Prevalence of Overweight and Obesity in Collegiate American Football Players, by Position

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Abstract. **Objective**: The authors' purpose in this study was to determine overweight and obesity prevalence in a collegiate football team. **Participants**: Eighty-five National Collegiate Athletic Association (NCAA) Division I football players volunteered to participate. **Methods**: The authors measured height, weight, and waist circumference (WC), and estimated body fat percentage (% BF) from bioelectrical impedance. **Results**: Body mass index (BMI), WC, and % BF were all positively correlated ($p < .01$), but BMI overestimated the prevalence of overweight and obesity in 50.6% of the cases. Fourteen players (16%) qualified as obese under all 3 methods. Offensive linemen had significantly higher % BF ($p < .01$) than most other positions, and on average this group exceeded the at-risk criteria for BMI (> 30 kg/m^2), WC (> 102 cm), and % BF (> 25%). **Conclusions**: BMI alone is not a valid indicator of overweight and obesity in a strength-trained athletic population. However, some collegiate football players, especially linemen, meet multiple criteria for obesity.

Keywords: body mass index, bioelectrical impedance, college athlete, obesity, overweight, waist circumference

Overweight and obesity continue to be major health concerns in the United States. According to results from the 2003–2004 National Health and Nutrition Examination Survey (NHANES), 66% of the population is overweight and nearly a third is obese.[1] These percentages have been increasing for the past 30 years. The "supersizing" of America appears to be occurring in athletes as well as the general population. This is particularly evident in sports such as American football, in which having a large mass might be advantageous. Research shows that high school,[2] collegiate,[3,4] and professional[5] football players have gradually increased in size over the past several decades. In 2005, Harp and Hecht[6] sent a research letter to the *Journal of the American Medical Association* reporting that 97% of players in the National Football League (NFL) were overweight and 56% were obese.

Much of the epidemiological research on obesity, including the NFL study by Harp and Hecht,[6] is based on body mass index (BMI) data. BMI is simply the ratio of body weight (kg) to height (m) squared. This ratio is a significant predictor of cardiovascular disease and type II diabetes,[7] and BMI is commonly used to classify individuals as overweight or obese. However, BMI is limited as an index of obesity because many factors affect the relationship between BMI and body fat percentage (% BF). For example, BMI does not take into account the ratio of fat mass (FM) to fat-free mass (FFM). Thus, a lean, mesomorphic athlete with a larger-than-normal amount of muscular hypertrophy, as is likely in strength-trained athletes such as football players, might be misclassified as overweight or obese when using BMI criteria.

When assessing the health status of strength-trained athletes, it seems prudent to use a comprehensive approach for body composition assessment. Clinical guidelines issued by the National Institutes for Health (NIH) recommend measuring waist circumference (WC, in cm) along with BMI as a screening tool for increased health risk.[8] In addition, bioelectrical impedance analysis (BIA) can provide a rapid estimate of % BF with a reasonable degree of accuracy (standard error of the estimate = 3.0%–4.0% BF)[9] in a field setting such as a physician's office, athletic training room, or strength and conditioning facility. In this study, we assessed the prevalence of overweight and obesity in a National Collegiate Athletic Association (NCAA) Division I football team by using a comprehensive assessment approach of measuring BMI, WC, and % BF. Furthermore, we wanted to determine whether BMI

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overestimates this prevalence compared with % BF (as estimated from BIA).

METHODS

Participants

Eighty-five players from an NCAA Division I football team, which included players from each position, volunteered to participate in the study. The team was not ranked in the NCAA Division I rankings in 2005. We obtained written informed consent. The university's institutional review board approved this study.

Procedures

We measured height, weight, WC, and % BF over a period of 2 weeks immediately after the football season. The strength and conditioning staff monitored players' weights throughout the year and noted that most of the athletes maintained a stable body weight throughout the season (± 1.36 kg), with an exception of the freshmen, whose weight fluctuated more readily (± 2.72 kg). Staff members collected data in the varsity athletics weight room during early morning midweek sessions prior to workouts during the season. Participants wore only shorts and a shirt during measurement. For the study, we measured their weight to the nearest 0.1 kg on a calibrated scale (Detecto Scales, Inc, Brooklyn, NY) and height to the nearest 0.1 cm using measuring tape (National Football Scouts, Houston, TX) to calculate BMI. Players with a BMI of 18.5 to 24.9 kg/m^2 were designated as normal weight, 25.0 to 29.9 kg/m^2 was overweight, and 30 kg/m^2 or greater was obese.[10]

We also measured WC with an anthropometric measuring tape in a horizontal plane at the visible narrowing of the waist after a normal exhalation, in accordance with NIH guidelines.[8] If we saw no narrowing, we placed the measuring tape at the level of the 12th rib. We then measured WC to the nearest 0.1 cm and used an average of 2 measurements within ± 1.0 cm for subsequent analysis.[9] The criterion for placing a participant at risk for coronary heart disease (CHD) or metabolic disease was a WC greater than 102 cm.[11,12]

We conducted BIA (Quantum II, RJL Systems, Clinton Township, MI) using the whole-body tetrapolar method. We placed electrodes on the dorsal surface of the participant's right wrist and ankle using anatomical landmarks according to the manufacturer's instructions. Participants lay on a nonconducting surface with their arms and legs abducted at an angle of 30° to 45° from the trunk of the body. The coefficient of variation (CV) for within-day repeated BIA measurements is 1% to 2%,[9] and previous test–retest reliability of this RJL-manufactured analyzer in our lab was excellent (r = .99), with a mean resistance difference between trials of 0.6 ohms, resulting in a difference in % BF of < 0.1% (data not shown).

Because the participant's hydration status can affect BIA estimates, the football players adhered to pretest hydration guidelines[9] to be in a euhydrated state during testing. We provided participants with a copy of these guidelines 1 day prior to their testing (to serve as a reminder) and administered a related questionnaire on the morning of testing to ensure they had followed the guidelines.

To obtain an FFM estimate, we entered the resistance measure obtained from the BIA machine into the equation[13]:

$$FFM = -10.68 + 0.65\ (HT^2/R) + 0.26\ (WT) + 0.02\ (R),$$

where FFM is measured in kg, HT is height measured in cm, WT is body weight measured in kg, and R is resistance measured in ohms. Sun et al[13] derived this equation from their multicomponent model body composition study that included 669 male participants (552 white and 117 black); it has a root mean square error of 3.9 kg and a CV of 6%. We assumed that WT = FM + FFM. Thus, we determined FM by WT – FFM and calculated % BF as (FM / WT) × 100.

There is no universally accepted health risk stratification for % BF. For the purpose of this study and to compare BMI values with % BF values, we defined *healthy* % BF as 8% to 19%. A % BF between 20% and 24% was *overweight*, and a % BF greater than 25% was *obese*. This grouping is consistent with what is presented for men aged 20 to 39 years in *ACSM's Guidelines for Exercise Testing and Prescription*, 7th ed.[11]

Data Analyses

We analyzed each player's descriptive data ($M \pm SD$), including height, weight, WC, BMI, and % BF. We performed a Pearson product–moment correlation to quantify the relationship between WC, BMI, and % BF measures. We used a chi-square cross tabulation to determine whether (1) there was a discrepancy between BMI and % BF and (2) the number of participants misclassified as obese on the basis of BMI (> 30 kg/m^2), even if they had a healthy % BF (< 20%) as measured by BIA. To run this analysis, we recoded % BF and BMI scores into categories of 1 for normal weight (BMI < 25 kg/m^2, % BF < 20%), 2 for overweight (BMI = 25.0–29.9 kg/m^2, % BF = 20.0%–24.9%), or 3 for obese (BMI ≥ 30 kg/m^2, % BF ≥ 25%).

In addition, we categorized participants by position as follows: running back (RB), offensive lineman (OL), wide receiver (WR), tight end (TE), linebacker (LB), defensive lineman (DL), quarterback/kicker/punter (QB/KP), and defensive back (DB). We completed a one-way analysis of variance (ANOVA) to determine whether there were significant mean differences in WC, BMI, or % BF among the different positions. If we found a significant ANOVA result, we ran a Tukey's post hoc test to determine which groups differed. We used SPSS version 13.0 for all data analyses (SPSS, Inc, Chicago, IL). We set the alpha level at .05 to determine statistical significance.

RESULTS

Table 1 lists descriptive data for the entire sample (N = 85) categorized by football position. Analyzing the team BMI data as a whole, 35% were obese. Using the criteria of a WC greater than 102 cm or % BF greater than 25%, 17.6% of the players were at a high risk for

TABLE 1. Descriptive Data of the Sample, by Team Position ($N = 85$)

		Height (cm)		Weight (kg)		WC (cm)		BMI (kg/m^2)		% BF	
Position	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Quarterback/kicker	9	183.7	1.6	85.0	3.4	82.7	4.8	25.2	2.3	18.9	1.8
Running back	6	180.3	2.0	90.9	4.2	84.1	2.9	27.9	1.6	16.3	2.2
Wide receiver	12	183.7	1.4	82.5	2.9	82.1	4.2	24.4	1.4	15.0	1.6
Tight end	4	191.8	2.5	111.5	5.1	95.3	9.2	30.4	2.5	21.3	2.7
Offensive lineman	17	191.6	1.2	126.0	2.5	105.9	10.9	34.4	4.0	27.6	1.3
Defensive lineman	19	186.6	1.1	111.0	2.3	99.3	16.0	31.9	3.5	22.1	1.3
Linebacker	4	185.4	2.5	99.1	5.1	89.4	2.2	28.9	2.1	18.3	2.7
Defensive back	14	182.2	1.3	85.3	2.7	81.8	4.5	25.7	1.5	13.2	1.5
All	85	185.9	6.0	101.0	19.3	91.8	13.6	29.1	4.6	19.8	7.3

Note. WC = waist circumference; BMI = body mass index; % BF = body fat percentage.

CHD and metabolic diseases. By position, only OL had a mean % BF greater than 25%.

All of the variables used to assess obesity or obesity-related disease risk were significantly correlated ($p < .01$): $r = .83$ for WC and BMI, $r = .65$ for WC and % BF, and $r = .71$ for BMI and % BF. We used the chi-square cross-tabulation analysis (see Table 2) to determine the number of players that BMI misclassified as overweight or obese when, by % BF measures, they were not. BMI categorization matched % BF grouping in 44.7% of the cases. However, even though 42 players (49.4%) had a healthy % BF (< 20%), only 16 players (18.8%) were accurately placed in the healthy category using BMI criteria (< 25 kg/m^2). Furthermore, 26 players were misclassified by BMI criteria as overweight instead of healthy, and 15 were overestimated as obese rather than overweight.

The OL group's means for WC, BMI, and % BF were significantly ($p < .01$) greater than those of the QB/KP, RB, WR, and DB groups. OL mean BMI was also significantly ($p < .02$) greater than the BMI of the LBs. DL had significantly ($p < .01$) higher WC, BMI, and % BF than did the WRs and DBs. DL also had a greater WC than both the QB/KP ($p < .01$) and the RB ($p = .03$) groups and a greater BMI than the QB/KP group ($p < .01$).

COMMENT

Using BMI as the assessment method, 81% of the collegiate football players in this study were classified as overweight and 35% were obese. Although these results are slightly less than the 97% and 56% of NFL players that Harp and Hecht[6] reported as being overweight and obese, respectively, it is still an alarmingly high percentage assuming that BMI is a valid indicator of obesity in an athletic population. These results suggest that the prevalence of overweight and obesity in collegiate football players is far greater than that of the general population.[1] However, such findings are misleading; compared with % BF estimates, BMI overestimated the prevalence of overweight and obese players in this study. Our quantitative comparison of % BF and BMI supports Kraemer et al's qualitative comparison of NFL players,[14] and we concur with their conclusion that BMI should not be used as an indicator of health status in football players. When making health status judgments in a strength-trained athletic population, we recommend an assessment of body composition that includes an estimate of % BF rather than a strict reliance on BMI. Judging overweight and obesity among mesomorphic football players on the basis of BMI alone will likely result in many false positives because high fat mass, rather than high body weight, is strongly associated with CHD and mortality risks.[15–17]

Even though the prevalence of overweight and obesity is falsely inflated when using BMI criteria, there is still cause for concern. Fourteen players (16%), as well as the average OL, exceeded the at-risk value for all 3 assessments (BMI > 30 kg/m^2, WC > 102 cm, and % BF > 25%). Participants' % BF values were slightly higher than those of participants in related studies over the past 10 years (see Table 3). The relatively higher values we found may have appeared because of variations in training and conditioning techniques and

TABLE 2. Cross Tabulation of Classifications, by Body Mass Index (BMI) and Body Fat Percentage (% BF)

	% BF class		
BMI class	Healthy	Overweight	Obese
Healthy	14	2	0
Overweight	26	11	2
Obese	2	15	13

Note. Healthy = BMI < 25 kg/m^2, % BF < 20%; overweight = BMI of 25.0–29.9 kg/m^2, % BF of 20.0–24.9%; obese = BMI ≥ 30 kg/m^2, % BF ≥ 25%.

TABLE 3. Summary of Recent Body Composition Studies of Collegiate and Professional Football Players

Study	Sample		Measurement method	Team % BF	OL % BF
	N	Level			
Present study	85	College (NCAA Division I)	BIA	19.8	27.6
Collins et al[27]	69	College (NCAA Division I)	HW	17.0	23.5
Kraemer et al[14]	53	Pro (NFL)	Bod Pod	14.2	25.1
Noel et al[3]	69	College (NCAA Division I)	HW	15.8	25.4
Snow et al[5]	36	Pro (NFL)	HW	19.1	24.7
Stuempfle et al[26]	77	College (NCAA Division III)	HW	17.2	21.9

Note. % BF = body fat percentage; OL = offensive line; NFL = (US) National Football League; NCAA = National Collegiate Athletic Association, BIA = bioelectrical impedance analysis; HW = hydrostatic weighing.

nutritional practices among the different samples, or simply a difference among the assessment methods (BIA vs Bod Pod or hydrostatic weighing) of the different studies.

Not surprisingly, our finding that linemen are more likely to be significantly overweight and obese than are other positions is consistent with previous research (see Table 3). In addition to having higher % BF, linemen also have higher levels of triglycerides and total cholesterol, lower levels of high-density lipoproteins, higher blood pressure, and lower aerobic capacity than do other players.[18,19] This may explain why NFL linemen have a 52% greater risk of CHD mortality and a 6-fold increase in cardiovascular disease compared with the general population.[20] Sleep-disordered breathing resulting in apnea and hypopnea, which is an additional risk factor for hypertension and cardiovascular disease, is another common ailment for overweight and obese individuals. Although this condition affects only about 4% of the general population, 14% to 34% of professional football players experience sleep-disordered breathing, with 85% of the affected players being linemen.[21] In addition, musculoskeletal pain and injuries may increase with additional weight gain; being overweight is a significant risk factor for noncontact ankle sprains in football players.[22]

Both the body mass and % BF of collegiate football linemen have been increasing over the past 20 years.[3,4] We speculate that this trend may be due to differences in training and conditioning regimens, a change in nutrition, the perception that a bigger athlete is a better athlete, or may simply be a reflection of the obesity epidemic in the society at large. Strength increases as a function of body mass, and the laws of physics dictate that a larger mass is more difficult to move than a smaller one; thus, an increased mass, regardless of body composition, may be advantageous to football linemen. Therefore, it is easy to understand why 81% of collegiate freshman football players express a desire to increase their mass.[23] However, for mass to contribute positively to strength, the mass should be more a result of muscularity than adiposity.[24] There is often a negative relationship or little benefit to physical performance tests when the increased mass is actually body fat.[25,26] Regardless of the effect on performance, we echo the concerns of Noel et al[3] that the long-term health of the athlete should take precedence over any real or perceived performance advantage from excessive size. We propose that coaches have football players' body composition assessed periodically throughout their collegiate careers and provide education regarding the health risks of excess adiposity.

For the assessment and education of student athletes, we recommend a team approach that includes student health practitioners, team physicians, athletic trainers, strength and conditioning coaches, and nutritionists. For example, experienced health practitioners or athletic trainers should assess players' body composition in the off-season. The team physician or health practitioner can lead a team meeting to educate athletes about the health risks associated with excess body fat. Throughout the conditioning period, the strength and conditioning coach should emphasize muscle hypertrophy and strength gains rather than weight gain. Last, at-risk athletes could be referred to a nutritionist for additional dietary counseling.

As with any research, the interpretation and generalizability of these results may be limited by several factors. First, we used BIA (a field method) instead of other body composition methods (eg, hydrostatic weighing, Bod Pod [lab methods]) so that athletes would not be required to visit a lab to undergo measurement, which may have resulted in lower compliance rates. Also, the use of a different assessment method or prediction equation might change % BF estimation. The predictive accuracy of estimating % BF from BIA is less than that of lab methods[9] (see Table 3). Also, the Sun et al[13] BIA equation used to estimate % BF in this study is not specific to football players; however, those authors developed the equation from a mixed-race sample with a multicomponent reference model and recommended it for NHANES datasets. Another limitation is the small number of participants at some positions in our sample. Thus, the statistical comparison among position groups should be cautiously interpreted. Nonetheless, our sample size was greater than that of previously published studies (see Table 3).

Despite these limitations, there are several practical findings in this study. Although WC, BMI, and % BF as estimated from BIA were all significantly correlated, we found that BMI notably overestimated the prevalence of overweight and obesity in collegiate football players. BMI should not be the sole indicator of obesity classification in strength-trained athletes. College health practitioners should measure body fat rather than rely solely on BMI when making body composition assessments of strength-trained athletes.

The % BF of OL was significantly greater than that of players in most other positions, and on average, the OL met the criteria for obesity or disease risk for WC, BMI, and % BF. These results suggest that some collegiate athletes, especially those participating in sports in which having a large mass might be considered advantageous, are at risk for obesity-related diseases. Health practitioners need to take an active role in educating these student athletes about the health risks associated with excess body fat.

NOTE

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