

Depressive Symptoms and Concussions in Aging Retired NFL Players

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Abstract

We examined the relationship between a remote history of concussions with current symptoms of depression in retired professional athletes. Thirty retired National Football League (NFL) athletes with a history of concussion and 29 age- and IQ-matched controls without a history of concussion were recruited. We found a significant correlation between the number of lifetime concussions and depressive symptom severity using the Beck Depression Inventory II. Upon investigating a three-factor model of depressive symptoms (affective, cognitive, and somatic; Buckley et al., 2001) from the BDI-II, the cognitive factor was the only factor that was significantly related to concussions. In general, NFL players endorsed more symptoms of depression on all three Buckley factors compared with matched controls. Findings suggest that the number of self-reported concussions may be related to later depressive symptomology (particularly cognitive symptoms of depression).

Keywords: Concussion; Depression; Cognition; Aging; Football; NFL

Introduction

According to the Centers for Disease Control and Prevention (CDC), approximately 1.6–3.8 million sports and recreational concussions occur each year (Centers for Disease Control and Prevention [CDC], 2007; Langlois, Rutland-Brown, & Wald, 2006). Whereas a vast majority of individuals who sustain mild traumatic brain injury (mTBI) show good recovery within several weeks (Levin et al., 1987; Mooney, Speed, & Sheppard, 2005), some continue to experience lingering somatic, cognitive, and/or mood symptoms (Garden & Sullivan, 2010; Garden, Sullivan, & Lange, 2010; Gunstad & Suhr, 2004; Pellman, Viano, Casson, Arfken, & Powell, 2004; Szymanski & Linn, 1992; Wood, 2004). Many of these symptoms are often accounted for by non-neuropathological factors such as stress, substance use, and other pre-existing issues; however, some studies have found an association between repeat injuries and cumulative deficits. This variable recovery time may leave some individuals vulnerable for repeat injuries. (Belanger & Vanderploeg, 2005; Collins et al., 2002; Gerberich, Priest, Boen, Straub, & Maxwell, 1983; Gessel, Fields, Collins, Dick, & Comstock, 2007).

While guidelines from the 2007 National Football League (NFL) “Health and Safety” meeting mandated baseline and post-concussion neuropsychological testing, in addition to educating athletes and their families about concussion symptoms (Casson, Pellman, & Viano, 2008), these rules were not in place for many players who are now retired. In 2009, guidelines were developed requiring players to refrain from practice or play the day they suffer a concussion. The guidelines state that players need to be cleared by a team physician and an “independent neurological consultant” before returning to play. Unfortunately, many NFL athletes who were playing before these guidelines were developed may have continued to play following a concussion. Some athletes may not have recognized the acute symptoms of concussion, and/or they wanted to continue playing (Elleberg, Henry, Macciocchi, Guskiewicz, & Broglio, 2009). As a result, athletes may have incurred repeat concussions prior to full recovery of the initial injury. It is thus difficult to estimate the lasting impact of concussions for retired players since symptoms of concussion were not always reported by athletes.

While it is known that concussions can result in acute cognitive (De Beaumont et al., 2009; Guskiewicz et al., 2005) and/or mood disturbances (Amen et al., 2011; Guskiewicz et al., 2007; Johnston et al., 2004; Solomon & Haase, 2008), few studies have investigated the effects that may emerge later in life, especially those related to depressive symptoms. Interest in this topic has gained recent national attention in part, as a result of several suicides of retired professional athletes and the discussion of autopsy findings of some of these deceased individuals (McKee et al., 2009). The neuropathology in the deceased athletes indicated a tau protein accumulation and has been referred to as chronic traumatic encephalopathy (CTE); however, this remains a putative association. While there are no consensus diagnostic criteria for CTE, behavioral and personality changes including depression, apathy, irritability, suicidality have been suggested to be part of its clinical spectrum (Gavett, Stern, & McKee, 2011). The University of Michigan Report and Hart and colleagues (2013) found that retired NFL players were more likely to report symptoms of depression compared with the general population (age and race matched) (Weir, Jackson, & Sonnega, September, 2009). Results of this survey indicated that while retired athletes were just as likely to be currently depressed compared with a male national average (3%–4%), athletes were more likely to experience a lifetime history of depression (16%) compared with a male national sample. In assessing symptoms of depression, retired athletes were also more likely to endorse feeling irritable compared with controls. Guskiewicz and colleagues (2007) further found that retired professional football players with a reported history of three or more concussions were three times more likely to suffer from depression after retirement compared with retired NFL players without a history of concussion (Guskiewicz et al., 2007). A study by Dave and colleagues (2006) investigated seven longitudinal studies of the Health and Retirement Study from 1992 to 2005 and found that complete retirement leads to a 6–9% decline in mental health post-retirement and these effects are mitigated by being married, having a high social support, being physically active and working part-time post retirement.

In addition to the recent investigations of long-term effects of head injury in athletes, military studies have also examined the impact of early head trauma. A military veteran study investigated the long-term effects of early TBI (mild, moderate, and severe) on a total of 1,718 retired World War II veterans with and without TBI. Military records were reviewed to determine severity of TBI on the veterans who experienced a head injury ($n = 520$) and from 1996 to 1997 clinical interviews were conducted on all 1,718 veterans to assess signs and symptoms of depression using DSM-IV criteria. Results revealed that TBI early in life was a risk factor for chronic depression. In the study, 18.5% of World War II veterans with a history of head injury were depressed, which was higher than the 13.4% lifetime prevalence for military veterans without a history of a head injury. Current depression was 11.2% in veterans with TBI, compared with 8.5% of veterans without TBI (Holsinger et al., 2002). While head injuries acquired during military service may have a different impact than concussions accrued during football, these results suggested that individuals with a 50-year-old TBI were at a higher risk for developing recurrent depressive disorder during their lifetime.

The current study investigated depressive symptoms in retired professional football players with a remote history of concussion. Additionally, we recruited age-, education-, and IQ-matched healthy controls without a known history of concussion as a comparison group to investigate endorsement of symptoms on the Beck Depression Inventory-II (BDI-II). We hypothesized that there would be an association between depressive symptoms and number of concussions in former professional NFL players, and that athletes would endorse more symptoms of depression compared with controls.

Methods

Participants

We recruited 42 subjects from a local gathering of retired NFL players living in the North Texas region, a meeting of the NFL Players Association local chapter, local advertising, and word of mouth. Each player received a complete neurologic and neuropsychologic evaluation and those who were identified as cognitively impaired via consensus review by a board-certified neurologist and neuropsychologist were excluded. Participants with cognitive impairment were excluded because we did not want possible overlap of depressive symptoms that may be associated with a new onset neurological diagnosis. The neuropsychological battery included The Wechsler Adult Scale of Intelligence (Wechsler, 1999), Trail Making Test parts A and B (Reitan, 1958), the Wechsler Adult Intelligence Scale—Fourth Edition (Wechsler, 2008) Digit Span and Coding subtests, verbal fluency, Boston Naming Test (Kaplan, Goodglass, & Weintraub 1983), Rey-Osterrieth Complex Figure Test (Rey, 1941), California Verbal Learning Test-II (Delis, Kramer, Kaplan, & Ober, 2000), and Semantic Object Retrieval Test (SORT; Kraut et al., 2006). A clinical neurological diagnosis was determined using the neuropsychological data in combination with a neurological evaluation and structural MRI scan. Criteria for the diagnosis consisted of DSM-IV criteria for dementia, McKhann and colleagues (1984) criteria for Alzheimer's disease, and Petersen and colleagues (1999) for Mild Cognitive Impairment (MCI). A total of 30 retired players representing 23 NFL teams were enrolled in the study.

Players ranged in age from 41 to 77 years, with a mean of 58.60 ($SD = 10.33$) years. Their NFL/professional football career ranged from 2 to 15 years, with a mean of 9.17 ($SD = 3.11$) years. Twenty-eight were active businessmen and two were retired. Twenty-one were Caucasian and nine were African American. The mean education level was 16.30 years ($SD = 0.79$).

Concussion history was obtained retrospectively from participants and informants, and classified using the American Academy of Neurology (AAN) Practice Parameter guidelines for grading concussion (1997). Players reported symptom severity ranging from just a few seconds of confusion to more severe, with loss of consciousness. Concussion history included all concussions prior to, during, and after retirement from the NFL. Only one athlete had received a concussion post retirement. All players had sustained at least one concussion (range = 1–11) with an average of 3.97 ($SD = 2.76$) concussions over their lifespan. The type of concussions included Grade 1 ($M = 1.91$), Grade 2 ($M = .76$), and Grade 3 ($M = 1.23$).

We also screened 95 healthy control participants from normal aging studies at the Center for BrainHealth at the University of Texas at Dallas. Control participants with known concussions or history of playing football were excluded, as were those with evidence of cognitive impairment. Twenty-nine control participants met criteria and were matched for age, estimated IQ, and education to the retired player group. They ranged in age from 41 to 77 with a mean of 59.52 years ($SD = 10.64$) and 16.14 mean years of education ($SD = 2.15$). Twenty-eight were Caucasian, and 2 were African American. Five were retired and 24 were active businessmen.

Each participant gave written informed consent in accordance with the Institutional Review Board of the University of Texas Southwestern Medical Center and University of Texas at Dallas.

Measures

All participants completed the BDI-II (Beck, Steer & Brown, 1996), widely used self-report questionnaire assessing cognitive, affective, and somatic symptoms of depression. Participants rated the severity of each item on a four-point scale. Total scores were divided into minimal symptoms of depression (1–9) and mild-to-moderate (>10) symptoms of depression (Chen, Johnston, Petrides, & Ptito, 2008; Spreen & Strauss, 1998). The BDI-II was further subdivided into the three-factor symptom model as proposed by Buckley, Parker, and Heggie (2001) to provide a more detailed analysis of the nature of reported symptoms among athletes and controls. Three factors appear to capture the dimensions of depression in most factor-analytic studies (Buckley et al., 2001; Green, Felmingham, Baguley, Slewa-Younan, & Simpson, 2001), including an affective factor (e.g., loss of pleasure, loss of interest, indecisiveness), a cognitive factor (e.g., pessimism, feelings of guilt, self-dislike), and a somatic factor (e.g., loss of energy, tiredness/fatigue, and agitation). The Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) was also administered to characterize and match controls with former NFL players for overall cognitive ability. The assessment also included a neurological history (including questionnaire for post-concussive symptoms) and neurobehavioral examination by a cognitive neurologist (J.H.) for each player. The neurobehavioral examination included detailed history of mental status, including assessment of attitude, behavior, mood/affect, speech, thought process, perceptions, insight, and judgment.

Statistical Analysis

Analyses were conducted using SPSS version 19. Independent *t*-tests were conducted to compare demographic factors between retired NFL players and controls. Pearson correlations were conducted to assess the relationship between the number of concussions and depressive symptoms as assessed by the BDI-II. Independent *t*-tests were also conducted to compare BDI-II scores between NFL players and controls. We calculated the percent of individuals endorsing BDI-II items by group and calculated the percent difference between athletes and controls. We then subtracted the percent difference between athletes and controls for each item.

Results

There was no difference in age, [$t(55) = 0.42, p = .68$], education [$t(54) = -0.46, p = .65$] or estimated FSIQ [$t(50) = 0.07, p = .95$] between retired NFL athletes with a history of concussion and controls (non-NFL participants) without self-reported history of concussion. As depicted in Table 1, the retired athlete group produced significantly higher scores on all aspects of the BDI-II.

The number of lifetime concussions and total scores on the BDI-II were significantly correlated ($r = .43, p = .02$). This association remained ($p < .05$) even when cardiovascular risk factors, headaches, and arthritis were covaried. In investigating the Buckley three-factor model of the BDI-II, the number of concussions was significantly correlated with the BDI-II cognitive factor ($r = .56, p = .002$). When using the AAN Practice Parameter guidelines to grade concussions, there was no significant

Table 1. BDI scores for athletes and controls

	Athletes (<i>N</i> = 30)	Controls (<i>N</i> = 29)	<i>t</i> -value	<i>p</i> -value
Total BDI-II	8.80 (8.33)	2.83 (3.95)	−3.50	.001
BDI-II Cognitive	2.62 (3.68)	0.66 (1.11)	−2.76	.008
BDI-II Affective	1.59 (2.21)	0.38 (.90)	−2.72	.009
BDI-II Somatic	4.38 (3.68)	1.79 (2.52)	−3.12	.003

Note: BDI-II = Beck Depression Inventory-II.

Table 2. Frequency of BDI-II item endorsement among concussed athletes and controls

BDI-II ^a	Athletes (%)	Controls (%)	Difference	<i>p</i> -value
Cognitive factor				
1. Sadness	26.7	3.2	23.5	.003
2. Pessimism	20.0	3.2	16.8	.033
3. Past failure	23.3	12.9	10.4	.018
5. Guilty feelings	33.3	12.9	20.4	<.001
6. Punishment feelings	6.7	0	6.7	.19
7. Self-dislike	23.3	3.2	20.1	.017
8. Self-criticalness	40.0	25.8	14.2	.013
9. Suicidal thoughts or wishes	16.7	0	16.7	.08
14. Worthlessness	20.0	0	20.0	.033
Affective factor				
4. Loss of pleasure	33.3	16.1	17.2	.012
10. Crying	26.7	3.2	23.5	.30
12. Loss of interest	33.3	6.5	26.8	.032
13. Indecisiveness	26.3	3.2	23.1	.015
Somatic factor				
11. Agitation	26.7	19.4	7.3	.05
15. Loss of energy	60.0	29.0	31.0	.001
16. Changes in sleep pattern	56.7	25.8	30.9	<.001
17. Irritability	36.7	12.9	23.8	<.001
18. Changes in appetite	46.7	12.9	33.8	.018
19. Concentration difficulty	53.3	19.3	34.0	.009
20. Tiredness or fatigue	36.7	22.6	14.1	.017
21. Loss of interest in sex	43.3	16.1	27.2	.019

^aNote: Three-factor model as proposed by Buckley and colleagues (2001).

correlation between grades 1, 2, or 3 concussions and BDI-II scores. BDI-II scores were also unrelated to age, education, IQ, or years played.

In examining total BDI-II scores, more athletes endorsed items on the BDI-II compared with controls (Table 2). Twelve athletes endorsed mild (BDI-II = 10–16, *n* = 6) to moderate (BDI-II > 17, *n* = 6) symptoms, and three controls endorsed mild depressive symptoms. Only two athletes received prior assessment and treatment for their depression. Independent *t*-tests were also performed to compare BDI-II scores between all players and controls to evaluate endorsement of depressive symptoms of healthy aging versus concussed athletes. Athletes scored significantly higher on total BDI-II scores and on each of the three Buckley factors; cognitive, affective, and somatic (Table 2).

Discussion

Results indicated a modest but significant relationship between the number of remote self-reported concussions and current self-reported depressive symptoms in retired professional football players. These findings suggest that as the number of concussions increase, the likelihood of reporting depressive symptoms also increases. These results are consistent with the finding of Guskiewicz (2007) who also found a relationship between concussions and depressive symptoms in retired NFL athletes. Upon further examination of the BDI-II using the Buckley three-factor model, only the Cognitive factor was significantly correlated with the number of concussions. This suggests that repeated head injuries are associated with “cognitive” symptoms of

depression such as sadness, feelings of guilt, and critical self-evaluations. In contrast, somatic and affective symptoms of depression were not significantly correlated with history of concussion.

In the current study, 12 of the 30 retired players endorsed mild-to-moderate symptoms of depression on the BDI-II, 10 of whom had not been previously assessed and/or treated. This is in comparison to only three controls in the study endorsing mild symptoms of depression. The percentage of retired athletes endorsing mild-to-moderate symptoms of depression (40%) is higher than the national average of ~15% of older adults experiencing symptoms of depression (Penninx et al., 1998). Overall, retired athletes obtained significantly higher scores on all three Buckley factors on the BDI-II, in comparison to the controls.

Athletes endorsed more symptoms of depression on every BDI-II item, and did so by more than 20% on 13 of the 21 total items. The five largest differences in BDI-II symptoms between athletes and controls included concentration, changes in appetite, loss of energy, changes in sleep, and loss of interest in sex (Buckley somatic factor). While somatic complaints were not significantly correlated with concussions, they were more prominent in the athletes in comparison to the other items on the BDI-II.

Many of the players with elevated BDI-II scores said that they did not realize their somatic complaints may reflect symptoms associated with depression. One study investigating depression and pain in retired athletes found that one of the most common barriers to seeking help was that athletes failed to recognize symptoms of depression (Schwenk, Gorenflo, Dopp, & Hipple, 2007). It is possible that athletes may attribute some of the somatic symptoms of depression to physical pain that many retired athletes experience as a result of competing at the professional level (Horn, Gregory, & Guskiewicz, 2009; Schwenk et al., 2007; Turner, Barlow, & Heathcote-Elliott, 2000). As a result, athletes did not acknowledge or endorse feeling “depressed” despite the high endorsement of somatic symptoms on the BDI-II. It is therefore not surprising that 10 of the 12 athletes endorsing mild-to-moderate symptoms of depression were not previously assessed or treated for depression. Undetected and untreated depression can lead to suicide, which has increased the investigations of CTE in former athletes. While there are no clear diagnostic criteria for CTE, it is important to assess the clinical symptoms reportedly associated with CTE (Gavett et al., 2011). In addition, Post-Concussive Syndrome consists of a collection of symptoms, including mood disruption, that do not have clear diagnostic criteria. Consideration should also be given to depression in these settings being possibly associated with white matter disease, given that concussion and depression have both been linked to white matter dysfunction (Hart et al., 2013).

One of the difficulties in assessing the consequence of concussions on mood in retired athletes is that most of the concussions occurred during their professional football career years ago. Retrospective reporting of concussion may be unreliable but is an unavoidable limitation in this type of research. However, Kerr, Marshall and Guskiewicz (2012) examined the reliability of retrospective reporting of concussions by retired NFL players 9 years apart and found moderate reliability. In addition, other limitations to symptom self-report can be related to contemporaneous terminology and susceptibility to report bias. We carefully interviewed each player, asking the same questions about events and symptoms, and all could identify episodes that were consistent with concussion. Furthermore, other factors such as retirement and physical pain can affect mood. Transition to retirement can be difficult for professional athletes, especially if it was a sudden cessation of the sport due to injury or other unexpected circumstances (Schwenk et al., 2007). Therefore, in addition to concussion, the context of retirement may be another contributing factor to depressive symptoms for retired NFL players and should be examined in future studies. It is, however, important to note that retirement for most of the athletes in this study occurred over 20 years ago, and 28 of the 30 retired NFL athletes in the current study were fully employed at the time of examination. It is possible that enough time has passed for these older athletes to adapt and accept the transition from the NFL to their second career so that “retirement” per se may not be a major factor in our findings.

Another limitation of this correlational study is the small sample size and the inclusion of only athletes with a remote history of concussion. Future studies will need to include a larger sample and compare former athletes with and without a history of concussion and possibly the impact of early concussions in professional athletes versus non-professional athletes. However, this study is unique in that it included current endorsement of affective, cognitive, and somatic depressive symptoms between retired professional athletes and carefully matched controls without a concussion history.

Overall, results compliment previous research that indicates individuals having sustained concussions in early adulthood may be at a higher risk for developing depression as they age compared with the general population (Guskiewicz et al., 2007; Holsinger et al., 2002; Koponen et al., 2002). The findings further indicated that specific symptoms of depression may occur more frequently in athletes compared with controls and merit further investigation. More specifically, concussions were related to *cognitive* symptoms of depression, and it is possible that the high endorsement of somatic symptoms may be related to pain or other factors. This highlights the need to educate individuals and families about somatic and psychological symptoms associated with depression and to thoroughly assess depressive symptoms throughout the lifespan in professional athletes.

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Conflict of Interest

None declared.

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