Associations between BMI Change and Cardiometabolic Risk in Retired Football Players

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ABSTRACT

TREXLER, E. T., A. E. SMITH-RYAN, J. D. DEFREESE, S. W. MARSHALL, K. M. GUSKIEWICZ, and Z. Y. KERR. Associations between BMI Change and Cardiometabolic Risk in Retired Football Players. *Med. Sci. Sports Exerc.*, Vol. 50, No. 4, pp. 684–690, 2018. **Purpose**: Elevated rates of cardiometabolic diseases have been observed in former American football players. The current study sought to determine whether change in body mass index (ΔBMI) after retirement influences the prevalence of CHD, diabetes, or high blood pressure (HBP) in former professional football players. **Methods**: Retired professional football players (n = 3729) were sent a survey with questions regarding health status, playing history, and demographic information. Self-reported BMI at the time of retirement was subtracted from current self-reported BMI to calculate ΔBMI. Prevalence of CHD, diabetes, and HBP were determined by asking participants if they had ever been diagnosed by a health care professional. Binomial regression with a Poisson residual and robust variance estimation was used to compute crude prevalence ratios (PR) and 95% confidence intervals (CI) for each outcome. Adjusted PR values were calculated by adjusting for BMI at the time of retirement, age, years of football experience, race, exercise habits, alcohol use, steroid history, smoking history, and playing position. **Results**: Complete data were available for 2062 respondents. Prevalence of CHD increased 25%–31% for each five-point increase in ΔBMI after retirement (crude PR = 1.25, 95% CI = 1.03–1.52, P = 0.026; adjusted PR = 1.31, 95% CI = 1.11–1.55, P = 0.001). Diabetes prevalence increased 69%–88% for each five-point ΔBMI increase (crude = 1.88, 95% CI = 1.45–2.44, P < 0.001; adjusted = 1.69, 95% CI = 1.32–2.15, P < 0.001). A five-point increase in ΔBMI was associated with a 35%–40% increase in HBP prevalence (crude = 1.40, 95% CI = 1.27–1.53, P < 0.001; adjusted = 1.35, 95% CI = 1.24–1.47, P < 0.001). **Conclusions**: After controlling for relevant covariates, postretirement ΔBMI was positively and independently associated with prevalence of CHD, diabetes, and HBP. Postretirement interventions using diet and/or exercise to influence body composition may improve long-term health in retired football players. **Key Words:** OBESITY, CARDIOVASCULAR DISEASE, CHD, DIABETES, HYPERTENSION, BLOOD PRESSURE

Cardiometabolic diseases, which include CHD and diabetes, carry substantial burdens with regard to morbidity, mortality, and health care costs. Cardiovascular disease alone is projected to account for $818 billion of direct medical costs in the United States by 2030 (1), and cardiovascular disease and diabetes are among the leading causes of death worldwide (2). Deaths attributable to cardiovascular disease have continued to increase over the past two decades, with 12.9 million global deaths attributable to ischemic heart disease and stroke in 2010 (3). Diabetes-related deaths nearly doubled in the same time frame (3). High blood pressure (HBP) is the primary risk factor for deaths related to cardiometabolic diseases, accounting for over 40% of deaths from cardiovascular disease, diabetes, and chronic kidney disease in 2010 (2). Body mass index (BMI), a commonly used clinical index for health, accounted for 15% of these deaths (2). The combination of HBP, high BMI, high blood glucose, and high cholesterol accounted for 63% of deaths related to cardiometabolic diseases, which equates to 10.8 million deaths

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worldwide. Identifying predictive risk factors is critical for the development of programs for disease prevention and risk reduction. This is particularly important in high-risk populations, such as former professional football players (4,5). Given the common practice of intentional weight gain among American football players (6), research is needed to assess how such habits relate to postcareer BMI changes and the prevalence of cardiometabolic diseases later in life.

American football players often seek to manipulate body mass as a means of performance enhancement, and the size of these athletes has increased as the popularity of the sport has grown (7). Longitudinal studies have noted that significant weight gain is observed across some collegiate football careers (8,9). Although the goal is often to build lean mass (10), gains in adiposity can also result (9). This increase in weight may be problematic with respect to long-term health outcomes because increased BMI is associated with greater risk of cardiovascular and all-cause mortality (11), and BMI values above 30 $kg \cdot m^{-2}$ are associated with increased prevalence of CHD, diabetes, and HBP (12). High prevalence of the components of metabolic syndrome, a cluster of risk factors associated with cardiometabolic diseases, has been identified in active football players at the high school (13), collegiate (14), and professional levels (15,16). There is currently a lack of research pertaining to how postcareer BMI changes may affect further progression of these cardiometabolic risk factors.

Research on retired professional football players regarding life span health outcomes has found high rates of obesity (5,17), hypertension (17), sleep-disordered breathing (17), and metabolic syndrome (4,5) in this population. If postcareer BMI changes influence the prevalence of unfavorable cardiometabolic outcomes in this population, then targeted weight loss or weight maintenance interventions after retirement may be viable strategies to improve long-term cardiometabolic health. Despite the clear link between BMI and cardiometabolic disease outcomes (12), there is a lack of evidence regarding the relationship between postcareer BMI changes and cardiometabolic disease risk. To address this question, and to facilitate the delivery of effective postcareer health management and disease prevention programs in retired professional football players, the current study sought to determine whether change in BMI (ΔBMI) after retirement influenced the prevalence of CHD, diabetes, or HBP in retired professional football players. It was hypothesized that ΔBMI would be positively and independently associated with the prevalence of all three conditions.

METHODS

The current study used data from the Health Survey of Retired NFL Players, an ongoing survey administered by the Center for the Study of Retired Athletes at the University of North Carolina at Chapel Hill. The general health questionnaire was developed by sports injury researchers with expertise in pertinent areas, including epidemiology and biomechanics. The survey collected information regarding a variety of factors related to health and wellness in retired NFL players. The current study used a historical sample of athletes who were sent the survey in 2001. Surveys were administered via mail, with the survey sent to each player on three occasions. Individuals who did not respond were contacted by telephone and asked to complete the survey verbally via phone interview. A reliability check of the general health questionnaire was conducted by readministering the instrument to 25 of the original respondents 24–36 months later to establish a high level of agreement between selected responses (18). The study protocol was approved by the university's institutional review board and adhered to the American Psychological Association ethical standards for survey research. In accordance with the university's institutional review board guidelines, a consent statement was incorporated into the survey and participant consent was implied by survey completion, or verbally confirmed during phone interviews.

General Health Survey. Participants received a 13-page, paper-based General Health Survey to ascertain information pertaining to demographic information, playing history, medical history, injury history, and overall health status. For the current analysis, key variables of interest included responses relating to BMI, age, years of football experience, race, exercise habits, alcohol use, steroid history, smoking history, and playing position.

The dependent variables in the current study were prevalence of CHD, diabetes, and HBP; for each outcome, participants responded to the following binary (yes/no) question: "Have you ever been told by a physician or health professional that you had/have any of the following conditions?" The independent variable, ΔBMI since retirement, was calculated based on self-reported estimates of height and weight. Participants were asked to estimate their height (in feet and inches) and weight (in pounds) at the time of retirement and their height and weight at the time of taking the survey. Height and weight were converted to metric units (height in meters and weight in kilograms) by study personnel and used to calculate BMI ($kg \cdot m^{-2}$) at each time point by dividing weight (kg) by height (m^2). ΔBMI was calculated by subtracting BMI at the time of retirement from BMI at the time of the survey.

Covariates. At the time of taking the survey, participants were asked to list their current age (in years) and years of football playing experience (at all levels of competition). These variables, along with BMI at the time of retirement, were treated as continuous variables.

Participants were asked to check all races or ethnicities that they identified with, from a list of nine options (Black/African American, White, Mexican/Mexican American, Other Spanish/Hispanic/Latino, American Indian/Alaska Native, Native Hawaiian or Other Pacific Islander, Asian Indian, Asian, and Other). On the basis of the options selected, race was coded as a binary variable, with each participant considered "non-Hispanic White" or "non-White." Exercise was also coded as a binary variable (Yes/No), based on the response to the question, "Do you currently exercise regularly?"

Additional binary variables included steroid history, smoking history, and alcohol use. Participants were asked, "During the time in which it was acceptable to use performance-enhancing steroids, did you use any steroids?" To assess smoking history, participants were asked, "One average, how many days a week did/do you smoke cigarettes?" This question was asked to address smoking habits during the participant's professional football career, and separately to address smoking habits over the past year. Participants who reported "None" were coded as nonsmokers, with all others coded as having a history of smoking. To assess alcohol habits, participants completed the CAGE (Cut down, Annoyed, Guilty, and Eye-opener) questionnaire (19) to address their habits during their professional football career, and separately in the time since their professional career. At each time point, values of 2 or above were coded as "high alcohol intake," with the referent group containing all participants with a score of less than 2.

Participants were asked to identify their primary playing position at the professional level from a list of 13 options. Participants were then categorized into position groups, using previously established categories (8). On the basis of the primary position selected, participants were group into three position categories, including linemen (offensive line, defensive line), skill players (running back, wide receiver, cornerback/safety), and big skill players (quarterback, tight end, linebacker, kick-off team/kicker, punt team/punter, kick-off return team, punt return team, and "other").

Statistical analyses. Binomial regression models were used to evaluate the relationship between prevalence of each outcome (CHD, diabetes, and HBP), using ΔBMI as the predictor variable. Crude prevalence ratios were calculated using univariable models containing only ΔBMI. Adjusted prevalence ratios were calculated by including in the model BMI at the time of retirement, age at the time of survey completion, years of football experience, race, current exercise habits, current and past alcohol use, steroid history, smoking history, and playing position. Poisson residual variance and robust variance estimation were used to stabilize variance estimation (20). Prevalence ratios corresponding to one-point and five-point BMI changes were reported, as established BMI risk categories progress in five-point increments (e.g., overweight = 25–29.9 $kg \cdot m^{-2}$, obese I = 30–34.9 $kg \cdot m^{-2}$, and obese II = 35–39.9 $kg \cdot m^{-2}$) (11,21). Statistical analyses were performed using SAS Software, version 9.4 (SAS Institute, Cary, NC).

RESULTS

Current sample. A total of 3729 surveys were sent in 2001; 2536 (68.0%) were completed by recipients. For the current analysis, the sample was restricted to participants with complete data for key variables of interest pertaining to medical history, BMI, age, playing history, playing position, exercise habits, and history of smoking, alcohol use, and steroid use, which were determined *a priori* (n = 2064). Univariate summaries of variables of interest were then screened for data entry errors or otherwise unfeasible values. Because of the influence of height on BMI, participants were excluded if a discrepancy of >10.2 cm existed between height at the time of survey completion and the reported height at the time of retirement (n = 2). The final sample contained 2062 participants.

Descriptive statistics. In the current sample, 9.7% (200 cases), 5.5% (114 cases), and 29.5% (609 cases) of participants had been clinically diagnosed with CHD, diabetes, and HBP, respectively. The prevalence of CHD, diabetes, and HBP for each ΔBMI quartile is presented in Figure 1; for each outcome, the highest prevalence was observed in the highest BMI quartile. Postretirement BMI change ranged from −15.7 to +22.3 $kg \cdot m^{-2}$, with a mean increase of 1.2 ± 3.4 $kg \cdot m^{-2}$. At the time of the survey, the mean age of the sample was 53.6 ± 13.1 yr, and the BMI was 30.6 ± 4.2 $kg \cdot m^{-2}$. Descriptive statistics for group demographics and multivariable model covariates are listed in Table 1.

Binomial regression models. Crude and adjusted prevalence ratios for CHD, diabetes, and HBP are presented in Table 2. An increase in ΔBMI was associated with increased prevalence for all three outcomes. A five-point BMI change corresponded with a 25.1% increase (95% confidence interval [CI] = 2.7%–52.4%) in CHD prevalence, and this association was even stronger in the multivariable model (31.1%

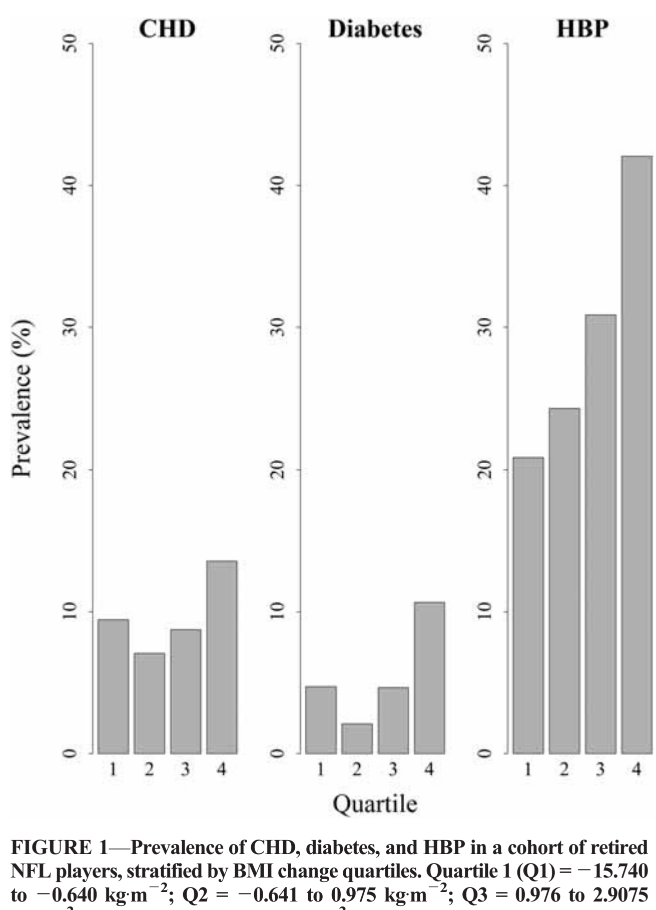

FIGURE 1—Prevalence of CHD, diabetes, and HBP in a cohort of retired NFL players, stratified by BMI change quartiles. Quartile 1 (Q1) = −15.740 to −0.640 $kg \cdot m^{-2}$; Q2 = −0.641 to 0.975 $kg \cdot m^{-2}$; Q3 = 0.976 to 2.9075 $kg \cdot m^{-2}$; Q4 = 2.9076 to 22.270 $kg \cdot m^{-2}$.

TABLE 1. Descriptive demographic data in a cohort of retired national football league players (n = 2062).

Continuous Variables			
Variable[a]	Mean	SD	Range
Current age (yr)	53.6	13.1	24 to 87
Years retired	24.4	13.3	<1 to 62
Current BMI[b]	30.6	4.2	14.8 to 56.3
BMI change since retirement	1.2	3.4	−15.7 to 22.3
Years of football experience	15.1	4.2	5 to 33

Categorical Variables			
Variable[a]	Categories	N	Pct.
Race/ethnicity	Non-Hispanic White	1490	72.3
	Non-White	572	27.7
Current exercise	Yes	1512	73.3
	No	550	26.7
History of steroid use	Yes	182	8.8
	No	1880	91.2
History of smoking tobacco	Yes	425	20.6
	No	1637	79.4
Alcohol use during career	CAGE score ≥2	274	13.3
	CAGE score <2	1788	86.7
Alcohol use since career	CAGE score ≥2	415	20.1
	CAGE score <2	1647	79.9
Position group	Linemen[c]	741	35.9
	Skill[d]	725	35.2
	Big skill[e]	596	28.9

[a]All values as reported at the time of survey completion.
[b]BMI (kg·m^{-2}).
[c]Offensive and defensive linemen.
[d]Wide receivers, defensive backs, and running backs.
[e]All other positions.

increase, 95% CI = 11.0%–54.9%). For diabetes, a five-point BMI change was associated with an 87.9% increase (95% CI = 44.9%–143.6%) in prevalence. Adjustment for covariates decreased the strength of this relationship, with the multivariable model indicating a 68.7% increase (95% CI = 32.5%–114.9%) in diabetes prevalence for a five-point increase in ΔBMI. The univariable model predicted a 39.7% increase (95% CI = 27.3%–53.4%) in HBP prevalence for a five-point increase in postretirement BMI change. The strength of this relationship was reduced in the multivariable model, which estimated a 35.1% prevalence increase (95% CI = 23.8%–47.4%) for a five-point BMI change.

Multivariable models indicated that BMI at the time of retirement was associated with the prevalence of cardiometabolic outcomes; a one-point increase in retirement BMI was associated with prevalence ratios of 1.10 (95% CI = 1.04%–1.16%) for CHD, 1.14 (95% CI = 1.06%–1.23%) for diabetes, and 1.09 (95% CI = 1.06%–1.12%) for HBP (all $P < 0.01$). To determine whether BMI at retirement had a significant moderating effect on the observed results, separate analyses were run on subsamples containing individuals who were obese at the time of retirement (BMI ≥ 30 kg·m^{-2}, n = 848) and those who were not (BMI < 30 kg·m^{-2}, n = 1214). Results of this stratified analysis are presented in Table 3. Because of overlapping CI and similar prevalence ratios between the obese and the nonobese subsamples, it was determined that there is insufficient evidence to suggest that BMI at the time of retirement had a significant moderating effect on the analysis for the current sample.

DISCUSSION

Our findings suggest that increases in BMI after retirement are positively associated with prevalence of CHD, diabetes, and HBP. The observed associations were present in univariable regression models, and relationships were largely unaffected by controlling for relevant covariates in multivariable models. Cardiometabolic diseases are major burdens with regard to mortality and medical costs, causing over 13 million annual deaths globally (3) and hundreds of billions of dollars in direct medical costs in the United States (1). Many football players intentionally increase body mass for purposes of maximizing performance. On the basis of established links between BMI and disease (12), this increase in body mass may be problematic for long-term health outcomes. Despite earlier evidence reporting an increased prevalence of cardiovascular disease in former linemen (5), previous research has not investigated the relationship between the postcareer BMI changes and the prevalence of CHD or other cardiometabolic outcomes, such as diabetes or HBP, in the former football athlete population. These results suggest that proper postretirement weight management may reduce the risk of cardiometabolic diseases in former American football players.

The current study focused on within-subject BMI change as the independent variable; longitudinal research indicates that BMI changes correlate with changes in adiposity in a variety of populations (22,23), and BMI can be used to effectively evaluate longitudinal changes in adiposity in the absence of substantial muscle gain or medical conditions that promote significant interstitial fluid retention (24). As a ratio of weight to height, BMI cannot directly distinguish fat mass from lean mass (24), and thus comparing BMI between individuals may be skewed by the contribution of lean mass (24). However, football players typically engage in rigorous resistance training, resulting in high degrees of lean mass in this population (10,25). Therefore, an increase in lean mass after the playing career is highly improbable in this population, and that any reduction in lean mass related to the cessation of sport training would be fairly uniform throughout the current

TABLE 2. Crude and adjusted prevalence ratios (PR) of cardiometabolic disease outcomes in relation to BMI change after retirement in a cohort of retired NFL players.

Outcome	ΔBMI	Crude PR (95% CI)	P	Adjusted PR (95% CI)[a]	P
CHD	One-unit increase	1.05 (1.01–1.09)	<0.05	1.06 (1.02–1.09)	<0.01
	Five-unit increase	1.25 (1.03–1.52)	<0.05	1.31 (1.11–1.55)	<0.01
Diabetes	One-unit increase	1.13 (1.08–1.20)	<0.001	1.11 (1.06–1.17)	<0.001
	Five-unit increase	1.88 (1.45–2.44)	<0.001	1.69 (1.32–2.15)	<0.001
HBP	One-unit increase	1.07 (1.05–1.09)	<0.001	1.06 (1.04–1.08)	<0.001
	Five-unit increase	1.40 (1.27–1.53)	<0.001	1.35 (1.24–1.47)	<0.001

[a]Adjusted for BMI at the time of retirement, current age, years of football experience, race, current exercise habits, alcohol use, steroid history, smoking history, and playing position.

TABLE 3. Crude and adjusted prevalence ratios (PR) of cardiometabolic disease outcomes in relation to BMI change after retirement in a cohort of retired NFL players, stratified by BMI at the time of retirement.

Outcome	ΔBMI	Crude PR (95% CI)	P	Adjusted PR (95% CI[a])	P
Retirement BMI under 30 (n = 1214)					
CHD	One-unit increase	1.04 (0.98–1.11)	0.22	1.05 (1.00–1.11)	0.07
	Five-unit increase	1.21 (0.89–1.66)	0.22	1.27 (0.98–1.65)	0.07
Diabetes	One-unit increase	1.16 (1.07–1.25)	<0.001	1.14 (1.05–1.23)	0.001
	Five-unit increase	2.10 (1.43–3.10)	<0.001	1.89 (1.29–2.78)	0.001
HBP	One-unit increase	1.08 (1.05–1.11)	<0.001	1.07 (1.04–1.10)	<0.001
	Five-unit increase	1.48 (1.29–1.71)	<0.001	1.41 (1.23–1.61)	<0.001
Retirement BMI over 30 (n = 848)					
CHD	One-unit increase	1.05 (1.00–1.11)	0.07	1.07 (1.02–1.12)	0.004
	Five-unit increase	1.28 (0.98–1.66)	0.07	1.39 (1.11–1.73)	0.004
Diabetes	One-unit increase	1.12 (1.06–1.20)	<0.001	1.10 (1.04–1.17)	0.001
	Five-unit increase	1.80 (1.32–2.44)	<0.001	1.63 (1.21–2.20)	0.001
HBP	One-unit increase	1.07 (1.04–1.09)	<0.001	1.05 (1.03–1.08)	<0.001
	Five-unit increase	1.40 (1.24–1.57)	<0.001	1.30 (1.16–1.46)	<0.001

[a]Adjusted for BMI at the time of retirement, current age, years of football experience, race, current exercise habits, alcohol use, steroid history, smoking history, and playing position.

sample. As such, changes in adiposity are the most probable factor affecting BMI change and driving the observed relationships with cardiometabolic outcomes in the current study.

Adipose tissue plays an active role as an endocrine and paracrine organ, releasing numerous adipokines and bioactive substances that influence inflammation, oxidative stress, and atherosclerotic plaque formation (26,27). In addition, excess adipose tissue typically results in impaired endothelial function (26), increased expression of adhesion molecules (26), and proatherogenic blood lipid profile (27). Collectively, these factors contribute to the formation of atherosclerotic plaque in the coronary arteries, and prospective research has linked high BMI to increased CHD risk (28). Although causation cannot be inferred from the current study, results suggest that postcareer BMI increase is associated with CHD risk.

Although the overall prevalence of diabetes was lower than CHD and HBP in the current sample, adjusted prevalence ratios indicate that the independent effect of BMI change on diabetes prevalence was approximately twice as large as its effect on CHD and HBP prevalence (69% vs 31% and 35%, respectively). The mechanisms relating obesity to diabetes development have substantial overlap with CHD; in the context of obesity, insulin function is altered by many of the same hormonal and metabolic signals contributing to CHD progression (29). These factors increase the serine phosphorylation of insulin receptor substrates and reduce the tyrosine phosphorylation of insulin receptor substrates (29), thereby causing insulin resistance. As insulin resistance persists, the combined effects of inflammation, nonesterified fatty acids, and hyperglycemia can reduce the mass and function of beta cells, ultimately resulting in development of type II diabetes (30). Hypertension is characterized by a mismatch between arterial pressure and natriuresis resulting in HBP (31), with excess weight gain explaining 65%–75% of the risk for developing hypertension (32). The obesity-driven development of HBP is related to the elevated insulin levels observed with insulin resistance and diabetes, in addition to increased sympathetic tone, activation of the renin–angiotensin–aldosterone system, structural changes in the kidneys, inflammation, and adipokines including leptin (31–33). Hypertension and diabetes are highly interrelated (31,33,34), and both contribute to the macrovascular complications that characterize CHD (34), with excess adiposity playing a large role in the development of all three conditions. The current results suggest that postcareer BMI change is associated with CHD, diabetes, and HBP risk. These observed associations are supported by a large body of literature indicating that increased adiposity is a common factor contributing to each of these related cardiometabolic outcomes.

In response to increasing weight (7), high prevalence of metabolic syndrome (14), and poor long-term health outcomes in football linemen (4,5,17), previous authors (6) have called for reconditioning programs to address health and fitness after the cessation of the playing career. Results of the current study support this call for postcompetitive reconditioning programs in retired football athletes, with an emphasis on weight management and cardiovascular health. Weight changes after retirement were significantly and independently associated with cardiometabolic health risks in the present study; as such, postretirement weight gain may be targeted by interventions to improve long-term cardiometabolic health outcomes in retired football players. In agreement with previous research (11,12), multivariable models indicated that BMI at the time of retirement was also significantly associated with cardiometabolic outcomes. However, stratified analysis indicated that obesity status at retirement did not have a moderating effect on the relationship between BMI change and cardiometabolic outcomes; as such, this evidence suggests that postcareer weight management programs would have similar protective effects in both obese and nonobese retirees. Currently, a combination of diet and exercise alterations is recommended for promoting a negative energy balance to induce weight loss. Weight loss has been shown to improve a variety of symptoms and risk factors associated with CHD (35), diabetes (36), and HBP (37), yielding improvements in blood lipid profile, insulin sensitivity, blood pressure, and systemic inflammation (35–37). Furthermore, alterations in both diet (38) and exercise (39) have been shown to independently improve cardiometabolic risk factors, even in the absence of weight loss. Collectively, there is strong observation and mechanistic support for the implementation of diet and exercise programs to facilitate weight management and improve cardiometabolic health in retired football players.

Limitations of the current study must be noted when interpreting the associations observed. The data were collected via self-reported surveys, which are dependent on the honesty and accuracy of the answers provided. Although a recent study found minor but statistically significant underreporting of BMI based on self-reported height and weight, the results indicated that self-reported estimates yielded acceptable levels of agreement with measured values for both current BMI and 12-month recall (40). In addition, BMI is inherently limited by the inability to distinguish lean tissue from fat tissue; this may make BMI disproportionately misleading in position groups associated with low body fat percentages, although position group was used as a covariate to account for this effect in the adjusted regression models. The study design was cross sectional in nature; as such, temporal relationships between weight gain and cardiometabolic diagnosis cannot be confidently identified, and the analysis cannot account for weight changes occurring after diagnosis, or the relative progression or remission of disease symptoms. Future research should build on the current results, using prospective designs to verify the relationships identified in the current cross-sectional study. The statistical approach used assumes a linear relationship between BMI change and cardiometabolic disease prevalence; although visual evaluation of the plotted data and stratified analysis did not provide evidence of a nonlinear trend, more research is needed to confirm the results of the current study. Finally, the feasibility of long-term exercise interventions for weight management must be evaluated in this population due to injury, mental illness, and other comorbidities observed in former football athletes. As such, highly individualized interventions may be required. Nonetheless, the current study provides evidence indicating that postcareer weight changes have a significant and independent association with the prevalence of cardiometabolic outcomes. These results suggest that interventions targeting weight management in retired professional football players may combat the poor long-term health risks that have previously been identified in this population.

CONCLUSIONS

Postretirement BMI change is independently and positively associated with the prevalence of CHD, diabetes, and HBP in retired NFL football players. These results suggest that postcareer weight gain may be an important and modifiable risk factor with regard to long-term cardiometabolic health outcomes in this population. Retired football players should be encouraged to participate in diet and exercise programs after finishing their career to facilitate weight management and disease prevention. Practitioners should seek to develop and implement weight management programs that are feasible and efficacious in this specific population. Efforts to encourage physical activity and proper dietary habits are likely to induce favorable changes in several cardiometabolic risk factors, including BMI, blood lipid profile, insulin sensitivity, blood pressure, and systemic inflammation, thereby improving long-term health outcomes in this high-risk population.

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