With that said, consider the following. According to the author's presented data, of the n = 45 NFL retired participants, only 7 did not report having sustained a concussion, in other words $\approx 84\%$ had sustained at least one concussion. From a biomechanical perspective, the hits delivered and/or received by players during the course of a football game can and do cause concussions; playing in the NFL does cause concussions. Further, per their presented data there is a positive moderate relationship between BDI-II inventory depression symptoms and number of sustained concussions ($r = 0.35$, $p < 0.05$) [23]. Interestingly, almost precisely the statistical relationship found in the current study between the number of sustained concussions and depressive symptoms as assessed by the CESD-R inventory. It should also be noted that Kerr et al. [12] provided evidence from a prospective study that there is a possible causal relationship between concussive episodes and depression in retired professional football players.

A study by Schwenk et al. [9] reported that retired NFL players (n = 1617) experienced depressive symptoms comparable to the general population. However, the Schwenk [9] study did not examine subpopulations on NFL players such as those having sustained at least one concussive event. With that said, we were unable to make a direct comparison between the Schwenk [9] study and the current investigation. However, it should be noted that in the current study that the CSED-R criteria for depression was met by 31% of the participants who sustained 1 or 2 concussive events, far greater than the depressive symptoms reported in the Schwenk [9] study.

The results of the current study also agree with results of prior studies in different sub-populations regarding the relationship of concussion and subsequent depression. Specifically, Chrisman et al. [25] (n = 36,060) and Barker et al. [26] (n = 14,082) both found elevated risk of depression diagnosis in adolescents with a history of concussion. Holsinger et al. [27] reported an increased lifetime risk of depression in head injured US World War II veterans (n = 520) and the risk was greatest for those who sustained severe head injuries. Finally, Kerr et al. [28] recorded an association between sustained concussions and severe depression in former collegiate athletes (n = 797).

Also of interest and an area for future study is the potential relationship between player position and likelihood of incurring multiple head injuries. Of the twenty participants that scored within 3 points or above the set criteria for mild depression (CESD-R score ≥16) there appeared a trend (although statistically insignificant due to small sample size) related to position played and the number of concussion(s) sustained; offensive wide receivers (n = 8) had more post-concussion depressive symptoms compared to other offensive players, as did defensive linebackers (n = 7) when compared to players in other defensive positions. Casson et al. [5] reported similar findings suggesting that defensive secondary, kick squads, offensive running backs and defensive line backers had the highest incidence of repeat concussions.

Several investigations have used medical imaging techniques to attempt to identify clinical abnormalities of the brain in retired NFL players [7,29,30]. Hart et al. [29] utilized neuroimaging to examine depression and cognitive impairment in retired NFL players (n = 34). The results of the study suggested that retired "NFL players may be more likely to develop depression and cognitive impairments as they age when compared to the general population". With these cognitive impairments being correlated with abnormalities in white matter and cerebral blood flow patterns. Strain et al. [30] used diffusion tensor imaging (DTI) to examine the relationship between depression and white matter dysfunction in retired NFL players (n = 26). The results demonstrated that DTI techniques (fractional anisotropy maps) were 100% sensitivity and 95% specificity with respect to identifying depressed and non-depressed participants. Casson et al. [7] used

a host of magnetic imaging techniques to examine if there is chronic brain damage in retired NFL players (n = 45) and if so, was the damage somehow related to depression symptoms. The results of the study indicated that up to 13% of the players had chronic brain injury likely related to football. The author's further stated that there was no clear link of chronic brain damage on depression in the retired players.

Other researchers have examined potential contributing factors associated with the difficulties attached to retirement from the NFL [9]. Schwenk et al. [9] noted the most common problems attached to retirement as reported by retired NFL players as: as difficulty with pain, loss of fitness/lack of exercise, weight gain, trouble sleeping, difficulty with aging, and transition to life after professional football. It should be noted here that many of the aforementioned difficulties have been reported to be associated with depressive symptoms in the general population [31-35]. The combination of loss of fitness and weight gain are of particular concern as these issues are related to a host of other medical conditions (metabolic syndrome, hyper-lipedema, cardio vascular disease, high blood pressure, diabetes, and certain cancers, etc.). Interestingly, active NFL players are often classified as obese by body mass index (BMI-body mass kg/height meters squared) criteria where BMI ≥ 30 is considered obese [36]. A BMI analysis of active NFL players for the Detroit Lions [37] yielded a team average BMI of 32.2 ± 4.7, considered obese. However, it should be noted that in this population there is a high amount of muscle mass contributing to the total body mass. After NFL retirement, data from previous research [12] has shown that BMI is relatively consistent with active playing days. Kerr et al. [12] reported the BMI of the retired NFL players as BMI = 30.3 ± 4.1, a value consistent with the reported BMI of the current NFL team reported above. What is likely occurring in this population is a "BMI shift". A condition much like what others [38] have referred to as sarcopenic obesity. A physiologic process where muscle mass is lost with age while there is a concurrent accumulation of body fat. Hence, total BMI is unaffected, but the individual is now predisposed to the myriad of health conditions associated with obesity. The difference between the "BMI shift" and sarcopenic obesity is that the population of NFL players are

initially younger adults and obese as per BMI classification but with an extreme amount of muscle mass as compared to the general population. Then after retirement, and as the years pass, muscle mass is lost at that same time as fat mass is gained. This accumulation of body fat is likely a potential trigger of depressive symptoms.

Furthering the importance of loss of fitness, Kerr et al. [12] suggested that reduced physical ability in previously elite athletes (NFL retirees) could lead to an increasing sense of "hopelessness and less physical independence", hence a potential trigger for depression onset. Additionally, Kerr et al. [12] postulated that retired NFL players who have been forced into retirement (injury, loss of ability, etc.) might feel a sense of un-fulfilled ambitions as well as facing financial troubles, both potentially leading to depression.

The primary limitation to the present study was a small sample size. Many players still do not want to share all their health information, especially something as sensitive as mental health information. Of the 200 invitations sent to Semi-Professional and Professional football players, only 51 responded and only 27 had actually sustained at least one concussion. The NFL has a clause in player's contracts that restricts the player from participating in medical surveys outside of the NFL. Another limitation was the exclusion of participants who had reported no concussive events from taking the CESD-R survey. In retrospect the CESD-R survey could have been administered to all respondents regardless of prior concussion status, albeit not a primary purpose of the current study. Concussion recall is also a potential limitation of the current study. Kerr et al. [39] reported a substantial lack of agreement between clinically documented and self-recalled concussion history. Likewise, we did not attempt to determine concussion history occurring prior to the player's professional or semi-professional careers, a potential contributing factor to current depression state/symptoms.

In summary, our data suggests that concussions are associated with depression in active North American semi-professional and professional football players. We have also compared and contrasted the results of the current study with others who have examined concussion and depression in retired NFL players, adolescence, collegiate athletes, and young adults [1,7,8,12,25-28]. Likewise, we have reviewed

additional sources of stressors that could contribute to depression in retired NFL players. The preponderance of the evidence strongly suggests that concussions are linked to depression in NFL players active and retired.

Untreated depression can lead to suicide [40]. Approximately 1/3rd of the retired NFL players in the Schwenk et al. [9] study were unaware that the depressive symptoms they were experiencing were even important. With that said, how would these individuals know to seek out treatment? We suggest the following three straightforward strategies:

- The social and professional structures surrounding these athletes need to be made aware of the increased risk of depression and help the athletes monitor for symptoms so that appropriate treatment can be sought if warranted. This would include friends, family, coaches, athletic trainers, team and personal physicians all of whom could be in a vantage to help the players monitor for depressive symptoms such as anger, irritability, substance abuse or overtraining [41].

- The CESD-R is available on the web [42] and can readily allow for self-monitoring of depressive symptoms and condition. Retired and active football players should periodically use an instrument such as the CESD-R in order to self-monitor for depressive symptoms. The CESD-R website also has crisis hotlines in the event that an individual needs immediate help.

- Physical activity has been found to be an effective treatment against depression [33]. Further, vigorous physical activity has been shown to be protective in regards to preventing depression in aging retired athletes [43]. Retired football players should maintain a highly physical active life style as a countermeasure to help offset the risk of depression. In fact, these retired athletes might consider competing in master's athletic games where participants have reported positive social, psychological, and physical health benefits [44-50].

We believe these three simple strategies may provide an effective front line defense against the development and/or progression of depression in active and retired football players. Given that there is a lack of understanding as to the ideal assessment of depression in athletes [41], it would seem prudent that a multifaceted approach be employed where the social and professional structures surrounding

these athletes stand vigilant and collectively monitor these athletes.

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