Sleep-disordered breathing, Hypertension and Obesity in Retired National Football League Players

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Keywords

In 1994, the Centers for Disease Control and Prevention conducted a study evaluating retired National Football League (NFL) players. Linemen were three times more likely than other position players to die of heart disease, and had a 52% higher risk of cardiovascular death than the general population. It was speculated that a higher body mass index (BMI) among linemen was responsible for this increased cardiovascular mortality; however most of the established cardiovascular risk factors were not assessed in this study (1). Sleep-disordered breathing (SDB) and hypertension have been linked to several cardiovascular diseases (2) and evidence suggests that SDB may be highly prevalent in active NFL players (3).

The Living Heart Foundation, a nonprofit organization, conducted multi-city health screenings of retired NFL players in conjunction with Mayo Clinic and the NFL Players

Association. Results were compared to the general population using data from the National Health and Nutrition Examination Survey (NHANES) 1999-2006 restricted to a sample of 1,539 males who were in the same age and BMI range as the former NFL players. A fasting blood sample was obtained during the screening visit. Obesity was defined as a BMI of ≥30 kg/m^2. Blood pressure (BP) was measured 3 times by an automated arm cuff blood pressure recorder and an average of the readings was calculated. Hypertension was defined as a mean systolic BP ≥140 mmHg or a diastolic BP ≥90 mmHg per JNC VII guidelines.

Retired NFL Players were consecutively assigned to undergo a self-applied unattended limited-channel portable overnight sleep study (ARES, Advanced Brain Monitoring Inc., Carlsbad, CA or Embletta, Embla, Broomfield, CO) to assess SDB. We used an apnea-hypopnea index (AHI) of ≥10 events/hour to diagnose SDB. Retired NFL players were divided into linemen (offensive and defensive linemen) and nonlinemen (every other position). Group means were tested for differences by two-sided t-test or Wilcoxon rank sum test depending on data distribution. Differences in proportions were tested using χ^2 and Fisher's exact test when appropriate. The covariates of interest as predictors of SDB and hypertension were investigated using simple logistic regression and then multiple logistic regression analysis after adjusting for age and BMI.

A total of 257 retired NFL players underwent evaluation. SDB was present in 52.3% of the former NFL players. The prevalence of hypertension and obesity were higher in the retired NFL players, however, total cholesterol, triglycerides, HDL, and fasting glucose levels were lower compared to NHANES (Table 1). When stratified by position, linemen were more likely to have SDB (61.3 vs 46.6%, p =0.02) and obesity (83.5 vs 52.5%, p<0.001) compared to nonlinemen. Linemen tended to have a higher prevalence of hypertension (44.1 vs 34.0%, p=0.1), and had higher fasting blood glucose (107±2.9 vs. 98±2.3 mg/dL, p<0.0001) and triglycerides (150±12.7 vs. 112±9.8 mg/dl, p<0.001), but lower total cholesterol (183±4.1 vs. 193±3.1 mg/dl, p=0.02), HDL (42±1.3 vs. 45±1.0 mg/dl, p<0.001), and LDL levels (114±3.7 vs. 125±2.8 mg/dl, p=0.017) compared to nonlinemen.

Covariates of age (OR per year =1.06, 95% CI= 1.03-1.08), BMI (OR=1.07 per kg/m^2, 95% CI=1.01-1.12), and position (OR for linemen=1.81, 95% CI=1.08-3.07) were significant predictors of SDB. However, after adjusting for age and BMI, position was not a predictor of SDB (OR for linemen=0.70, 95% CI=0.37–1.29). Predictors of hypertension in retired NFL players were age (OR=1.04 per year, 95% CI=1.02-1.07), BMI (OR=1.10 per kg/m^2, 95% CI=1.04-1.16), and SDB (OR=1.93, 95% CI=1.15-3.25). However, after adjusting for age and BMI, neither position (OR for linemen=0.98, 95% CI=0.53-1.86) nor SDB (OR=0.94, 95% CI=0.58-1.92) were significant predictors of hypertension.

Our study demonstrates an increased prevalence of SDB, hypertension, and obesity in retired NFL players, particularly in linemen. Retired NFL players were less likely to have diabetes and had lower fasting glucose levels as previously shown in active players (4). This finding may be explained by the current or past exercise history in the former elite athletes, although a lower mean HDL cholesterol level may argue against this hypothesis. Results from multivariate analysis suggest that the higher prevalence of SDB in retired NFL players may be explained by the higher BMI. If true, this may serve as a warning to both retired elite athletes and physicians alike about the dangers of adiposity in later life, regardless of prior physical fitness.

Even though study subjects were consecutively screened, volunteer bias could have resulted in a higher prevalence of SDB and hypertension. Another possible limitation of our study may be the use of a portable monitoring device to diagnose SDB. However, both devices used in our study have been validated and shown to be reasonably accurate compared to

nocturnal polysomnography. We recognize that the accuracy of BMI in diagnosing obesity is limited, and can potentially overestimate its prevalence in certain populations as it cannot differentiate lean and fat mass. Finally, lack of SDB data in the NHANES sample limits our ability to fully compare our two study populations and our relatively small sample size limits more complex analyses.

In summary, our data show that obesity is common in retired NFL players and is associated with hypertension and SDB. The negative health consequences of obesity in retired professional athletes may serve as a caution to not overlook this important health indicator, to take preventative measures, even among former elite athletes.

Acknowledgments

Abbreviations

SDB	Sleep-disordered breathing
BMI	Body mass index
NFL	National Football League
NHANES	National Health and Nutrition Examination Survey
BP	Blood pressure
HDL	High density lipoprotein
LDL	Low density lipoprotein
OR	Odds ratio

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Table 1

Baseline demographics and characteristics.

Variables	NFL (n=257)	NHANES (n=1539)	P-Value
Age (years)	53.9±1.0	52.9±0.4	0.35
BMI (kg/m^2)	32.3±0.3	30.0±0.1	<0.001
Race			
White (%)	52	53	0.67
Black (%)	47	22	<0.001
Other (%)	1	24	<0.001
Systolic blood pressure (mmHg)	133.5±1.1	126.5±0.5	<0.001
Diastolic blood pressure (mmHg)	80.0±0.7	72.7±0.3	<0.001
Hypertension (%)	37.8	21.4	<0.001
Overweight (%)	33.9	53.1	<0.001
Obesity (%)	63.7	40.5	<0.001
Total cholesterol (mg/dL)	183.4±4.1	195.3±1.5	0.02
Triglycerides (mg/dL)	149.8±12.7	168.0±4.7	<0.001
HDL concentration (mg/dL)	44.0±0.8	47.0±0.3	<0.001
LDL concentration (mg/dL)	121.4±2.3	117±1.3	0.16
Fasting glucose (mg/dL)	101.1±1.8	109.6±1.0	<0.001
History of diabetes (%)	7.0	12.4	0.03
History of smoking (%)	4.3	57.6	<0.001
Apnea-hypopnea index (events/hour)	16.6±1.0	*	
SDB (%)	52.3	*	

Abbreviations: BMI, body mass index; SDB, sleep-disordered breathing.

Data are presented as mean ± SD for continuous variable and % for categorical variables. Obesity was defined as a BMI of ≥30 kg/m^2, and overweight as a BMI of 25 to 29.9 kg/m^2.

[*] The NHANES group did not undergo sleep evaluation to diagnose SDB.