## CORRESPONDENCE

**Research Correspondence**

# Sleep-Disordered Breathing, Hypertension, and Obesity in Retired National Football League Players

**To the Editor:** In 1994, the Centers for Disease Control and Prevention conducted a study evaluating retired National Football League (NFL) players. Linemen were 3 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 multicity health screenings of retired NFL players in conjunction with the Mayo Clinic and the NFL Players Association. Results were compared with the general population using data from the National Health and Nutrition Examination Survey from 1999 through 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$^2$ or more. 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 blood pressure of 140 mm Hg or more or a diastolic blood pressure of 90 mm Hg or more, per Joint National Committee on Preventions, Detection, Evaluation, and Treatment of High Blood Pressure VII guidelines.

Retired NFL players were assigned consecutively to undergo a self-applied unattended limited-channel portable overnight sleep study (ARES, Advanced Brain Monitoring, Inc., Carlsbad, California, or Embletta, Embla, Broomfield, Colorado) to assess SDB. We used an apnea-hypopnea index of 10 events/hour or more 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 a 2-sided $t$ test or Wilcoxon rank sum test, depending on data distribution. Differences in proportions were tested using chi-square and Fisher exact tests 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 prevalences of hypertension and obesity were higher in the retired NFL players; however, total cholesterol, triglycerides, high-density lipoprotein, and fasting glucose levels were lower compared with results from the National Health and Nutrition Examination Survey (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 with 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 mg/dl vs. 98 ± 2.3 mg/dl; p < 0.0001) and triglycerides (150 ± 12.7 mg/dl vs. 112 ± 9.8 mg/dl; p < 0.001), but lower total cholesterol (183 ± 4.1 mg/dl vs. 193 ± 3.1 mg/dl; p = 0.02), high-density lipoprotein (42 ± 1.3 mg/dl vs. 45 ± 1.0 mg/dl; p < 0.001), and low-density lipoprotein (114 ± 3.7 mg/dl vs. 125 ± 2.8 mg/dl; p = 0.017) levels compared with nonlinemen.

Covariates of age (odds ratio [OR] per year: 1.06; 95% confidence interval [CI]: 1.03 to 1.08), BMI (OR: 1.07 per kg/m$^2$; 95% CI: 1.01 to 1.12), and position (OR for linemen: 1.81; 95% CI: 1.08 to 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 to 1.29). Predictors of hypertension in retired NFL players were age (OR: 1.04 per year; 95% CI: 1.02 to 1.07), BMI (OR: 1.10 per kg/m$^2$; 95% CI: 1.04 to 1.16), and SDB (OR: 1.93; 95% CI: 1.15 to 3.25). However, after adjusting for age and BMI, neither position (OR for linemen: 0.98; 95% CI: 0.53 to 1.86) nor SDB (OR: 0.94; 95% CI: 0.58 to 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 high-density lipoprotein 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.

Although study subjects were screened consecutively, volunteer bias may 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 with nocturnal polysomnography. We recognize that the accuracy of BMI in diagnosing obesity is limited and potentially can overestimate its prevalence in certain populations because it cannot differentiate lean and fat mass. Finally, lack of SDB data in the National Health and Nutrition Examination Survey sample limits our ability to compare fully our 2 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 not to overlook this important health indicator and to take preventative measures, even among former elite athletes.

| Table 1 | Baseline Demographics and Characteristics | | |
|---|---|---|---|
| Variables | NFL (n = 257) | NHANES (n = 1,539) | p Value |
| Age (yrs) | 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 (mm Hg) | 133.5 ± 1.1 | 126.5 ± 0.5 | <0.001 |
| Diastolic blood pressure (mm Hg) | 80.0 ± 0.7 | 72.7 ± 0.3 | <0.001 |
| Hypertension (%) | 37.8 | 21.4 | <0.001 |
| Overweight (%)* | 33.9 | 53.1 | <0.001 |
| Obese (%)† | 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/h) | 16.6 ± 1.0 | ‡ | |
| SDB (%) | 52.3 | ‡ | |

Data are presented as mean ± SD for continuous variable and as percentages for categorical variables. *Defined as a BMI of ≥ 30 kg/m$^2$. †Defined as a BMI of 25 to 29.9 kg/m$^2$. ‡The NHANES group did not undergo sleep evaluation to diagnose SDB.

BMI = body mass index; HDL = high-density lipoprotein; LDL = low-density lipoprotein; NFL = National Football League; NHANES = National Health and Nutrition Examination Survey; SDB = sleep-disordered breathing.

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3. George CF, Kab V, Levy AM. Increased prevalence of sleep-disordered breathing among professional football players. N Engl J Med 2003;348: 367–8.
4. Tucker AM, Vogel RA, Lincoln AE, et al. Prevalence of cardiovascular disease risk factors among National Football League players. JAMA 2009;301:2111–9.

## Letters to the Editor

# Electrocardiographic Criteria in Takotsubo Cardiomyopathy and Race Differences
## Asians Versus Caucasians

Recently, Kosuge et al. (1) reported an interesting set of electrocardiographic criteria in order to differentiate Takotsubo cardiomy-