Division IAA Football Players and Risk Factors for Metabolic Syndrome

by Wendy E. S. Repovich and Garth J. Babcock, Eastern Washington University

Abstract

The purpose of this study was to determine if body composition and blood pressure (BP), two markers for Metabolic Syndrome (MetS), were correlated in college football players. Height, weight, BMI, systolic (SBP) and Diastolic (DBP) blood pressure and body composition (three measures) were assessed in a Division IAA football team (N=55). Data analysis included a MANOVA, a Pearson Product Moment Correlation, and a Multiple Regression. Linemen were significantly different on all body composition measures from players in the other two positions. All body composition measures were correlated. The regression analysis revealed a single variable model to account for the variability between the four BMI categories.

Keywords: body composition

In 1994 the National Institute of Occupational Health and Safety (NIOHS) compared risk of death from cardiovascular disease (CVD) of retired NFL football players to the general population (Baron & Rinsky, 1994). It was determined in that study that as a group, football players had lower risk. However, if they examined the data from only the linemen (offensive and defensive), the players had a higher risk of death from CVD than the general population. Because the NIOHS study in 1994 was done using BMI for obesity risk and because they had not included markers specific for Metabolic Syndrome (MetS), the study was repeated in 2004-2006 (Miller et al., 2008). MetS is generally thought of as a group of risk factors that cluster and are highly correlated with CVD. However, the definition of MetS varies some, depending on which markers are used (Alberti, Zimmet, & Shaw, 2006; Grundy, Cleeman, & Daniels, 2005). Based on the literature, abdominal obesity, hypertension, insulin resistance and hyperlipidemia are risk factors associated with most of the definitions of MetS.

In the second study Miller et al. (2008), with the addition of specific risk factors to identify the prevalence of MetS, found that retired NFL linemen were not only at greater risk of death from CVD than the general public based on general standards, but that they were almost double in the incidence of MetS (clustered risk factors) than non-linemen. Tucker et al. (2009) had similar findings when comparing NFL players from 12 professional teams to a group of aged-matched men from the general public. They found that football players had a higher prevalence of prehypertension and that all participants of greater size, as measured by Body Mass Index (BMI), presented with increased blood pressure, low-density lipoprotein-cholesterol, triglycerides, and fasting glucose, and decreased high-density lipoprotein-cholesterol. Potentially the most important statement from Miller et al., however, was the recommendation that this increase in risk factors for MetS and CVD is not something that can be remedied by waiting until the linemen are retired professionals. The authors stated that the issue would best be addressed in preprofessional training programs, of which college athletics play a part.

In 2008 Buell et al., possibly in response to the recommendation by Miller et al. (2008), conducted a small cross-sectional study of 76 NCAA football linemen across all divisions (I, II, and III). The authors found multiple risk factors in these athletes, enough to identify MetS in almost half (34) of the players. The identifiers used in the study included blood markers (fasting insulin, glucose, high-density lipoprotein, total cholesterol, triglycerides, C-reactive protein and glycosylated hemoglobin) as well as blood pressure and body composition. The criterion for identifying MetS in players was that they had to exhibit at least three of the risk factors (Buell, et al.).

American Football is a game in which there are multiple positions with a variety of physical requirements demanding that players be skilled in a variety of performance components such as: strength, power, speed, agility, and to a degree endurance (Wilmore & Haskell, 1972). This variance in performance requirements has propagated the conduction of several research studies over the past 60 years related to the physical characteristics of players. Two of the most important physical changes identified have been in body weight and body composition, whether in the professional ranks (Baron, Hein, Lehman, & Gersic, 2012; Gettman, Storer, & Ward, 1987; Harp & Hecht, 2005; Welhan & Behnke, 1942; Wilmore & Haskell, 1972), college ranks (Buell et al., 2008; Millard-Stafford, Rosskopf, & Sparling, 1989), or high school ranks (Laurson & Eisenmann, 2007). Between the 1940s and 1970s professional players increased in body weight from an average of 97.1 kg to 115.1 kg and in percent fat from an average of 14.0% to 17.4% (Wilmore & Haskell, 1972). Though these studies measuring player physical characteristics did not all use the same technique to measure percent fat, the increase still appears to be substantial (Buell et al., 2008; Gettman et al., 1987; Millard-Stafford et al., 1989; Wilmore & Haskell, 1972). When the research examined separate players by position, the increases identified were even more pronounced in linemen (Baron et al., 2012; Baron & Rinsky, 1994; Buell et al., 2008; Gettman et al., 1987; Miller et al., 2008).

The incidence of cardiovascular disease (CVD) and its accompanying conditions in all populations has also increased dramatically since the 1940s (Buell et al., 2008; National Center for Health Statistics, 2009). Studies of risk factors for CVD have identified major modifiable risks that include obesity and hypertension (Buell et al. 2008; Harp & Hecht, 2005; Millard-Stafford et al., 1989; Miller et al., 2008). These two modifiable risks have also been identified as two of the more important factors contributing to MetS in the general population (Kraja et al., 2005).

Based on the increased risk of cardiovascular disease and its related health concerns, especially in professional football players, as well as the potential that earlier identification may allow for health modifications, the authors of the current study had two primary purposes. First, to examine the differences and relationships in body composition (using air displacement plethsmography and bioelectrical impedance) and blood pressure - two risk factors of MetS - between participants in three different player positions (linemen, line backers and all others). Second, to determine whether any of the measured body composition assessments were able to predict variability by BMI category, potentially providing a way to classify football players who might be at risk for MetS and eventually CVD.

Methods

This study was conducted at a university with a Division IAA sports program participating in the Big Sky Athletic Conference. The football coaches were approached and gave permission to ask players to participate. Approval was sought and received from the Institutional Review Board for the University. At the beginning of the 2009 spring season a meeting was held with the players to explain the research and asked for volunteers. Any player expressing interest was scheduled for a testing session. Fifty-five players agreed to participate and provided informed consent. Data collected included body composition and blood pressure measures as well as height and weight for BMI calculation.

Participants

Data for the study was gained from 55 of the football players participating during the 2009 spring season. Their mean age in years was 20.31 ± 1.15, their mean height in meters was 1.85 ± 0.07, and their mean weight in kilograms was 106.33 ± 17.78. Sixteen of the players were linebackers, 25 were linemen encompassing both offensive and defensive lines, and the rest were grouped together under all others.

Procedures

The spring practice was afternoons only and began with strength training followed by sport specific drills and play. All participants were scheduled for testing prior to the strength training sessions. All reported eating lunch (no caffeinated products) at least an hour before reporting to the Human Performance Lab. They were asked to void immediately before testing began. When they arrived they sat and rested for five minutes in the BOD POD® room (a 10' X 10' room closed off from the general lab). Blood pressure was then taken using a standard aneroid sphygmomanometer with an extra-large adult cuff and teaching stethoscope so two technicians were listening at the same time. Blood pressures were measured on the left arm in a sitting position with the arm supported by the technician. If the technicians agreed (within 1mm Hg) on the measures of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) the measures were recorded. If the technicians disagreed on either the SBP or DBP the test was repeated following three minutes of rest until agreement was reached.

Height was measured using the stadiometer on a Detecto Physician Scale (Cardinal Scale Manufacturing Co., Webb City, MO). Weight was measured during the body composition analysis using the BOD POD® (COSMED USA, Inc., Concord, CA). Height and weight were used to calculate BMI for each participant. To begin the BOD POD® assessment, the formula chosen for determining body density which is used to determine body composition was the default Siri equation. Participants were required to wear Under Armour® compression shorts and a swim cap for the BOD POD® measurements. Procedures for estimating %BF using the BOD POD® were completed including the measurement of residual lung volume following the manufacturers' guidelines. Upon completion of the BOD POD® test each player's body composition was also assessed using the Tanita Bioelectric Impedance Analyzer scale (BFA 300A) (Tanita Corp of America, Arlington Heights, IL). The machine has two formulas built in so each player was measured twice, one with the standard formula (BIASF), and the other with the athletic formula (BIAAF). All formulas for the Tanita Analyzer are proprietary so it is not possible to report which formula is used to determine body density and body composition from the measure of impedance. The lowest weight possible, 0.06 lbs was used as the clothing weight for both measures. The three measures of estimated %BF (BOD POD®, BIASF, and BIAAF) were recorded on the data sheet.

Data Analysis

All data were entered into an Excel spreadsheet (version 2003; Microsoft Corp, Redmond, WA), then checked and loaded into SPSS. Statistical analysis was completed using SPSS 17.0 for Windows (SPSS, Inc., Chicago, IL). Descriptive statistics were completed for all variables. Players were grouped by position Çú linebackers (N = 16), linemen (N = 25), and all others (N = 14) for those analyses requiring player classification. A 5 x 3 MANOVA (BOD POD®, BIASF, BIAAF, SBP, and DBP by position) was conducted. A univariate ANOVA post hoc analysis was used to determine which subgroups had significant differences in the dependent variables compared with the other subgroups.

In addition, four Pearson Product Moment Correlations were used to determine the strength of relationships between all three reported body composition measures (BOD POD®, BIASF, and BIAAF), the two blood pressure measures (SBP and DBP), and BMI categories for all players and by player position (linemen, line backer, and all others). Finally, a Multiple Regression Analysis was used to predict the amount of variance between the BMI categories and the body composition measures by position.

Results

The calculated BMI scores for the participants produced a mean of (30.71 ± 3.74). As would be expected for football players, all but three of the participants fell into the overweight or obese categories and nine were in the obese Class II category with a BMI between 35.1 and 39.9.

While no universally accepted norms are available for body composition, percentile values are reported by the ACSM (2010) from data gathered at the Cooper Clinic on almost 29,000 adults. Compared with those norms the percent body fat means reported for all participants using the BOD POD® and the BIAAF essentially fell into the normal range (BOD POD® 17.55 ± 7.26; and BIAAF 18.76 ± 4.71) of the 40th to 75th percentiles (fair to good) of 11.5% to 18.6% for males 20-29 years. The BIASF (24.59 ± 4.98) measure matched with the 1st to 15th percentile of 24.6% to 33.3%. If the 1st to 15th percentiles (very poor) were equated to norms, the BIASF measure in the present study would fall into an obese category. The SBP values fell into the normal to prehypertensive categories. (normal < 120 mmHg and prehypertension 120 mmHg

139 mmHg), while DBP values were in the normal range (< 80 mmHg) (ACSM, 2010). Descriptive statistics for the entire team for all variables can be found in Table 1.

Table 1. ***Descriptive Statistics for Demographic data, Blood Pressure and Body Composition***

Variable	Mean	*SD*
Height (m)	1.85	(.07)
Weight (kg)	106.33	(17.78)
% Body Fat (BodPod)		
Lineman (L)	22.85	(4.77)
Line Backer (LB)	12.79	(4.80)
All Others (AO)	13.51	(7.13)
All Combined	17.55	(7.26)
% Body Fat (BIAAF)		
Lineman	21.60	(3.13)
Line Backer	15.99	(3.89)
All Others	16.85	(5.27)
All Combined	18.76	(4.71)
% Body Fat (BIASF)		
Lineman	27.81	(3.55)
Line Backer	21.53	(3.52)
All Others	22.34	(5.33)
All Combined	24.59	(4.98)
Systolic Blood Pressure (mmHg)		
Lineman	120.20	8.71
Line Backer	120.13	(10.76)
All Others	121.57	(8.70)
All Combined	120.53	(9.20)
Diastolic Blood Pressure (mmHg)		
Lineman	69.68	(8.04)
Line Backer	67.19	(7.88)
All Others	69.36	(5.49)
All Combined	68.87	(7.38)

Note. BIAAF = Tanita Bioelectric Impedance Analyzer athletic formula.
BIASF = Tanita Bioelectric Impedance Analyzer stand formula.

A one-way MANOVA was calculated examining the effect of position (linebackers, linemen, all others) on all three %BF measures, SBP and DBP. A significant effect was found (*Wilks'* $\wedge$(.503), p = .0001). Follow-up univariate ANOVAs indicated that %BF of linemen was significantly different from the other two groups for each machine; the BOD POD® (F(2,52) = 21.663, p = .0001), and the Tanita scale for the two formulas, BIASF (F(2,52) = 14.562, p = .0001), and BIAAF (F(2,52) = 11.901, p = .0001). No significant effect was found in the follow-up univariate ANOVAs for either blood pressure measure; SBP (F(2,52) = .117, p > .05), or DBP (F(2,52) = .588, p > .05). Mean percent fat by player positions can be seen in Figures 1 — 3.

All three groups by position had SBP means slightly over the cutoff for borderline hypertension (≥ 120 mmHg) (ACSM, 2010). The range from low to high was also similar, but in the linemen, about 80% fell into the borderline hypertensive category, while only 40% and 30% were in that category for the linebackers and all others, respectively. DBPs means all fell into the normal range (< 80 mmHg) (ACSM), but one linebacker, four linemen, and two all others had measures of 80 mmHg or higher which falls into the borderline diastolic hypertension category (80 mmHg — 89

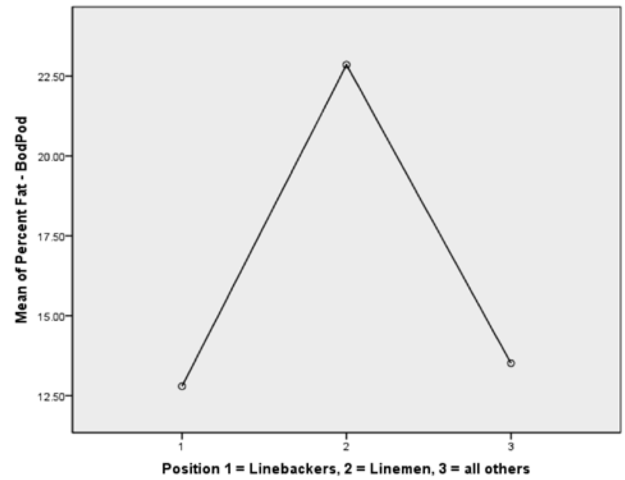

Figure 1. Mean of %Body Fat for BOD POD® by position Linemen were identified as significantly different (F(2,55)=21.66, p=.0001)

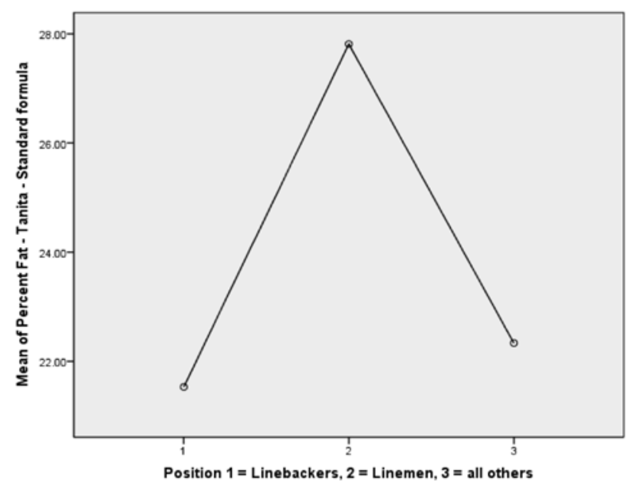

Figure 2. Mean of %Body Fat for BIASF by position Linemen were identified as significantly different (F(2,55)=11.90, p=.0001).

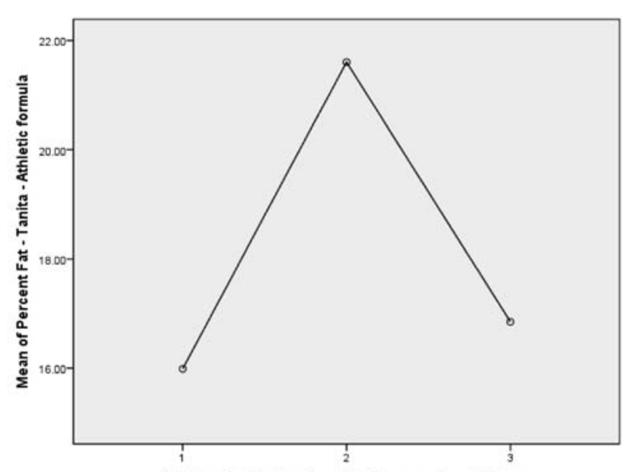

Figure 3. Mean of %Body Fat for BIAAF by position Linemen were identified as significantly different (F(2,52)=11.90, p=.0001).

mmHg) (ACSM).

Significant (p = .01) correlations ranging from r = .639 to r = .993 were found in the relationships between the three body composition measures when comparing all participants combined and in each of the three player position groups. No significant correlations were found between DBP and any other variable. SBP showed three moderate though significant correlations with the two BIA measures (BIAAF and BIASF) in the linemen and all others groups (see Tables 4 and 5). All three body composition measures were significantly correlated with the BMI categories. Correlations can be found in Tables 2 — 5.

Table 2. ***Correlations, Percent Fat Measures, Blood Pressure and BMI Category***

Measure	BOD POD®	BIASF	BIAAF	SBP	DBP	BMI Category
BOD POD®						
Correlation	--					
Sig. (2-tailed)						
BIASF						
Correlation	.816**	--				
Sig. (2-tailed)	.000					
BIAAF						
Correlation	.811**	.974**	--			
Sig. (2-tailed)	.000	.000				
SBP						
Correlation	-.002	.012	-.007	--		
Sig. (2-tailed)	.987	.932	.957			
DBP						
Correlation	.173	.231	.189	.131	--	
Sig. (2-tailed)	.206	.089	.167	.340		
BMI Category#						
Correlation	.768**	.846**	.808**	.064	.161	--
Sig. (2-tailed)	.000	.000	.000	.641	.240	

All Participants (N=55)
** p ≤ .01
# BMI Category - 1 = Normal, 2 = Overweight, 3 = Obese, 4 = Extreme Obese

Table 3. ***Correlations, Percent Fat Measures, Blood Pressure and BMI Category Linebackers (N=16)***

Measure	BOD POD®	BIASF	BIAAF	SBP	DBP	BMI Category
BOD POD®						
Correlation	--					
Sig. (2-tailed)						
BIASF						
Correlation	.696**	--				
Sig. (2-tailed)	.003					
BIAAF						
Correlation	.639**	.985**	--			
Sig. (2-tailed)	.000	.000				
SBP						
Correlation	-.017	.178	.144	--		
Sig. (2-tailed)	.949	.510	.595			
DBP						
Correlation	-.146	-.040	-.077	.197	--	
Sig. (2-tailed)	.590	.882	.776	.465		
BMI Category#						
Correlation	.525**	.850**	.827**	.475	-.046	--
Sig. (2-tailed)	.037	.000	.000	.063	.865	

*p ≤ .05
** p ≤ .01
# BMI Category - 1 = Normal, 2 = Overweight, 3 = Obese, 4 = Extreme Obese

Table 4. ***Correlations, Percent Fat Measures, Blood Pressure and BMI Category Linemen (N=25)***

Measure	BOD POD®	BIASF	BIAAF	SBP	DBP	BMI Category
BOD POD®						
Correlation	--					
Sig. (2-tailed)						
BIASF						
Correlation	.684**	--				
Sig. (2-tailed)	.000					
BIAAF						
Correlation	.745**	.915**	--			
Sig. (2-tailed)	.000	.000				
SBP						
Correlation	.356	.395	.411*	--		
Sig. (2-tailed)	.081	.051	.041			
DBP						
Correlation	.255	.272	.171	.248	--	
Sig. (2-tailed)	.219	.188	.414	.232		
BMI Category						
Correlation	.492*	.680**	.646**	.267	.214	--
Sig. (2-tailed)	.013	.000	.000	.197	.305	

*p ≤ .05
** p ≤ .01
# BMI Category - 1 = Normal, 2 = Overweight, 3 = Obese, 4 = Extreme Obese

Table 5. ***Correlations, Percent Fat Measures, Blood Pressure and BMI Category All Others (N=14)***

Measure	BOD POD®	BIASF	BIAAF	SBP	DBP	BMI Category
BOD POD®						
Correlation	--					
Sig. (2-tailed)						
BIASF						
Correlation	.711**	--				
Sig. (2-tailed)	.004					
BIAAF						
Correlation	.730**	.993**	--			
Sig. (2-tailed)	.003	.000				
SBP						
Correlation	-.345	-.540*	-.575*	--		
Sig. (2-tailed)	.227	.046	.032			
DBP						
Correlation	.277	.413	.446	-.319	--	
Sig. (2-tailed)	.337	.143	.110	.267		
BMI Category						
Correlation	673**	.876**	.847**	-.379	.122	--
Sig. (2-tailed)	.008	.000	.000	-.181	.678	

*p ≤ .05
** p ≤ .01
# BMI Category - 1 = Normal, 2 = Overweight, 3 = Obese, 4 = Extreme Obese

A multiple stepwise linear regression was calculated to predict participants' BMI category based on the three body composition measures. A significant regression equation was found (F(1,53) = 133.578, p = .0001), with an R2 of .846. The regression analysis revealed a single variable model (BIASF) to account for the variability of the four BMI categories. Of the three measurements of body composition, only the BIASF was able to reflect all four BMI categories in the regression equation. The other two methods were not able to specifically distinguish between the two obese categories.

Discussion

It is widely accepted that in general football players and especially linemen are taller, heavier and have a higher percent body fat than the general population (Baron & Rinsky, 1994; Buell et al., 2008; Gettman, et al., 1987; Harp & Hecht, 2005; Laurson & Eisenmann, 2007; Millard-Stafford, et al., 1989; Welhan & Behnke, 1942; Wilmore & Haskell, 1972). In recent years, however, research has identified that this increase in size may be putting these players at increased risk of CVD. (Baron & Rinsky, 1994; Buell et al., 2008; Miller et al., 2008; National Center for Health Statistics, 2009). Knowing that there is a group of clinical symptoms (MetS) that cluster in people who later present with type 2-diabetes and cardiovascular disease, some researchers have been prompted to see whether younger football players (college and high school) might be at risk for MetS and eventually CVD (Buell et al., 2008; Laurson & Eisenmann, 2007).

Confirming MetS medically requires the presence of a minimum of three of the following markers, (a) hyper cholesterolemia, (b) elevated blood glucose, (c) inflammatory markers, (d) hypertension; and (e) either elevated BMI or body composition (Alberti, et al., 2006; Grundy, et al., 2005). However, from the perspective of practicality, cholesterol, glucose and inflammatory markers all require blood sampling and analysis. BMI, though noninvasive and practical, has been questioned as to its validity in working with athletes of higher weight such as football players and especially linemen (Buell et al. 2008; Miller et al., 2008). As a result blood pressure and body composition are the remaining noninvasive, practical measurements (Alberti, et al., 2006; Grundy, et al., 2005).

In an effort to add to the body of growing knowledge related to football players and the risk of MetS and CVD, the researchers in the present study examined the differences between body composition and blood pressure in players from three different player positions. The results of the present study showed that BMI measures classified all participants into the overweight, obese Class I or Class II categories supporting the findings of other researchers (Baron, et al., 2012; Buell et al., 2008; Gettman, et al., 1987; Harp & Hecht, 2005; Laurson & Eisenmann, 2007; Millard-Stafford, et al., 1989; Miller et al., 2008; Tucker et al. 2012). Further, results supported the idea that BMI may not be accurate when predicting risk in athletes. Though the mean BIASF measure for all participants (all three player positions) concurred with the BMI measures, placing the participants in the obese classification (ACSM, 2010), the mean BOD POD® and BIAAF measures for all participants (all three player positions) placed these participants into the normal body fat percent category. The disparity between these measures may warrant the need for further investigation as to which body composition technique should be used and if BMI can be used to identify risk in this population

When separated by player position, the football linemen in the present study had a significantly higher %BF measure from all three measurement techniques than linebackers or all others. This finding corresponds with those of previous researchers for players at both the college and professional levels (Baron et al. 2012; Baron & Rinsky, 1994; Miller et al. 2008 and Tucker et al. 2009).

Blood pressure measures were also similar to those found in previous research. The findings in the current study indicated that all players (the three positions combined) on average fell into the normal category for DBP ($\leq$ 80 mmHg) and into the normal to borderline hypertensive category for SBP ($\geq$ 120 mmHg) according to the standards set forth by the ACSM (2010). This was also in agreement with previous research where all found that football players in general had a higher prevalence of prehypertension (Baron et al., 2012; Buell et al., 2008; Tucker et al., 2012).

When comparing SBP by player position in the present study, more linemen fell into the borderline hypertensive category (80%) then did linebackers (40%) and all others (30%). This tendency toward hypertension along with an increased percent fat in linemen may indicate the need for health care providers and coaches to pay more attention to educating these athletes about their weight, monitoring them for other risk factors related to the development of MetS and CVD, and helping them with weight loss after their participation ends as suggested by Buell et al. (2008).

Several studies have indicated that obesity and hypertension are major modifiable risks for MetS and CVD (Buell et al. 2008; Harp & Hecht, 2005; Millard-Stafford et al., 1989; Miller et al., 2008) as well as important factors contributing to both conditions (Kraja et al., 2005). It was thought, therefore, that there might be a strong relationship between these two factors and that if a measure of %BF had the capacity to predict BMI category possibly BP and %BF could be used to identify players with a propensity toward MetS. However, based on the results of this study blood pressure (DBP or SBP) and body composition (all three measures) were not correlated except for SBP and BIAAF for Linemen ($p = .04$) and for SBP with BIAAF and BIASF for all others ($p = .03$ and $p = .05$; respectively). An interesting finding was the correlations between SBP and both BIAAF and BIASF for the all other group were negative. This finding of a negative correlation indicates that the participants in this group who had lower body composition measures had higher SBP measures. This finding was not supported in the literature, but it does support the fact that determining the risk of MetS and CVD is multifaceted (Buell et al., 2008) and that there may be a need to look at more then just one or two of the risk factors in determining overall risk in all players.

The correlations between all three body composition measures and the BMI categories for all players combined and by position were strong ($p \leq .01$; for all correlations). Though all body composition measures were correlated with BMI categories only one, BIASF, was able to predict all four categories. The BOD POD® and BIAAF were able to predict the first two categories but had difficulty differentiating between the two classification categories for obesity. This was not completely a surprise in that the measures in both the BMI and BIASF were created from the general population, but the fact that the BOD POD® was not able to predict all four categories when using the more general Siri equation, may support the need for further research into the use of BMI or body composition as a measure for identifying risk in the athletic population.

A primary limitation of the current study was that players were tested in the afternoon just before beginning practice. It is possible that hydration levels of the players varied enough to impact the measures of BIA with the Tanita analyzer (Kyle et al., 2004) however both BIA measures were strongly correlated with the BOD POD®. Blood pressure assessments are also more standard if they are done in the morning in a fasting state (ACSM, 2010) and if a second measure is taken five minutes after the first as is the standard protocol to identify hypertension. The variations seen in the blood pressure of the patients in the present study were not confirmed with a second measurement. Therefore, even though measures seen in this study tended to agree with previous research that football players may have elevated blood pressure, it is recommended that future research be done with better control of the player's behavior prior to the assessment and repeated measures of blood pressure.

Conclusions

Determining risk for eventual CVD in football players is complicated and appears to require more than the most common noninvasive markers used in determining MetS. The results of the present study suggest that other players on the team, even those with the lowest body composition, may also possess risk factors. Further, finding a single elevated risk measure may not necessarily require follow up, but it appears to be prudent that the attending health care provider for the team (generally a physician or athletic trainer) should follow players with higher than normal body composition and/or blood pressure through a season and over the players years of participation. It is recommended that a protocol be created to accurately identify anyone who may be at risk and in need of early intervention. It is recommended that the protocol could potentially include education on monitoring and reducing risk factors and encouragement to seek further assessment of blood glucose, cholesterol, and/or inflammatory markers such as C-Reactive Protein if risks are not reduced (Alberti, et al., 2006; Buell et al., 2008; Grundy, et al., 2005; Kraja et al., 2008). Education about long-term health and lifestyle change for players about to finish their careers could also be promoted.

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