Functional Limitations Mediate the Relationship Between Pain and Depressive Symptoms in Former NFL Athletes

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Abstract

The objective of this study was to analyze data from the National Football League Player Care Foundation Study of Retired NFL Players to understand potential risks for depressive symptoms in former athletes by investigating the relationship between pain and depressive symptoms in a multivariate context, while simultaneously exploring the potential connection with functional limitations. Descriptive statistics were used to describe the study sample and to conduct bivariate comparisons by race and age cohort. Linear regression models were conducted in the subsample of respondents reporting on depressive symptoms using the PHQ-9. Models examine the relationship of bodily pain, injury as a reason for retirement or not re-signing with a team, length of NFL career, sociodemographic characteristics, chronic conditions, and functional limitations to depression. Interaction terms tested whether race and age moderated the effect of bodily pain and functional limitations on depressive symptoms. Bivariate associations revealed no significant differences between younger and older former players in indicators of pain and only slightly higher functional limitations among younger former players. In the multivariate models, pain was significantly associated with depressive symptoms ($\beta = 0.36$; $p < .01$), net of a range of relevant controls. Adding an index of functional limitations reduced this association by nearly half ($\beta = 0.20$; $p < .01$) and functional limitations was significantly associated with depressive symptoms ($\beta = 0.40$; $p < .01$). No statistically significant interactions were found. Overall, bodily pain was strongly associated with depressive symptoms. After accounting for the effects of functional limitations, this association was notably reduced. These results may be useful in identifying aging-related physical declines in relatively younger adult men who may be at the greatest risk for depression. They highlight how physical functionality and activity may mitigate the risk of depression, even in the presence of significant bodily pain.

Keywords

aging, pain, NFL athletes, depressive symptoms, functional limitations

The mental health and well-being of former National Football League (NFL) athletes is of increasing public interest (Dean & Rowan, 2014; Kerr, Marshall, Harding Jr, & Guskiewicz, 2012; Weir, Jackson, & Sonnega, 2009). Previous research has focused on the link between mild traumatic brain injury (mTBI) or concussion and depressive symptoms (Guskiewicz et al., 2007; Kerr et al., 2012; Solomon, Kuhn, & Zuckerman, 2016; Stern et al., 2011). While prevalent, results from a multiyear study suggest most NFL athletes have not been diagnosed with concussion, nor do they display recognized symptoms of head injury during their careers (Casson, Viano,

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Powell, & Pellman, 2010). Some former athletes without a reported history of sports-related concussion experience depressive symptoms (Schwenk, Gorenflo, Dopp, & Hipple, 2007). Little research has examined whether other, non-concussion-related injuries increase the risk of depressive symptoms (Guskiewicz et al., 2007; Holsinger et al., 2002).

Given the well-documented association between pain and depressive symptoms (Feeley et al., 2008; Shankar, Fields, Collins, Dick, & Comstock, 2007), surprisingly few studies have examined this link in former NFL athletes. Schwenk et al. (2007) reported a 73% comorbidity of high levels of self-reported pain and high depressive symptoms in retired NFL athletes. That study examined only bivariate associations, leaving open the question of what other physical factors may be associated with depressive symptoms. A leading contender is functional limitations, which are defined by Verbrugge and Jette (1994) as "restrictions in performing fundamental physical actions used in daily life" (p. 3). Functional limitations are associated both with pain (Liechtenstein, Dhanda, Cornell, Escalante, & Hazuda, 1998) and with depressive symptoms, especially in older populations (Bair, Robinson, Katon, & Kroenke, 2003; Ormel, Rijsdijk, Sullivan, Van Sonderen, & Kempen, 2002; Schieman & Plickert, 2007; Yeom, Fleury, & Keller, 2008). Because of the extreme demands of NFL play, functional limitations may be a cause for concern even in younger former players who may exhibit diminished physical capability associated with a pattern of accelerated aging (Belsky et al., 2015), with, for example, rates of arthritis comparable to much older men (Weir et al., 2009).

Despite recent public interest in the health of NFL athletes, a dearth of literature exists on the relationship between injury, pain, functional limitation, and depressive symptoms in this population. Using cross-sectional data from the National Football League Player Care Foundation Study of Retired NFL Players, this study builds on Schwenk et al. to examine the relationship between pain and depressive symptoms in a multivariate context permitting the exploration of the potential connection with functional limitations. Patterns of physical decline might be expected to appear at an earlier stage in the life course in this population. Indeed, prior work has reported high levels of pain in younger retired NFL athletes (Turner, 2018). The present study investigates potential age differences in the associations among pain, functional limitations, and depressive symptoms. Similarly, as the demographic profile continues to shift from a once–White majority sport to one where nearly 70% of the NFL athletes are Black (Turner, 2018), it has become important to elucidate potential racial differences in the risk pathways. Therefore, this study examines the potential effects of racial group differences.

In the case of NFL football players, injury emerges as an occupational hazard that exposes healthy young men to increased risk of functional limitations as they age. This is similar to the cases of many other collision sport athletes (e.g., boxing, roller derby, ice hockey, soccer, lacrosse, rodeo, full-contact martial arts; *Segen's Medical Dictionary*, 2011) who may equally be at risk for premature functional decline and potentially elevated depressive symptoms (Gouttebarge, Aoki, Lambert, Stewart, & Kerkhoffs, 2017; Hume et al., 2017; Manley et al., 2017; Marshall et al., 2015). Improved understanding of risks for depressive symptoms in former NFL athletes may serve as a potential model for pain, functional status, and aging to support efforts in depression treatment and intervention.

Method

Sample

Data are from the National Football League Player Care Foundation Study of Retired NFL Players (Weir et al., 2009), a survey of retired players conducted at the University of Michigan's Institute for Social Research with a cross-sectional field period that spanned 2006–2007. The Foundation provided a complete listing of 6,983 former NFL players with vested rights (3–4 years active career) in the NFL's pension system. A stratified random sample of 1,625 players was selected for telephone interviews. Strata were based on age and disability pension status, with older age groups and those with disabilities oversampled. The overall response rate was 65.4%, resulting in an analytic sample of 1,063. Sampling weights were used to adjust for the sample design and nonresponse (Weir et al., 2009).

Measures

Depressive symptoms. Depressive symptoms were measured in a subsample of the total sample using the Patient Health Questionnaire-9 (PHQ-9; Kroenke, Spitzer, & Williams, 2001). All respondents completed the following four screening questions (Jackson et al., 2004): "Have you ever in your life had a period of time lasting several days or longer when most of the day you felt sad, empty or depressed?"; "Have you ever in your life had a period of time lasting several days or longer when most of the day you were very discouraged about how things were going in your life?"; "Have you ever in your life had a period of time lasting several days or longer when you lost interest in most things you usually enjoy like work, hobbies, and personal relationships?"; and "Have you ever in your life had a period of time lasting several days or longer when most of the time you were very irritable, grumpy or in a bad

mood?" The fourth question is thought by some researchers to capture a more masculine form of depression, that is, irritability rather than sadness (Jackson et al., 2004). Respondents who answered yes to at least one of these questions were also asked if they had those feelings within the past month. If they responded affirmatively to having these feelings in the past month, they were then asked to answer the nine items of the PHQ-9.

Questions on the PHQ-9 asked how much in the past 2 weeks respondents were bothered by the following: "Having little interest or pleasure in doing things"; "Feeling down, depressed, or hopeless"; "Trouble falling asleep, staying asleep, or sleeping too much"; "Feeling tired or having little energy"; "Poor appetite or overeating"; "Feeling bad about yourself—or that you are a failure or have let yourself or your family down"; "Trouble concentrating on things, such as reading the newspaper or watching television"; "Moving or speaking so slowly that other people could have noticed—or the opposite—being so fidgety or restless that you have been moving around a lot more than usual"; and "Thoughts that you would be better off dead, or of hurting yourself in some way." Responses ranged from 0 to 3, and the resulting scale ranged from 0 to 27.

NFL career variables. We created a dichotomous indicator measuring the importance of injuries in the respondents' decision to retire or in their not re-signing with a team, where 1 indicated *very important* and 0 indicated *somewhat* or *not very important*. Tenure in the NFL indicated number of years playing in the NFL (range 3–29).

Pain. Respondents were asked whether in the past 3 months, they had experienced severe headaches or migraines and whether in the past 3 months, they had experienced nonminor pain that lasted a day or more in their neck or lower back. Respondents were asked whether they had experienced any joint pain within the past 30 days. Four dichotomous indicators were created for (a) severe headaches or migraines, (b) neck pain, (c) low back pain, and (d) any joint pain. A pain index indicated the number of pain symptoms reported with a range from 0 to 4.

Functional limitations. Functional limitations were assessed using the 12 items of the Nagi scale (Nagi, 1976). Respondents were asked how difficult it was for them to do things like climbing several flights of stairs; stoop, bend, or kneel; or pull or push large objects. A count of limitations was created that ranged from 0 to 12 for the number of activities respondents experienced "somewhat or greater difficulty" performing. This method of assessment provides a direct measure of everyday physical functioning.

Chronic conditions. To assess history of several chronic diseases, respondents were asked, "Have you ever been told by a health care professional that you had (disease)?" A count of the history of the following seven chronic diseases was created: high blood pressure, diabetes, coronary heart disease, stroke, emphysema, cancer, and asthma with a range of 0–7. This simple disease count method is the most commonly used form to determine multiple conditions (Wallace, McDowell, Bennett, Fahey, & Smith, 2016).

Sociodemographic characteristics. Respondents' age in years was coded both continuously and as a dichotomous variable distinguishing younger (30–49 years) and older aged men (50–90 years). Race was dichotomously coded with White equal to 1 and Black equal to 0. Education was a continuous measure of the number of years of schooling. Marital status was coded 1 for currently married and 0 for currently unmarried. Total household income and net household wealth were computed based on a series of questions on various sources of income (including wages, royalties, dividend income, pension income, etc.) and assets (including value of home, vehicles, investments, retirement accounts, etc., minus any debts). These values were reported in 2007 dollars in the table of descriptive results. The natural log of total assets and total income was used in the regression models.

Data Analysis

Descriptive statistics were generated for all study variables in the total sample of 1,063 respondents in Column 1 of Table 1. The rest of Table 1 presents a series of bivariate comparisons. The first comparison was between those who screened into the PHQ-9 section ($n = 207$, Column 2 of Table 1) with those who did not screen into the PHQ-9 ($n = 856$, Column 3 of Table 1). The next two sets of comparisons were within the PHQ-9 subsample. To examine potential race and cohort differences, a comparison between Black men ($n = 104$, Column 4) and White men ($n = 103$, Column 5) and between younger men ($n = 100$, Column 6) and older men ($n = 107$, Column 7) was conducted. Chi-square tests were used to compare dichotomously coded variables, and t tests were used to compare means on all continuous variables (Weiss & Weiss, 2012).

Correlations among the study variables were conducted. Linear regression models were employed to examine the independent relationships of study covariates with depressive symptoms in the subsample of men who screened into the PHQ-9 section. Zero-order regression coefficients are first reported. Model 1 evaluated the influence of the pain index and relevant sociodemographic characteristics. Model 2 added an index of

Table 1. Descriptive Statistics on Study Variables and Bivariate Comparisons.

Characteristic	Total sample n = 1,063	Sample not in PHQ-9 n = 856	PHQ-9 subsample[a] n = 207	Black men n = 104	White men[b] n = 103	Younger men n = 100	Older men[c] n = 107
Migraine past 3 months (%)	20.98	16.37	39.57**	46.74	31.89*	42.74	34.65
Any back pain past 3 months (%)	52.85	49.45	66.60*	80.38	51.83**	67.76	64.80
Any neck pain past 3 months (%)	35.42	30.85	53.86**	50.32	57.66	53.30	54.74
Any joint pain past 30 days (%)	78.84	76.67	87.54*	90.60	84.27	87.82	87.12
Pain index (0–4)	1.88	1.73	2.48*	2.68	2.26	2.52	2.41
Age (range 27–90 years)	49.89	50.46	47.46	44.28	50.86**	39.07	60.45
White race (%)	53.78	44.85	51.72	-	-	40.98	59.60**
Education (mean years)	17.49	17.56	17.18	16.84	17.54*	17.03	17.41
Married (%)	78.73	80.66	70.80*	61.63	80.40**	65.59	79.29**
Household income ($)	155,836	163,255	130,858**	123,992	138,212*	139,286	117,799*
Household wealth ($)	2,805,192	3,008,055	1,986,313**	1,098,209	2,937,676**	2,618,805	1,006,377**
Injury as a reason for retirement (%)	62.32	59.94	73.48**	78.51	68.09**	79.95	63.44**
Tenure in the NFL (mean years)	6.76	6.74	6.81	6.82	6.80	6.37	7.50
Number of chronic conditions	2.53	0.80	1.10	0.96	1.26	0.90	1.41
Number of functional limitations (0–12)	3.20	2.71	5.16**	5.61	4.68	4.71	5.86
Depressive symptoms (0–27)			9.62	10.32	8.87	9.22	10.24

Note. Percentages and means are weighted using sampling weights as described in the text; sample sizes reflect the unweighted *n*. NFL = National Football League; PHQ-9 = Patient Health Questionnaire-9.

[a]Comparison of PHQ-9 subsample with the sample not in PHQ-9. [b]Comparison of Black men and White men. [c]Comparison of younger men and older men.

*p < .05. **p < .01.

chronic conditions and an index of functional limitations. A last set of models added interaction terms to Model 2 for race and age with the pain index and race and age with functional limitations. *S*tandardized regression coefficients are reported and the variance inflation factor (VIF) was used to test for potential collinearity among the independent variables (O'Brien, 2007). All analyses were conducted using SAS 9.4 (Institute, S.A.S., 2014) and included appropriate sampling weights.

Results

The first column of Table 1 displays means and percentages for all study variables in the total sample of 1,063 respondents. The mean age in the total sample was 49.89 years with a range of 27–90 years. Average tenure in the NFL was 6.76 years. Injury as a reason for retirement or not re-signing with the NFL was reported by 62.32%, although some athletes may overstate the role of injury as a more comfortable alternative explanation to age-related decline. Average annual household income was $155,836 and average household wealth was $2,805,192. Self-reports of recent pain were high, with 78.84% experiencing any joint pain, 52.85% experiencing any back pain, 35.42% experiencing any neck pain, and 20.98% reporting migraine headache.

Comparing those who screened into the PHQ-9 section to those who did not (Columns 2 and 3), men in the PHQ-9 subsample had significantly less household income and wealth than those not in the PHQ-9 subsample. There were marked differences in health, pain, and functional limitations. For example, 16.37% of those not in the PHQ-9 subsample had experienced recent migraine compared to 39.57% of men in the PHQ-9 subsample ($p < .01$). The report of any joint pain was fairly high even in the subsample who did not screen in but was significantly higher among those in the PHQ-9 subsample (76.67% vs. 87.54%; $p < .05$). Those who reported that injury was a very important reason for retirement or not re-signing with a team were more likely to screen in (73.48% vs. 59.94%; $p < .01$).

The comparison by race (Columns 4 and 5) revealed older average age among Whites (50.86% versus 44.28%; $p < .01$), a higher rate of current marriage in Whites compared to Blacks (80.40% vs. 61.63%; $p < .01$), and higher levels of household income and wealth. In terms of NFL experience, Black men were more likely to report injury as a reason for retiring or not re-signing (78.51% vs. 68.09%; $p < .01$), but there were no differences in the average tenure in the NFL. White men had significantly lower rates of migraine (31.89% vs. 46.74%; $p < .05$) and back pain than Black men (51.83% vs. 80.38%; $p < .01$).

Comparing younger and older men (Columns 6 and 7), 59.96% of the older men were White compared to nearly

40.98% of the younger group, which reflects the fact that more Blacks entered the NFL over time. Younger men were more likely to report that injury played a significant role in their retirement or not re-signing decision (79.95% vs. 63.44%; $p < .01$). Older men reported a slightly higher number of functional limitations than younger men (5.86% vs. 4.71%; $p < .05$), but strikingly, there were no age-related differences in any of the four individual pain measures or the pain index. In the total PHQ subsample, an average of 9.62 depressive symptoms was reported within the past 2 weeks. There were no statistically significant differences across race and age groups in mean depressive symptoms.

Table 2 presents correlation coefficients for all study variables within the PHQ-9 subsample. Depressive symptoms were positively and statistically significantly associated with migraine ($r = 0.33, p < .01$), neck pain ($r = 0.33, p < .01$), back pain ($r = 0.30, p < .01$), joint pain ($r = 0.25, p < .01$), injury as a reason for retirement or not re-signing ($r = 0.33, p < .01$), and functional limitations ($r = 0.53, p < .01$). Depressive symptoms were inversely correlated with net household wealth ($r = −0.28, p < .01$). All four pain measures were positively intercorrelated ($r = 0.22–0.31, p < .01$) and were all positively correlated with functional limitations ($r = 0.25–0.38, p < .01$). The pain index was significantly associated with functional limitations ($r = 0.48, p < .01$).

Turning to the regression results (Table 3), in Model 1, the pain index and injury as a reason for retiring or not re-signing were both positively associated ($β = 0.36, p < .01$ and $β = 0.23, p < .01$, respectively) and household assets were negatively associated ($β = −0.18, p < .01$) with depressive symptoms. In Model 2, functional limitations exerted a large and statistically significant risk for depressive symptoms ($β = 0.40, p < .01$) and reduced the effects of pain by nearly half ($β = 0.20, p < .01$). Higher household wealth remained significantly associated with lower depressive symptoms ($β = −0.17, p < .05$). VIF was no higher than 1.57 for any covariate, indicating no significant multicollinearity (Allison, 2012). Interaction terms with age and race and pain as well as age and race and functional limitations were not statistically significant, that is, the relationship between any bodily pain and depressive symptoms and between functional limitations and depressive symptoms did not differ by either race or age. This outcome may be at least partially the result of conducting three-way interaction tests of race, pain, and functional limitation in a relatively small sample.

Discussion

The major findings of this study build upon Schwenk et al. (2007), who pointed to a strong association between

Table 2. Correlations Among Study Variables in PHQ-9 Subsample ($n = 207$).

Characteristic	Migraine	Neck pain	Back pain	Joint pain	Pain index	Injury	Tenure	Age	White race	Education	Married	Income	Assets	Chronic	Functional limitations
PHQ	0.33**	0.33**	0.30**	0.25**	0.46**	0.33**	−0.04	−0.004	−0.11	−0.15*	−0.10	−0.08	−0.28**	0.07	0.53**
Migraine		0.29**	0.22*	0.26**	0.68**	0.07	0.03	−0.12	−0.15*	−0.09	−0.03	−0.03	−0.27**	−0.04	0.28**
Neck pain			0.31**	0.29**	0.73**	0.11	0.03	−0.04	0.07	−0.15*	−0.02	−0.05	−0.00	−0.02	0.38**
Back pain				0.17*	0.66**	0.13	0.21*	0.01	−0.30**	−0.16*	−0.02	−0.01	−0.15*	−0.05	0.36**
Joint pain					0.57**	−0.03	−0.03	−0.07	−0.10	−0.07	−0.01	−0.01	−0.15*	−0.10	0.25**
Pain index						0.12	0.10	−0.08	−0.18**	−0.18*	−0.03	−0.04	−0.22*	−0.06	0.48**
Injury							−0.07	−0.20**	−0.12	−0.11	−0.06	−0.01	0.07	0.03	0.31*
Tenure								0.29**	−0.00	0.02	0.14*	−0.04	0.04	−0.10	0.09
Age									0.27**	0.11	0.19*	−0.04	−0.14*	0.30**	0.17*
White race										0.23**	0.21*	0.05	0.19*	0.14*	−0.11
Education											0.10	0.05	0.12	0.01	−0.29**
Married												−0.00	0.09	0.06	−0.13
Income													0.18*	0.07	0.00
Assets														−0.08	−0.18**
Chronic conditions															0.15*

Note. PHQ-9 = Patient Health Questionnaire-9.
*$p < .05$. **$p < .01$.

Table 3. Linear Regression of PHQ-9 Depressive Symptoms.

	Model 1	Model 2
Parameter	β	β
Pain index	0.36**	0.20**
Injury as reason for retirement	0.23**	0.14*
Tenure in the NFL	−0.07	−0.07
Age	0.06	−0.06
White race	0.01	0.03
Years of education	−0.03	0.06
Married	−0.06	−0.01
Household income	−0.02	−0.05
Household assets	−0.18**	−0.17**
Chronic conditions		0.01
Functional limitations		0.40**
R^2	0.31	0.41
Adjusted R^2	0.27	0.37

Note. Regressions weighted using sampling weights as described in the text. NFL = National Football League; PHQ-9 = Patient Health Questionnaire-9.
*$p < .05$. **$p < .01$.

pain and depressive symptoms in former NFL athletes. The findings extend those Schwenk et al. by reporting that much of this relationship is accounted for by functional limitations. The Nagi scale (Johnson & Wolinsky, 1993; Nagi, 1976; Unger, McAvay, Bruce, Berkman, & Seeman, 1999), a well-regarded measure of physical functioning, was used to ascertain former athletes' perceived difficulties in performing 12 functional tasks. While bodily pain was strongly associated with depressive symptoms, after accounting for the effect of functional limitations, the association was reduced by nearly half. Prior research has identified that adults who self-reported significant pain prematurely developed functional limitations typically associated with those experienced by older age adults. For example, results from a nationally representative study of community-living persons age 50 years and older found that participants with significant pain had high rates of functional limitations similar to those of participants two to three decades older (Covinsky, Lindquist, Dunlop, & Yelin, 2009), although a causal association could not be determined.

Declines in functional limitations that impair independent living often occur with age. These functional limitations—such as difficulty with basic body functions, for example, lifting and carrying, climbing, or walking upstairs—rather than the more usual activities of daily living (ADLs) and independent activities of daily living (IADLs; Freedman & Martin, 1998) are so strongly associated with aging that they are regarded as a core part of the aging phenotype. Previous empirical analyses provide support that functional limitations are important initial markers of later life disability (Altman, Seelman, & Bury,

2001; Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995; Johnson & Wolinsky, 1993; Lawrence & Jette, 1996). A key finding of this study is that younger former NFL athletes (30–49 years) experienced only slightly lower functional limitations than their more senior peers (ages 50+ years). While research on functional limitations among former athletes is sparse, these results align with a cohort study of 103 female soccer players between the ages of 26 and 40 years who sustained an anterior cruciate ligament (ACL) injury 12 years earlier (Lohmander, Östenberg, Englund, & Roos, 2004). In both studies, a very high prevalence of arthritis, pain, and functional limitations was reported in these former athletes prior to age 50 years. The findings of the present study suggest that in the context of high levels of pain among former NFL athletes, the early onset of functional limitations may well lead to an increased likelihood of depressive symptoms in adulthood.

These results are consistent, albeit indirectly, with research suggestive of protective effects of physical activity on depressive symptoms. It may be that the strong results in this study related to functional limitations represent the obverse effect, especially for former NFL athletes who were accustomed to high rates of physical activity as young adults (Turner, Barlow, & Heathcote-Elliott, 2000). Additionally, the hypothesis that patterns of physical decline appear at an earlier stage in the life course was confirmed. Among former NFL athletes, functional limitations may lead to reduced physical activity and have a similar negative psychosocial impact on mental health similar to, for example, osteoarthritis (Turner et al., 2000). While restricted physical activity may be related to depressive symptoms among older men, it might be especially so in younger men. For example, outcomes from a study of community-dwelling adults demonstrated the protective effects of physical activity on depression among older adults (Strawbridge, Deleger, Roberts, & Kaplan, 2002). Similarly, a longitudinal study of elite former male athletes revealed that low or decreased physical activity at baseline was related to greater risk of depression over time (Bäckmand, Kaprio, Kujala, & Sarna, 2003).

Considerable effort has been directed at documenting the relationship between depressive symptoms and physical functioning, disability IADLs and ADLs, and mobility. Findings from the Italian Longitudinal Study on Aging indicate that baseline depressive symptoms were associated with higher rates of reported disability in men and women over a 3.5-year period (Dalle Carbonare et al., 2009). In a separate study of high-functioning older adults free of any disability, Bruce, Seeman, Merrill, and Blazer (1994) determined that increased levels of depressive symptoms predicted an increased risk of the onset of disability in basic ADLs over a 2.5-year interval. As the population of older

adults continues to expand, the need to examine the relationship between functional limitations and depressive symptoms will become even more pronounced. The results of our study align with findings of investigators who reported a relationship between functional limitations and depressive symptoms in an older adult population (Gallo, Rabins, Lyketsos, Tien, & Anthony, 1997; Hybels, Pieper, & Blazer, 2009; Penninx, Leveille, Ferrucci, van Eijk, & Guralnik, 1999). Nevertheless, the current analysis uncovered similar findings in the younger cohort of former NFL athletes, which may again suggest an accelerated aging process in functional limitations.

Reducing costs and managing burdens associated with aging depends on understanding the progression from health to chronic disease and disability (Belsky et al., 2015). It is valuable to study this progression in younger samples of adults with extremely physically demanding occupations earlier in life, which may lead to premature age-related functional limitations and can place them at risk for depressive symptoms in older age.

Limitations

Several limitations must be considered when interpreting the results of this study. These data are based on self-reported measures and did not use direct measures of disease and functional limitations. Retired professional athletes are a population for whom physical performance was critical to occupational success and they may well be more medically aware than the general population, thus resulting in an over-reporting bias. Prior findings suggest that these reports benchmark well to the general population (Weir et al., 2009). Nonetheless, the National Football League Player Care Foundation Study of Retired NFL Players did not include questions about the use of pain medications and the treatment of depression or other mental health disorders.

The current study did not include information on position played and what, if any, injuries were sustained during tenure in the NFL. This information would improve the capability to more accurately identify exposure. Former players in this sample were eligible for an NFL pension, including between 3 and 4 years of NFL league experience. These results may not generalize to all retired players. Furthermore, the cross-sectional design limited the exploration of potential causal associations with depressive symptoms. Future research should focus on obtaining more than one observation to provide stronger evidence about the relationships among pain, functional limitations, and depressive symptoms over time.

Implications

Given the growing concerns of illicit drug use disorders and nonmedical use of prescription drugs among adults age 50+ years (Wu & Blazer, 2011), this study highlights the importance of developing alternative methods to manage pain that may be associated with depressive symptoms. In the case of NFL football players, injury emerges as an occupational hazard that exposes healthy young men to increased risk of functional limitations as they age. The finding that injury is a major reason for retirement or not re-signing suggests that this group of retirees may merit a special focus for intervention. While participation in this study was limited to retired NFL athletes with vested retirement rights, there is reason to believe that aging collegiate football players may be at similar risk of experiencing depressive symptoms. This concern is highlighted by high rates of injury experienced by individuals in this population (Hootman, Dick, & Agel, 2007).

In addition to vested former NFL athletes, the finding from this study may extend to nonvested former NFL athletes, Arena Football League (AFL), Canadian Football League (CFL), semiprofessional, and collegiate football players as well as. Football players often experience a long apprenticeship playing in high school and college prior to working on the professional level (Turner, 2018). Epidemiological research in the United States indicates American football is the leading cause of sport-related injuries among high school and collegiate athletes (Shankar, Fields, Collins, Dick, & Comstock, 2007). The present study finds that functional limitations, even after accounting for bodily pain, pose a significant risk for depressive symptoms. This information can inform the development of programs to help former football players.

Conclusion

Existing research has focused on assessing the prevalence of depressive symptoms and difficulty with pain in retired football players. In the present study, in a sample of former NFL athletes, the association between pain and depressive symptoms and premature aging-related functional limitations was studied. The variability of these relationships across race and age cohort was examined. In line with earlier research among former NFL athletes (Schwenk et al., 2007), pain was studied in relation to depression symptoms without assuming a pathway of influence exists in either direction.

The results of this study highlight the importance of examining the relationship among physical activities covariates, depressive symptoms, and gender, and may be useful for clinicians and others that treat men who were exposed to intensely physically demanding occupations as young adults. In summary, the findings from this study suggest that diminished physical function is particularly important for the mental health of former NFL athletes

and largely explains the relationship between pain and depressive symptoms. Future studies focused on the risk factors for depressive symptoms associated with functional limitations should expand beyond vested former NFL athletes to consider studying male and female collision sport athletes (e.g., hockey, soccer) who face high levels of bodily pain and injury.

Declaration of Conflicting Interests

Funding

Statement of Ethics Approval Is Not Required

Ethics approval is not required for this article, given that it does not rise to the level of human subject research. No data were collected from human subjects. This is an analysis of secondary data intended to contribute generalizable knowledge about functional limitations, pain, and depressive symptoms among former NFL athletes. The primary beneficiaries of the research are other researchers and scholars in the field of social science and medicine.

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