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Identifying risk factors for metabolic syndrome in Division I FCS football players

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IDENTIFYING RISK FACTORS FOR METABOLIC SYNDROME IN DIVISION I FCS FOOTBALL PLAYERS

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MASTER'S THESIS

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Abstract

Metabolic syndrome (MetS) is a collection of symptoms or markers leading to a higher risk for health problems including diabetes and cardiovascular disease. These markers include high blood pressure (BP), increased waist circumference (WC), high triglycerides, low HDL-C and increase glucose. Football players may be more at risk for developing MetS and other health problems due to the need for their large size, especially linemen. The purpose of this study was to determine the relationship between the MetS markers as well as the relationship between WC and visceral fat depth and measured with an ultrasound. MetS markers and visceral fat depth were measured on 12 collegiate football players from an FCS team. Statistical analysis included Pearson correlation, simple regression and multiple regression. A statistically significant correlation was found between WC and visceral fat as well as SBP and DBP. Glucose had a significant correlation with both WC and triglyceride levels. There was also a statistically significant, positive relationship between visceral fat and WC.

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Chapter 1

Introduction

In the sport of football, a team has multiple position players that include, but are not limited to, quarterbacks, wide receivers, defensive backs, offensive linemen and defensive linemen. By observing the game, fans can see that the height, weight, and body composition of players varies between positions. Past research showed offensive and defensive linemen as taller and heavier with an increased percent body fat (%BF) compared to other positions (Kraemer, et al. 2005).

This increased size of football players can lead to future health risks such as Metabolic Syndrome (MetS), cardiovascular disease (CVD), type 2 diabetes, etc. (Buell et al., 2008; Dobrosielski et al. 2010; Grundy, Brewer, Cleeman, Smith & Lenfant, 2004; Steffes et al., 2013). MetS is a collection of three to five risk factors and is a precursor for future health risks such as CVD and type 2 diabetes. The risk factors for MetS include elevated serum triglycerides (TG), reduced high-density lipoprotein cholesterol (HDL-C), elevated plasma glucose, hypertension, and increased waist circumference. Overweight or obese individuals seem to be the most at risk. Those with an increased waist circumference are at higher risk for MetS than those without (Kraja et al., 2005; Mansell, Blackburn, Arnold & Arnason, 2011). It is suggested cardiac conditions can be exacerbated due to larger body sizes and hypertension (Debrosielski, et al., 2010). In younger athletes with increased WC like collegiate football players, research should determine if the increase stems from excess subcutaneous fat or visceral fat. Elite NFL players with BMI of ≥30 were twice as like to develop CVD or die from CVD than the general population (Baron, Hein, Lehman & Gersic, 2012).

Two groups, the World Health Organization (WHO) and the National Cholesterol Education Program (NCEP), each released definitions of MetS that are commonly used throughout research (Grundy, et al., 2004). Both definitions require three out of five markers of the aforementioned criteria be present for a full diagnosis. The WHO, however, requires the presence of insulin resistance or Type 2 diabetes for diagnosis whereas the NCEP does not. The tests required for diagnosis include a small blood sample, waist circumference, and vitals (height, weight, and blood pressure). With these criteria and the importance of size in football, researchers have attempted to discover if it is possible to recognize those players at risk for MetS during or after their athletic career (Mansell et al., 2011; Miller et al., 2008; Repovich & Babcock, 2008; Wilkerson, Bullard, & Bartal, 2010).

Problem Statement

The purpose of this study was to determine the differences and/or relationships between markers of MetS including waist circumference, blood pressure, and fasting triglycerides, HDL-C, glucose, and visceral fat depth.

Null Hypothesis

There will be no significant correlation between markers of MetS including visceral fat depth, total fat percentage, BMI, waist circumference, blood pressure, fasting blood glucose, HDL cholesterol and triglycerides in collegiate football players.

There will be no significant relationship between visceral fat depth and WC.

Operational Definitions

- Abdominal Obesity-characterized by waist circumference >102cm measured with a Gulick Tape Measure as well as fat depth, both subcutaneous and visceral using the Body Metrix ultrasound (IntelaMetrix, Inc., Livermore, CA).
- Percent Body Fat- Characterized by the three-site formula by Jackson and Pollock for males using the BodyMetrix ultrasound (IntelaMetrix, Inc., Livermore, CA).
- Elevated Triglycerides-Characterized by triglyceride levels ≥150 mg/dL, measured with the Alere Cholestech LDX (Alere, Waltham, MA)
- Reduced HDL-C-Characterized by HDL-C levels <40 mg/dL, measured with the Alere Cholestech LDX (Alere, Waltham, MA)
- Elevated Fasting Glucose-Characterized by fasting glucose levels ≥110 mg/dL, measured with the Alere Cholestech LDX (Alere, Waltham, MA)
- Hypertension-Characterized by systolic and diastolic blood pressure >140/90; measured with an aneroid sphygmomanometer
- Body Mass Index-Body mass index (BMI) will be measured using the ratio of height to weight. The formula for this study will be weight (kg) ÷ height $(m)^2$.

Assumptions

It was assumed that participants will adhere to the rules of testing. This includes fasting before testing.

Limitations/Delimitations

Limitations of this study included the sample size. Participants were volunteers from a single FCS football team. This was a sample of convenience and as such the sample size was limited to only one team's volunteers. The volunteers were not required to report ethnicity, medications, past medical history or family history due to time constraints.

This study was delimited to the current players at Eastern Washington University who volunteered for the study.

Significance

Athletes may have a hard time adjusting to a healthy lifestyle outside of competitive sports. Since most collegiate football careers do not extend to professional play, it is important to educate the athlete for life after sports. By taking precautions and testing for MetS at the collegiate level, it is possible to help those at risk prevent or reverse the development of disease later in life.

Summary

Football is a very popular sport that lives by "bigger is better". Health risks associated with increased size may be putting players at risk for future issues like MetS. MetS, a collection of markers including increased BP, triglyceride levels, glucose levels, and WC, and low HDL-C, is a precursor other conditions such as CVD and Type 2 Diabetes. The purpose of this study was to determine the differences and/or relationships between MetS markers in the diagnosis of MetS and the effectiveness of ultrasound as a measuring tool for abdominal obesity.

Chapter 2

Review of Literature

Introduction

The purpose of this study was to determine the differences and/or relationships between markers of MetS including waist circumference, visceral fat depth, blood pressure, and fasting triglycerides, HDL-C and glucose in collegiate football players. This chapter will review previous literature pertaining to MetS. Topics included a definition of MetS, prevalence and common risk factors within the general public and football players, football player physique, prevalence of MetS in current and retired football players.

Definition of Metabolic Syndrome

Research has defined MetS in multiple ways. The National Cholesterol Education Program (NCEP) and the World Health Organization (WHO) released similar definitions commonly used throughout studies on MetS.

NCEP. The NCEP's ATP III "identified the metabolic syndrome as multiple risk factors for cardiovascular disease (CVD)" (Grundy et. al, 2004, p. 435). The report identified six common components for MetS also relevant to CVD, abdominal obesity, atherogenic dyslipidemia, elevated blood pressure, insulin resistance with or without glucose intolerance, proinflamatory state, prothrombic state (Grundy et. al., 2004). The clinical requirements for ATP III can be found in Table 1. Any three criteria combined are used as a positive diagnosis for MetS.

WHO. The WHO also released a similar definition of MetS in which CVD is also the principal outcome. For diagnosis, however, the WHO required insulin resistance (type 2 diabetes, impaired fasting glucose, or impaired glucose tolerance) for a diagnosis of MetS. Along with insulin resistance, the WHO requires an additional two criteria be met (see Table 1).

Table 1

Criteria for MetS diagnosis: WHO vs. ATP III

MetS Factors	WHO Criteria	ATP III Criteria
Body Weight	Waist to hip-men: >.9 Waits to hip-women: >.85 And/or BMI of > 30	WC Men: ≥102cm WC Women: ≥88cm N/A
Triglyceride levels	≥150 mg/dL	150 mg/dL OR on drug treatment for elevated triglycerides
Reduced HDL-C	Men: <35mg/dL Women: <39 mg/dL N/A	Men: <40 mg/dL Women: <50mg/dL OR on drug treatment for reduced HDL-C
Elevated BP	≥140 mmHg systolic ≥90 mmHg diastolic N/A	≥130 mmHg systolic ≥85 mmHg diastolic OR on antihypertensive medication
Glucose	Type 2 Diabetes, Increased fasting glucose, OR impaired glucose tolerance	≥100 mg/dL OR drug treatment for elevated glucose
Other	Microalbuminuria	
Notes	***Glucose impairments are required for diagnosis along with 2 other standards**	***Any 3 standards are required for a diagnosis**

Though both have been widely used in similar research, the ATP III only requires a small blood sample whereas the WHO's definition may require both a more rigorous blood sample to rule out glucose impairment, as well as a urine sample. In a collegiate setting, it is unrealistic to test both drawn blood and urine samples, since these are usually tested in a lab setting.

Prevalence and Common Risk Factors of MetS

Many factors can be attributed to the development of MetS. Health professionals and researchers commonly link sedentary lifestyles, lack of proper exercise and dietary choices to MetS (Clarke & Janssen, 2013; Fernandes & Lofgren, 2011; Greer, Sui, Laslow, Greer, & Blair, 2015; Lakka et al., 2003; Lopez-Martinez, et al., 2013; Morrell, et al., 2014). It is suggested that an increase in aerobic capacity and muscle strength help decrease the chance of MetS in adults (Lopez-Martinez, et al., 2013). Those who participate in low-intensity physical activity are much more likely to present with MetS risk factors than those who participate in moderate or high-intensity activities (Greer, et al., 2015; Lakka, et al., 2003). The American College of Sport Medicine (ACSM) suggests an adult must participate in ≥30 minutes of moderate activity ≥5 days per week or ≥150 minutes per week to maintain a "healthy" lifestyle (Garber, et al., 2011). Football players practice or compete up to six days a week for 1-2 hours putting them well within ACSM's suggested limits.

Lifestyles and diet may also be predictors for MetS. Habits such as alcohol intake and food consumption are usually developed early in an adult's life. College may play a key role in the development of a young adult's habits (Fernandes & Lofgren, 2011; Morrell, et al., 2012; Morrell, et al., 2014). College freshman, most of whom eat meals at a buffet-style cafeteria, gain up to 6.7 times more weight than other adults in America, and those who were overweight, continued to gain even more weight (Kasparek, Corwin, Valois, Sargent & Morris, 2008). The number of choices in food at a cafeteria may lead some individuals to eat high-caloric or high-fat meals, more often than well balanced meals.

It has also been suggested the chance of developing MetS as an individual's age increases (Ervin, 2009). Currently, 34% of the population over the age of twenty already meets the criteria for MetS. Males and females ages 40-59 are up to three times more likely to develop MetS than 20 year-olds (Ervin, 2009). If BMI is associated with the increase in age, the risk of MetS increases even more.

Football Player Physique

Since the beginning, the game of football has transformed with the addition of rules and regulations, changes to offensive and defensive strategies, and developments in training techniques (Kraemer et al., 2005). It requires a large variety of skill and performance demands. The different positions in football pose an interesting dynamic between quick, agile running backs and wide receivers to strong, immoveable linemen. These qualities and position demands may predispose these athletes to risk factors related to MetS.

High school athletes have recently started to trend upward in size overall. Offensive and defensive linemen at this level tend to have increased BMIs and WC overall compared to non-linemen (Steffes, et al., 2013). College football programs have the ability to recruit the biggest, strongest, and fastest athletes from these high school athletes. The larger high school linemen may be considered top recruits for colleges and universities since they already fit the "bigger is better" mantra. Like high school, collegiate linemen also average a larger WC and BMI than non-linemen (Steffes, et al., 2013). Within NCAA divisions I, II, and III, linemen increase in size as the school sizes and football programs increase (Buell, et al., 2008). This year's current NFL OL draft class, as reported by ESPN, placed the top 10 recruits as all over 300 pounds and 6 feet 5 inches.

Table 2

2016 Offensive Line Draft Class

Name	**Rank**	**School**	**Year**	**Height**	**Weight**
Laremy Tunsil	1	Ole Miss	Jr	6-5	310
Ronnie Stanley	2	Notre Dame	rJr	6-6	312
Jack Conklin	3	Michigan St	rJr	6-6	308
Taylor Decker	4	Ohio State	Sr	6-7	310
Jason Spriggs	5	Indiana	Sr	6-6	301
Germain Ifedi	6	Texaz A&M	rJr	6-6	324
Shon Coleman	7	Auburn	rJr	6-5	307
Le-Raven Clark	8	Texas Tech	rSt	6-5	316
Jerald Hawkins	9	LSU	Jr	6-6	305
John Theus	10	Georgia	Sr	6-6	313

In the NFL, body composition has remained relatively the same. Professional teams have the luxury of choosing the best, biggest, and strongest players from the collegiate ranks. Over 70 years, the largest increase in body composition was the offensive and defensive linemen body mass (Kraemer, 2005). Overall, all players had an increase in height, weight, and body fat overall (Anzell, et al., 2013). When analyzed by positions, multiple studies show linemen to have the highest overall weight and %BF of all positions (Anzell, Potrieger, Kraemer & Otieno, 2013; Buell et al., 2008; Kraemer et al., 2005; Repovich & Babcock, 2008).

Metabolic Syndrome in Football Players

With the increasing size of football players to meet the demand of the game, it is possible this change is causing more athletes to be at risk for MetS. To review, an individual must have three out of five markers: increased WC, hypertension, increased fasting glucose, decreased HDL, or elevated serum triglycerides (Grundy et al., 2004). Three studies had 50% (Buell et al,. 2008), 46% (Wilkerson, Bullard & Bartal, 2010) and 46% (Dobrosielski et al., 2010) of linemen report 3/5 markers for MetS. On the contrary, another study only had 14% of participating linemen positive for MetS (Mansel et al., 2011). This difference could be due to the fact participants from the University of Saskatchewan in Canada only had one participant with elevated BP (Mansel et al., 2011) compared to another study at an American university which had at least 50% of participants with elevated BP (Dobrosielski et al., 2010; Wilkerson, Bullard & Bartal, 2010).

Waist circumference and hypertension had a high correlation with linemen throughout multiple studies (Buell et al., 2008; Dobrosielski et al., 2010; Mansel et al., 2011; Wilkerson et al., 2010; Wilkerson, Bullard & Bartal, 2010). Specifically, one study had 100% of participating linemen with a waist circumference over 90cm (Dobrosielski et al., 2010). It is suggested that WC >90cm is a more sensitive predictor for those individuals who have three or more MetS indicators than either BF% or BMI in collegiate players (Wilkerson, Bullard & Bartal, 2010). Hypertension and/or prehypertension were also commonly associated with linemen. Two studies had over 50% of participating linemen with hypertension (Dobrosielski et al. 2010, and Wilkerson, Bullard & Bartal, 2010) whereas a third study had multiple participants fall only in to the pre-hypertensive category (Repovich and Babcock (2008). Of the studies that tested both linemen and non-linemen, results showed non-linemen to be at lesser risk of MetS (Debrosielski et al., 2010; Mansell, Blackburn, Arnold & Arnason, 2011; Wilkerson, Bullard, and Bartal, 2010).

Body Fat: Abdominal

It is commonly accepted that BMI does not work for athletes because muscle mass is more dense than fat mass. So, to measure %BF, useing other tests such as a Bod Pod®, bioelectrical impendence, DEXA, calipers, or ultrasound. Although the use of ultrasound for testing %BF is relatively new, its use has been validated against air-displacement (Bod Pod®) and bioelectrical impedance, two gold standards (Johnson, Naccarato, Corder, & Repovich, 2012). The use of ultrasound was also just as effective at computed tomography (CT) (Hirooka et al., 2005; Stolk et al., 2001). The use of ultrasound can be a cheaper, less invasive, less demanding imaging technique for clinical settings (Gong et al. 2007; Kirooka, et al., 2005). In athletics, athletic trainers, physical therapists, coaches and doctors do not always have access, training or the funds to use tests such as MRI’s, CT scans, or Bod Pods for body composition testing.

Blood Sampling

An accurate diagnosis for MetS requires blood sampling for triglyceride, HDL cholesterol, and glucose levels. Triglycerides are the predominant form of fat found in the body and Cholesterol is a sterol (a molecule with a four-ring structure) that is produced by animals. These terms are often used together due to their association with foods, especially those derived from animals (Wildman & Miller, 2004). Glucose refers to the level of “sugars” or carbohydrates readily available in the blood stream (Wildman & Miller, 2004). Many studies have not tested blood samples due to the cost and equipment demands. Without blood testing, a true diagnosis of MetS cannot be determined just based on waist circumference and blood pressure, the two measures that can be done in any setting. One study, which recommended the use of blood sampling for MetS for collegiate athletes, was able to complete blood testing for $57 per participant (Buell, et al., 2008).

Presence of MetS in Retired Football Players

One major concern for healthcare professionals is the wellbeing of the athletes after their careers are complete. Retired linemen and non-linemen had much higher obesity rates than their non-athlete cohorts of the same age (34.8%) (Miller et al., 2008). While many retired non-linemen are also considered obese (50.3%), linemen had an even higher rate of obesity (85.4%) (Miller et al., 2008). Obesity, cardiovascular, and metabolic concerns become much more serious due to the lack of or decrease in activity (Miller et al., 2008). In a study of 510 retired National Football League players, MetS was present in 59.8% of linemen and 30.1% of non-linemen (Miller et al., 2008). One study by the NFL found defensive linemen to be 42% more at risk for death from CVD compared to men of similar age and those with a BMI of ≥30 kg/m^2 doubled CVD mortality risk compared to other players (Baron, Hein, Lehman, & Gersic, 2011).

Summary

MetS is a widespread disease compiled of abdominal obesity, hypertension, low HDL, increased triglycerides, and increased glucose. It has had an effect on one third of the population so far and continues to increase. In a sport like football where weight and size are important, athletes are at a much greater risk for developing MetS at some point in their life. Some of the players, specifically linemen, are at a higher risk because their position requires them to be large. Currently, the majority of schools and teams do not have specific tests or protocols set for post-collegiate athlete health and wellness. This study will help identify those athletes most at risk for MetS, validate the use of ultrasound for abdominal obesity and discover the relationships between the risk factors of MetS and visceral fat depth.

Chapter 3

Methods

Introduction

The purpose of this study was to determine whether WC, blood pressure, blood samples and visceral fat can be used to determine the likelihood of MetS in Division I AA collegiate football players according to the ATP III guidelines. This chapter will discuss the methods, participants and statistical analysis performed.

Participants

After obtaining IRB approval from Eastern Washington University, participants were asked to volunteer from the EWU football team with permission from the coaching staff.

Instrumentation

For this study, each player's height, weight, age, blood pressure, %BF, waist circumference, BMI, triglyceride, glucose and cholesterol levels were measured. Blood pressure was measured using a standard sphygmomanometer (ADC Diagnostix, Hauppage, NY) after being seated for at least five minutes. Height and weight was measured using a Physician Scale and stadiometer (Cardinal Scale Manufacturing Cl., Webb City, MO). Body composition was measured using the BodyMetrix ultrasonography machine (IntelaMetrix Inc., Livermore, CA). BMI was determined using the following formula:

BMI = (weight in lbs/2.2) / (height in inches/39.37)^2 (Wildman & Miller, 2004). Fasting cholesterol, triglyceride and glucose levels was tested using the Cholestech LDX analyzer (Cholestech Co., Hayward, CA).

Procedure

Approval was obtained through the Istitutional Review Board (IRB) at EWU. After IRB approval, permission was obtained from the EWU football coaching staff to ask the players to volunteer for the study. Players were addressed at an informational team meeting prior to the testing to obtain their consent for the study.

All testing for the study was completed in the Eastern Washington University Human Performance Lab. Each participant was scheduled for a time prior to their strength training and instructed not to eat eight hours prior to reporting. After reporting to the lab, each participant had their BP taken after five minutes of rest using the sphygmomanometer. Each participant had three BP's taken consecutively. The average for both systolic and diastolic was used for analysis. Participants then had their height and weight measured on the Physician's scale without shoes. Cholesterol, triglycerides, and glucose were tested using a finger stick blood sample obtained with a sterile lancet. To ensure a viable sample, participants were asked to warm their hands under hot water for 2-3 minutes. A small sample was extracted (approximately 6 drops) and placed on a cholestech diskette. The diskette was analyzed using the cholestech LDX Analyzer. The cholestech analyzed total cholesterol, triglyceride, HDL-C, and glucose. The %BF was tested with ultrasound scans using the formula by Jackson and Pollock of the chest, thigh and abdomen. To determine the abdominal fat depth of the subcutaneous and visceral fat, an abdominal scan was performed. The three points (chest, thigh and abdomen) were measured three times and automatically analyzed by the BodyMetrix software. The abdominal scan, taken one inch from the umbilicus across the abdomen toward the anterior superior iliac spine, was measured once. The photo was then analyzed for both subcutaneous fat depth as well as visceral fat depth. Lastly, WC was measured from the top of both iliac crests. This was measured twice and averaged for final analysis.

Statistical Analysis

Each participant's results were recorded on a data spreadsheet. After data collection was completed, a statistical analysis was done using SPSS version 20 (SPSS Inc., Chicago, IL). Players were grouped together by position (i.e. linebackers, linemen, and others). A Pearson Correlation was run to find the relationships between the following individual variables: positions, height, weight, SBP, DBP, waist circumference, triglycerides, HDL-C, glucose and visceral fat depth. A multiple linear regression was run to determine the significance of each independent variable and the direction of the relationship and a simple regression was run to determine the relationship of WC and visceral fat (Cronk, 2004).

Summary

This study included volunteers from a Division I FCS football program. Each participant was tested during a fasting state for triglyceride levels, glucose levels, BMI, visceral and subcutaneous fat depth, WC, BP, height and weight. After data collection, results were input to SPSS for statistical analysis using a Pearson correlation and multiple linear regression tests.

Chapter 4

Results

Introduction

The purpose of this study was to determine the differences and/or relationships between MetS markers in the diagnosis of MetS and to determine the effectiveness of ultrasound as a measuring tool for abdominal obesity. This chapter will discuss the results of the analysis as described in the last chapter including descriptive statistics, Pearson correlation, simple and multiple regression between variables and primary markers of MetS.

Table 3

Descriptive Statistics

measures	N	Mean	SD	Minimum	Maximum	ATP III Guidelines
SBP	12	121.08	11.24	107.00	138.00	>130
DBP	12	77.58	8.13	69.00	95.00	>85
WC	12	100.50	12.74	83.25	118.75	>102
Tri	11	124.73	133.05	45.00	506.00	>150
HDL	11	39.18	10.45	18.00	57.00	<40
Glucose	11	88.73	13.02	72.00	113.00	>100
TC	11	172.82	47.95	100.00	245.00	
Visceral	12	9.92	4.85	2.40	20.00	
Height	12	74.58	2.81	67.50	77.00	
Weight	12	254.78	52.16	171.00	338.40	
Age	12	19.67	1.07	18.00	21.00	

Descriptive Statistics

Initially, 25 participants from the EWU football team showed interest in completing the study. After testing was complete, a total of 12 reported for their appointment times. Eleven participants completed all aspects of the test while one did not have a viable blood sample. The one participant's blood sample results were eliminated from being analyzed. The overall mean and standard deviation for the MetS risk factors and visceral fat are listed in Table 4.1.

Out of 11 participants one presented with MetS, two had two markers, six had at least one marker and two had no markers. The most common risk factor present during testing was both WC and low HDL with five participants each. Four participants reported high BP, two with high glucose and one with high triglycerides.

Five of the twelve participants were offensive linemen. One OL participant had four out of five MetS risk factors. He was also the only participant with a positive diagnosis for MetS. Two OL had two out of five risk factors and one OL had one out of five risk factors. One OL did not have a viable blood sample however he still reported with two out of five risk factors. Two participants reported as defensive ends and both only had one out of five MetS markers each. Of the five non-linemen, three had one out of five MetS markers each and two had no markers.

Pearson Correlation

Correlations between MetS risk factors, age, height, weight and visceral fat depth are reported in Table 2. Moderate significant correlations were found between visceral fat depth and WC (r=.638, p=.05). No other significant correlations were found between visceral fat and other MetS markers. There was also a significant correlation between glucose and WC (r=.7, p=.05) and glucose and triglyceride levels (r=.63, p=.05) SBP and DBP (r=.972, p=.01).

Table 4

Correlations

Measure	SBP	DBP	WC	Tri	HDL	Glucose	age	Visceral
SBP	1	.927**	.014	.038	.649*	.047	.215	.447
DBP	.927**	1	.258	.170	.567	.247	.014	.506
WC	.014	.258	1	.600	-.059	.700*	-.431	.638*
Tri	.038	.170	.600	1	-.265	.630*	-.662*	.446
HDL	.649*	.567	-.059	-.265	1	.170	.282	.284
Glucose	.047	.247	.700*	.630*	.170	1	-.368	.475
Age	.215	.014	-.431	-.662*	.282	-.368	1	-.393
Visceral	.447	.506	.638*	.446	.284	.475	-.393	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Simple Linear Regression

A simple linear regression was calculated predicting the subject's visceral fat depth based on WC. A significant regression equation was found (F(2, 8)=7.764, p<.05), with an R^2 of .437. A subject's visceral fat depth is predicted to be equal to

-15.395+.252 (WC) cm. A subject's average WC increases .252 cm for every 1 cm of visceral fat.

A simple linear regression was also run between visceral fat and the remaining MetS factors however there were no other significant findings. Triglyceride levels, HDL levels, glucose levels, and SBP/DBP cannot predict visceral fat depth.

Multiple linear regression

A multiple linear regression was calculated to predict the participant's visceral fat depth based on all five MetS markers. The regression equation was not significant ($F(6,4)=1.254$, $p>.05$) with an R^2 of .653. None of the five MetS markers (glucose, triglyceride, HDL, BP, or WC) can predict visceral fat depth.

Summary

A statistically significant correlation was found between WC and visceral fat as well as SBP and DBP. Glucose had a significant correlation with both WC and triglyceride levels. There were not significant correlations between any of the other MetS markers or visceral fat depth. There was also a significant linear regression between visceral fat and WC. As WC increases, so does visceral fat. Overall, only one subject (9%) had MetS. The most common risk factors were increased WC and low HDL.

Chapter 5

Discussion

Introduction

The purpose of this study was to determine the differences and/or relationships between MetS markers in the diagnosis of MetS and to use ultrasound as a measuring tool for abdominal obesity. This chapter discusses the results of the statistics and how it relates to past research.

Summary of Results

A total of 12 players participated in the study with 11 participants completing all aspects of testing. In the current study, only one participant's results confirmed a MetS diagnosis according to ATP III guidelines. These results were lower than other reports from similar studies (Buell et al,. 2008; Dobrosielski et al., 2010; Wilkerson, Bullard & Bartal, 2010).

MetS in football players

Body composition plays a key role in football. Many times we associate "bigger is better" with these athletes due to skills needed for each role. Visceral fat depth can be evaluated by using ultrasonography, which has been tested as just as valid and reliable as MRI and CT (Hirooka et al., 2005; Stolk et al., 2001).

In this study, visceral fat was shown to have a direct correlation to WC. The regression tests showed that an increase in visceral fat depth lead to an increase in WC. Previous MetS studies have not used ultrasound however WC is very commonly associated with those who are at a high risk for the disease, especially in football players

(Wilkerson, Bullard & Bartal, 2010). WC findings from this study were similar to other football related literature with at least 50% of individuals having a WC over 90cm (Buell et al., 2008; Dobrosielski et al., 2010; Mansel et al., 2011; Wilkerson et al., 2010; Wilkerson, Bullard & Bartal, 2010).

Three players reported with hypertension during this study which is slightly lower than similar research which reported at least 50% of participants as hypertensive (Dobrosielski et al., 2010; Wilterson et al., 2010). Further research is needed to determine whether the type of training required by football athletes or overall health caused an increase in BP. One study reported 23% of players as hypertensive and 54% as pre-hypertensive following their first year at the collegiate football level (Carbuhn et al., 2008).

MetS is commonly associated with larger individuals because it is shown to be a key factor to its diagnosis (Dobrosielski et al., 2010). Multiple studies show linemen, typically the largest players on a team, are most at risk for developing the syndrome (Debrosielski et al., 2010; Mansell, et al., 2011; Wilkerson, et al., 2010). In the current study, one lineman was positively diagnosed with MetS and three others had at least two out of five. Of those three, one participant did not have a valid blood sample however he still had high blood pressure and an increased WC. In this study, non-linemen did not have any participants with more than 1/5 MetS risk factors. These results are consistent with past research that linemen are more at risk for developing MetS than non-linemen (Dobrosielski et al., 2010, Buell et al,. 2008 and Wilkerson, et al., 2010).

Athlete Screening

Currently, the NCAA does not have a screening process for post-competitive athletes. Nutrition and exercise requirements often change drastically at the end of an athlete's career. Football players, specifically linemen while playing, are usually required to "bulk up" in adaptation to a higher level of competition. At the end of a career, most athletes are not educated on new exercise routines and nutrition for life after competition. This gap in education may be putting these already high-risk individuals even more at risk for health risks such as MetS, diabetes, or CVD.

Post competitive screening by team physicians, athletic trainers, and nutritionists may aid in the prevention of major health risks associated with these individuals. These screenings should include a physical workup, fasting blood samples (i.e. glucose, triglyceride and HDL-C), blood pressure, WC measurements, and other tests deemed necessary by a team physician. These screenings will help identify those individuals most at risk for future health problems. Future research can determine if a football athlete's MetS risks increase or decrease by tracking levels while they are out of season. If levels do not come within normal, it may require future testing for post-competitive athletes.

Limitations

This study was limited to the use of volunteers from a single FCS football team at Eastern Washington University. Twenty-five players originally showed interest however only 12 responded and were tested. Of those12 participants, only 11 had viable blood samples for analysis limiting our data. When analyzed, the single participant without a viable blood sample still had 2/5 MetS markers however his overall results were not analyzed within the correlation or regression tests due to lack of data. Research was also limited when comparing by positions. With a limited number of participants, it was difficult to compare multiple positions so the only division was between linemen and non-linemen.

Conclusion

The results of this study support past research that links WC with those individuals at a higher risk of MetS as 50% of participants had an increased WC. It also supports the conclusion there is a positive relationship between visceral fat depth and WC. Within the MetS markers, there were significant correlations between SBP and DBP, glucose and WC, glucose and triglyceride levels. Visceral fat measurements with an ultrasound have a high correlation with WC and may be an indicator for those at risk for certain conditions. More research needs to be made in the future regarding the relationship between visceral fat depth, WC and possible health risks in young football players.

Recommendations state an athlete may require post career counseling from coaches, athletic trainers or nutritionists on issues such as nutrition, health and life after sports (Judge, Stone, & Craig, 2010). Although the NCAA is the governing body of collegiate athletics and may have the resources to begin a program to help transition athletes to post-competitive wellness, these issues are mostly considered outside the jurisdiction since the athletes are no longer collegiate athletes (Judge, et al., 2010). This means the responsibility lies within the college or university to help educate their graduating athletes.

Moving forward, it is important to educate athletes on the significance of proper post-competitive nutrition and exercise. Future research and development is needed to create a program easily accessible to all athletes regarding health and health risks specifically those such as MetS, diabetes, and CVD. A post-season physical may become a key factor in identifying those most at risk and allow for much needed referrals to specialists.

Summary

The purpose of this study was to determine the relationships between MetS markers and use ultrasound as a measuring tool for abdominal obesity. Because of the small sample size, the results did not have many similarities with previous research. Visceral fat depth can be used as a tool to help determine an athlete's susceptibility to MetS because of its correlation with WC. Even with only one player positive for MetS, having multiple players with at least two risk factors leads to the conclusion athletes, specifically football players, may benefit from post-competitive consultation with specialists.

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Appendix

Simple Regression

Visceral Fat vs WC

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	WC[b]		Enter

a. Dependent Variable: Visceral

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.661[a]	.437	.381	3.82013

a. Predictors: (Constant), WC

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	113.303	1	113.303	7.764	.019[b]
	Residual	145.934	10	14.593		
	Total	259.237	11			

a. Dependent Variable: Visceral

b. Predictors: (Constant), WC

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-15.395	9.151		-1.682	.123
	WC	.252	.090	.661	2.786	.019

a. Dependent Variable: Visceral

Multiple Regression

Visceral fat vs MetS factors

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Glucose, SBP, Tri, WC, HDL, DBP[b]		Enter

a. Dependent Variable: Visceral

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.808[a]	.653	.132	3.58727

a. Predictors: (Constant), Glucose, SBP, Tri, WC, HDL, DBP

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	96.846	6	16.141	1.254	.432[b]
	Residual	51.474	4	12.868		
	Total	148.320	10			

a. Dependent Variable: Visceral

b. Predictors: (Constant), Glucose, SBP, Tri, WC, HDL, DBP

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-28.202	22.336		-1.263	.275
	SBP	.396	.447	1.067	.885	.426
	DBP	-.455	.676	-.743	-.673	.538
	WC	.231	.148	.762	1.561	.194
	Tri	.003	.015	.097	.186	.862
	HDL	.031	.202	.084	.152	.886
	Glucose	.000	.171	.000	-.001	.999

a. Dependent Variable: Visceral

Data Collection

Position	OL	OL	OL	OL	OL	LB	TE	R	QB	DE	DE	WR
Age	19	18	21	20	18	20	19	20	21	19	20	21
Height(in.)	77"	76.5	76.5"	75.75	75.25	73"	76.75	67.5	76.25	75.5"	74"	71.25
Weight(lbs)	300	338.4	314.5	294	291.5	225.5	234	171	219.5	243	238	188
BP	142/98, 138/97, 135/92	118/78, 120/80, 120/76	114/76, 118/72, 116/74	120/82, 118/70, 116/78	120/76, 198/80, 118/82	136/78, 120/80, 122/84	100/70, 110/68, 110/70	110/68, 106/70, 108/70	136/84, 138/84, 140/80	118/68, 118/70, 114/74	132/90, 140/80, 140/92	110/70, 110/68, 112/68
WC (cm)	111, 115	119, 118.5	113, 113.5	114.5, 116, 115.5	110.5, 111	91 91.5	94 95	83.5 83	88.5 89	93 93.5	98 98	86 86.5
TC	NA	241	115	178	245	200	145	<100	182	200	168	127
Triglyceride	NA	506	45	134	129	<45	82	<45	64	149	128	<45
HDL	NA	31	41	32	47	45	39	<18	57	32	45	44
Glucose	NA	113	91	92	106	74	82	75	86	72	89	96
BMI	35.6	41.1	38.2	35.8	36.5	29	27.7	26	15.1	29.6	30.6	25.5
Lean Mass	218.4	257	252	201	217	174	196	146	186	197	192	160
BF	27	23.8	19.6	31.5	25.7	22.9	16.4	14.5	33	18.7	19.3	14.7
Sub Q depth	2.5	2.7	2.8	2.7	2.4	2.2	1.9	1.6	2.8	3.0	2.2	2.0
Visceral depth	20	11.7	7.7	13.5	14.2	7.2	4.3	2.4	10.9	11.9	9.5	5.7

Clinical Experience

Assistant to the Physician-Orthopedic Physician Associates **November 2014-Present**

Assist in daily clinic coverage. Schedule surgeries, MRIs and procedures as deemed necessary by physician. Complete patient care in office such as suture or stable removal, dressing changes, etc. Answer patient phone calls daily. Update patient health histories in EPIC as needed.

Head Athletic Trainer-Spokane Shock Arena Football Team **July 2013-November 2014**

Oversaw all medical coverage for the Spokane Shock Arena Football Team including prevention, treatment, rehabilitation, and documentation of injuries. Coordinated all referrals for athletes to team doctors and physical therapists. Communicated all injuries to coaching staff daily as well as other medical staff as needed. Responsible for reporting all injuries to the arena football league on a daily basis as well as completing weekly conference calls.

Heat Athletic Trainer-Ferris High School-Physical Therapy Associates **August 2013-November 2014**

Oversaw medical coverage for all high school athletes at both practices and athletic events. Responsible for prevention, treatment, rehabilitation and documentation of injuries. Communicate injuries to athletes, parents, coaches, physical therapists, and doctors as necessary.

Graduate Assistant Athletic Trainer-Eastern Washington University **August 2008-May 2011**

Oversaw medical coverage for the NCAA Division I Women's Soccer team. Responsible for prevention, treatment, rehabilitation, and documentation of all injuries. Proficient in using the Presagia online documentation system as well as implementing the ImPact concussion testing. Also served as preceptor to the Eastern Washington University Athletic Training Education Program's students.

Athletic Training Student-Upper Iowa University **August 2008-May 2011**

Aided the certified athletic trainers with daily treatments, rehabilitation, and evaluations of athletic injuries at the division 2 level. Sports coverage included football (2 seasons), men's and women's soccer, wrestling, men's and women's basketball, and baseball. Represented the athletic training program on the student athlete advisory committee for 3 years.

Education

Upper Iowa University-Fayette, IA 52142 **Graduate year: 2011**

Bachelor of Science-Athletic Training
Honors Include graduating *cum laude* and senior athletic training student of the year

Eastern Washington University-Cheney, WA 99004 **Graduate year: 2016**

Masters in Exercise Science-GPA: 3.86
Thesis: Identifying Risk Factors for Metabolic Syndrome in Division I FCS Football Players

Certifications, Memberships, and Licensures

NATABOC August 2011-Present
Washington State-Licensed Athletic Trainer November 2011-Present
Certified in First Aid, CPR, and AED August 2008-Present
Member of the NATA, District 10 August 2008-Present