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The Relationship of Anthropometric Measures to Vertical Jump Height.

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The Relationship of Anthropometric Measures to Vertical Jump Height.

A thesis presented to the faculty of Exercise and Sports Science

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By

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ABSTRACT

The capability to perform your best is an important aspect in the sport of soccer. The relationship between anthropometric measures to vertical jump height among NCAA Division I Women's soccer players is a subject lacking sufficient scientific research. **Purpose:** To analyze this relationship, body mass and %body fat was correlated with un-weighted countermovement jump height to determine the strength of this relationship in NCAA DI female soccer players. **Methods:** Data from an ongoing athlete monitoring program from fourteen NCAA D1 female soccer players in the year 2007 was analyzed. Air Displacement Plethysmography (ADP) via a BOD POD (Life Measurement, Inc., Concord, CA) measured body composition. Height and weight were measured using BOD POD Scale (Life Measurement Inc., Concord, CA) and a stadiometer (Detecto Scale Program, Webb City, MO). To measure the strength characteristics, a Countermovement Jump was utilized. Those jumps were measured using force plates (Rice Lake Weighing Systems, Rice Lake, WI). **Results:** There was an inverse and moderate correlation (r = -0.371) between 0kg CMJ and %BF, and an inverse and trivial correlation (r = -0.034) between the 0kg CMJ and BM. **Conclusion:** The relationship between %BF and jump height has a larger impact on this particular group compared to the BM relationship with jump height, but they both however play a significant role in DI women's soccer.

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CHAPTER 1: INTRODUCTION

Statement of Problem

The purpose of this research was to find the relationship between the anthropometric and vertical jump height measures among NCAA D1 female soccer players. The anthropometric characteristics were measured through height, weight, and BOD POD, whereas the strength characteristics of the countermovement un-weighted jumps were measured through a force plate isolating flight time.

Hypothesis

It is hypothesized that as body mass and percent body fat increases, the coinciding un-weighted countermovement jump height will decrease. Furthermore, as body mass and percent body fat decreases, the un-weighted countermovement jump height will increase among NCAA D1 female soccer players.

Introduction

The ability to develop high levels of muscular power is critical for a successful performance in many sports (Anderson, 2007; Harris, Stone, O'Bryant, Proulx, & Johnson, 2000). Various strength and anthropometric measurements have been tested in sports to determine how training methods are affecting the athlete's ability to perform (Kraska, et al., 2009; Ugarkovic, Matavuli, Kukolj, & Jaric, 2002). In doing so, accurate measures of body composition in collegiate athletes have been shown to be either beneficial or hinder athletic performance (Horvat, Ramsey, Franklin, Gavin, Palumbo, & Glass, 2003; Moon, et al., 2009). Past research has concluded that anthropometric measures and jump height have a strong correlation in determining the explosiveness of the athletes (Kraska, et al., 2009). In addition to past research, longitudinal studies have taken place that proves the benefits of body composition on athletic performance and how specific resistance and cardiovascular training programs benefit to the athletic performance as well (McNeal, Poole, & Sands, 1999). Body composition analysis has proven that athletes in certain sports have similar body compositions compared to opposing sports and athletes (Gonzalez-Rave, Arijia, & Clemente-Suarez, 2011). The explosiveness in athletes is a determining factor in the success they bring on and off the field and court.

Superior jumpers are also considered to be more explosive and stronger athletes (Kraska, et al., 2009). The more body mass carried by an athlete, the more power it takes to jump the same height as an athlete carrying a smaller amount of body mass (Johnson & Bahamonde, 1996). It has been suggested that to prepare athletes for competition and to compare performance between athletes, strength and endurance measurements should be acutely predicted for female athletes (Horvat, Ramsey, Franklin, Gavin, Palumbo, & Glass, 2003).

Pertinent Vocabulary and Definitions

1. Air Displacement Plethysmography (ADP): A method for determining body volume, and body density is calculated as the ratio between body mass and body volume(Kollias, Panoutsakopoulos, & Papajakovou, 2004).
2. BOD POD: Utilizes Air Displacement Plethysmography (ADP) to estimate %BF quickly and noninvasively (Vescovj, Hilderbrandt, Miller, Hammer, & Spiller, 2002). % Body Fat was obtained from the BOD POD software.
3. Countermovement Jump (CMJ): A movement that involves the stretch shortening cycle that allows the body to store and redirect energy through and an eccentric movement quickly followed by a concentric movement (Earp, et al., 2010).
4. Jump Height (JH): The time when the athlete leaves the force plate and ends once their feet

make contact back onto the force plate is the measure of flight time. Jump height is derived from flight time.

CHAPTER 2: REVIEW OF LITERATURE

Analysis of the Air Displacement Plethysmography; BOD POD and body composition:

Air Displacement Plethysmography; BOD POD:

Whole-body plethysmography is a method for determining whole body volume and body density and is calculated as the ratio between body mass and body volume (King, Fulkersonn, Evans, Moreau, McLaughlin, & Thompson, 2006). Numerous studies have been conducted to determine how reliable ADP is and the validity it produces. The BOD POD is frequently used as the testing measurement for ADP. The ease of the design leaves minimal discomforts for the patients who utilize the BOD POD. The largest issue about the BOD POD, or any ADP testing measurements, is the different amount of gasses in the chambers. According to King et al, there are two relevant gas laws to be considered when using the BOD POD: isothermal conditions and Poisson's Law. Poisson's Law describes the relationship between pressure and volume with adiabatic conditions (King, Fulkersonn, Evans, Moreau, McLaughlin, & Thompson, 2006). Gas under the isothermal conditions is more readily compressed, which can generate an uncertainty about the BOD POD (King, Fulkersonn, Evans, Moreau, McLaughlin, & Thompson, 2006). The air that is trapped in the hair and clothing of the patients is considered to be near an isothermal state (King, Fulkersonn, Evans, Moreau, McLaughlin, & Thompson, 2006). To help minimize the effects of the isothermal conditions on the patients, they are told to wear negligible clothing and wear a suctioned swim cap to cover their hair. The ADP system attempts to control the differences in the gases by estimating body surface area through the minimal clothing the participants wear during the procedure (King, Fulkersonn, Evans, Moreau, McLaughlin, & Thompson, 2006). It was suggested by Anderson et al., that in order to produce the most accurate results, the participants should be given test trials, which allow them the opportunity to adjust to the procedure and get more comfortable with the process. The reliability among the BOD POD testing measurements strongly suggest that the same amount of minimal and the same minimal clothing should be worn during the repeated studies (King, Fulkersonn, Evans, Moreau, McLaughlin, & Thompson, 2006). Studies have concluded that through their research, very few individuals own clothing suitable for testing in the BOD POD (King, Fulkersonn, Evans, Moreau, McLaughlin, & Thompson, 2006).

Following up with the statement of different gases affecting the end result of the test, ADP has produced significantly higher numbers for %BF compared to Hydrostatic Weighing (HW) and Skin Fold (SF) (Vescovj, Hilderbrandt, Miller, Hammer, & Spiller, 2002). Contradictory to the %BF being higher compared to the other methods of testing, body density (BD) was found to be notably lower (Vescovj, Hilderbrandt, Miller, Hammer, & Spiller, 2002). According to Vescovi et al., there was reasonable doubt concerning the gender differences with ADP and the testing results concluding that women's %BF results were overestimated and the men's %BF results were underestimated. Another consideration to be made in determining the most accurate reading for the ADP is the participant's lung volume. The two ways to determine the lung volume of an individual are predicted and measured lung volumes, which can produce a difference of up to 3% BF (Anderson, 2007).

Body Composition:

It has been well documented that female athletes undergo physical changes in anthropometric measures (body composition, lean body mass, body density, fat mass, etc.) by participating in sports (Carbuhn, Fernandez, Bragg, Green, & Crouse, 2010). Particular sports have a much higher ratio aerobic activity compared to other lower aerobic based sports. Those particular sports indicate a higher rate of change in anthropometric measures for the female athletes compared to more sedentary sports primarily because of the physical aspect the sports require from the athlete (Carbuhn, Fernandez, Bragg, Green, & Crouse, 2010). Recent studies have shown that the largest increase in anthropometric measures occur between either off-season and preseason or preseason and postseason (Carbuhn, Fernandez, Bragg, Green, & Crouse, 2010; Carling & Orhant, 2010). The time frames previously mentioned between seasons and off periods, show that the rise in body composition data is due to the increase in the training periods, which are intended to prepare the athlete for the upcoming season.

Body composition analysis commonly uses the height and weight of the participant in order to more accurately calculate their Body Mass (BM), fat free mass (FFM), and %BF. The reliability and validity of body composition testing have been proven to be a substitution for assessing body fat percentages (Anderson, 2007; Eaton, Israel, & O'Brian, 1993; Evetovich, et al., 1997; Fornetti, Pivarnik, Foley, & Fiechtner, 1999; Jackson, Pollock, Graves, & Mahar, 1988; Segal, VanLoan, Fitzgerald, Hodgdon, & Van Itallie, 1988; Stout, Housh, Eckerson, Johnson, & Betts, 1996; Vescovj, Hilderbrandt, Miller, Hammer, & Spiller, 2002). Body composition greatly affects the energy-related physical strength and skill in various sports (Tsunawake, Tahara, Moji, Muraki, Minowa, & Yukawa, 2003). Body composition varies among men and women, especially in the sites where each gender carries more subcutaneous fat deposits. Women typically carry more fat in their thigh, abdominal and subscapular regions (Holcomb, Lander, Rutland, & Wilson, 1996). The more fat carried in those specific places on a female athletes body, increases the percent fat mass, and lowers the lean body mass (LBM). Previous studies have shown that changes in body weight don’t necessarily affect the vertical jump heights and explosiveness of athletes (Miller, White, Kinley, Congleton, & Clark, 2002).

Body mass is determined by certain 2-compartment equations that have been modified into the modern equations. Jackson et al, created 2-compartment, generalized equations through the use of the hydrostatic weighing and a 4-zone skin calibration test (Jackson, Pollock, & Ward, 1980; Moon, et al., 2009). The amount of errors on the generalized and older equations can now be measured through the creation of another equation that specifically measures the estimated error from the 2-compartment model equations. Modern equations were created using the most current and up-to-date technology measuring body composition and other anthropometric data that questions the older and generalized equations (Fornetti, Pivarnik, Foley, & Fiechtner, 1999; Moon, et al., 2009).

Longitudinal studies have been done that explore whether or not specific training methods and programs benefit the athlete's performance and impact their body composition. The conclusions of those studies came back that training programs and methods do play a vital role in the athlete's performance and body composition (McNeal, Poole, & Sands, 1999). Coaches implement training programs by evaluating certain fitness characteristics that are supposed to be beneficial to the athletes. In female athletes, body composition is one of the main characteristics that coaches can evaluate by physically monitoring the athletes. The thought that lower body mass allows female athletes to play better could in turn cause them to begin having eating disorders, which can lead to the female triad. Measuring body density over time could indicate that the strength training program and the aerobic training programs are leading to hypertrophy which will in turn lead to a favorable lean mass to fat mass ratio (Gonzalez-Rave, Arijia, & Clemente-Suarez, 2011). Body Mass Index (BMI) and other methods of calculating body mass using height and weight have been shown to be unreliable compared to other more extensive testing procedures including ADP through BOD POD and other testing procedures.

There are relevant anthropometric measures that recent studies have narrowed down when trying to evaluate the physical performance of soccer players and the success each player will have (Carling & Orhant, 2010; Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007; Vescovj, Hilderbrandt, Miller, Hammer, & Spiller, 2002). The body size and body composition affects the functional performance of soccer players and the work rate they can produce on the field. Body size and composition have also been known to fluctuate throughout season depending on the training sessions, habitual time and nutrition intake (Carling & Orhant, 2010; Ostojic, 2003). However some changes in body composition are not necessarily good, which is why %BF techniques are used to determine if the percent fat mass has increased or decreased (Carling & Orhant, 2010).

Analysis of countermovement un-weighted jumps:

Countermovement un-weighted jumps:

Vertical jump plays a large part in the success of strength and power in sports (Kraska, et al., 2009). Most vertical jumps are tested doing weighted and un-weighted static and countermovement jumps. The weighted jumps are supposed to stimulate equipment, fatigue, collisions with other players, and additional obstructions athletes encounter in any type of training sessions (Kraska, et al., 2009). Past studies have shown that power is maximized when vertical jumps are performed un-weighted (Cormie, McGaulley, & McBride, 2007; Cormie, McCaulley, Triplett, & McBride, 2007; Dayne, McBride, Nuzzo, Triplett, Skinner, & Burr, 2011; Swinton, Stewart, Lloyd, Agouris, & Keogh, 2012). Jump heights can be used to measure explosiveness and are typically coupled with measuring strength for athletes. Because the static and countermovement jumps help measure explosiveness and strength, they are normally part of the testing procedures and training programs for athletes (Kraska, et al., 2009). Both longitudinal and cross-sectional studies have shown improvements in vertical jumps with the aid of plyometric training for athletes (Cormie, McBride, & McCaulley, 2009; Flanagan, Ebben, & Jensen, 2008; Holcomb, Lander, Rutland, & Wilson, 1996; Luebbers, Potteiger, Hulver, Thyfault, Carper, & Lockwood, 2003; Markovic, Dizdar, Jukic, & Cardinale, 2004). The reliability of the vertical jump has been proven acceptable means of measurement by numerous studies (Markovic, Dizdar, Jukic, & Cardinale, 2004; Vitasalo, 1988), but to ensure the validity of the measurements, the athletes must be consistent in their landings for each jump (Markovic, Dizdar, Jukic, & Cardinale, 2004). Plyometric training combined with aerobic training has shown to increase performance (Brown, Ray, Abbey, Shaw, & Shaw, 2010), however plyometric training could have a negative effect on power production, so to receive benefits all around, it needs to be performed before aerobic training periods (Brown, Ray, Abbey, Shaw, & Shaw, 2010; Chambers, Noaks, Lambert, & Lambert, 1998).

Studies have indicated that athletes with increased levels of lower-body strength have been shown to have higher peak jumping movements compared to other athletes with decreased levels of lower-body strength (Cormie, McBride, & McCaulley, 2009; Harman, Rosenstein, Frykman, Rosenstein, & Kraemer, 1991; Stone, O'Bryant, McCoy, Coglianese, Lehmkuhl, & Schilling, 2003). With the addition of a training program introduced to the athletes, improvements in jump curves have been shown to increase compared with their counterparts that received no training program (Bullock & Comfort, 2011; Cormie, McBride, & McCaulley, 2009). CMJ typically produce much higher numbers in the jump height, velocity and power output, because it is a more natural movement for athletes to perform (Harman, Rosenstein, Frykman, Rosenstein, & Kraemer, 1991; Johnson & Bahamonde, 1996). Countermovement jumps are typically the type of jumps performed in a sport. Another factor that leads to increased jump heights is the athletes body mass. The heavier athlete must produce more power to achieve a JH equal to that of a lighter athlete (Baker, 1996; Horvat, Ramsey, Franklin, Gavin, Palumbo, & Glass, 2003; Johnson & Bahamonde, 1996; Walsh, Bohm, Butterfield, & Santhosam, 2007). Also taking into consideration the different types of athletes, some use more strength for their jumping actions compared to others who use more explosiveness (Earp, et al., 2010).

Sport coaches currently believe that maximum strength is related to power production and that increases in maximum strength can cause increases in power production (Kollias, Panoutsakopoulos, & Papajakovou, 2004; Stone, O'Bryant, McCoy, Coglianese, Lehmkuhl, & Schilling, 2003). Stone et al stated that maximum strength plays a major role in power output in both static and countermovement jumps even at relatively light weights. It also improves jumping with light external loads (Stone, O'Bryant, McCoy, Coglianese, Lehmkuhl, & Schilling, 2003). For certain athletes, specific training methods focusing on the velocity of the movement may be required to improve power output (Harris, Stone, O'Bryant, Proulx, & Johnson, 2000; Kraemer & Newton, 2000; Newton & Kraemer, 1994) as well as focus on separate components of muscular power (Newton & Kraemer, 1994). The vertical jump is an important feature of many sports and is frequently coupled with other explosive body weight exercises in training that is aimed at developing muscular power and athletic performance (Baker, 1996; Swinton, Stewart, Lloyd, Agouris, & Keogh, 2012).

CHAPTER 3: METHODS

Subjects

Fourteen NCAA Division I female soccer players took part in an ongoing athlete-monitoring program during the 2007-2008 academic year. The averages among the athletes tested were; age 19.6 ± 0.92 yrs, height 167 ± 3.68 cm, and weight 64.2 ±4.68 kg. Noteworthy information regarding subject characteristics is located in Table 2. %BF was measured using ADP via BOD POD, weight was measured using the attached BOD POD scale, height was measured using a stadiometer, and jump height was measured via flight time with force plates (Rice Lake Weighing Systems, Rice Lake, WI). De-identified data was used so that informed consent was not needed.

Experimental Design

All tests were conducted at the same time each morning of testing. Each athlete was given a specific time for each testing in order to maintain as much standardization as possible for the research study. In addition to sustaining as much consistency as possible, every athlete tested carried out the same warm-up procedure and order of testing as the other athletes who participated in the study, as well as wearing the same type clothing as the other participants in the study.

Vertical Jump Testing Procedures (CMJ)

The data is part of an ongoing athlete-monitoring program, so it was conducted in a standard order (Kraska, et al., 2009; Stone, Stone, & Sands, Principles and Practice of Resistance Training, 2007). Similar to Kraska et al., a standardized warm-up procedure was followed for all participants before vertical jump and strength testing. The athletes performed twenty-five jumping jacks and then a series of clean pulls, including one set of five clean pulls at the mid-thigh pull with an empty bar weighing 20kg and three sets of three mid-thigh pulls with 40 kg(Kraska, et al., 2009). The type of jump tested was the CMJ. The jump was performed with a load of 0kg (PVC Pipe) that was placed between the seventh vertebra and the third thoracic vertebra (Kraska, et al., 2009; Stone, O'Bryant, McCoy, Coglianese, Lehmkuhl, & Schilling, 2003). The amount of rest varied between each jump, but was estimated to be around 1 minute. All jumps were performed using a force plate that had a sampling rate of 1000Hz (Rice Lake Weighing Systems, Rice Lake, WI) (Kraska, et al., 2009). Athletes were instructed to step onto the force plate. Next they were told to stand in the upright position with the un-weighted bar (PVC Pipe) pressed firmly against their upper back and shoulder area. After the athletes were in the ready position, they were told to dip down to any angle the athlete felt comfortable with and jump straight up at a 50% perceived effort following a 3-2-1-jump countdown (Kraska, et al., 2009). Next they performed the same procedure, following the same countdown, at a 75% perceived effort. Finally, if the athletes felt ready for the actual test at 100% perceived effort, they were given the countdown to begin the trials. The athletes were instructed to make the movements, mentioned in the previous sentences, in one-fluent motion. The athletes were given at least two trials to make sure the data was correctly shown on the computer program and the athletes felt confident with their maximal jump efforts.

The vertical jump height (JH) was measured by the flight time (FT) (Kraska, et al., 2009). All CMJ force time curve characteristics were recorded and analyzed using Lab View 8.0 (Kraska, et al., 2009). Jump height difference was calculated as a percent loss from the average jump height achieved under 0-Kg loading conditions with [Percent Loss=(Jump Height at 0 kg-Jump Height under 20 kg) ÷ Jump Height at 0kg x 100] (Kraska, et al., 2009).

BOD POD

The athletes arrived and were immediately given a hydration test. Next their height was measured to the nearest 0.1 cm using a stadiometer (Detecto Scale Program, Webb City, MO) and weight was measured to the nearest 0.01kg (Life Measurement Inc., Concord, CA). The athletes were instructed to change into a minimal amount of clothing, which consisted of a sports bra, compression shorts, and a tight fitting swim cap. While the athlete was changing, the machine was being calibrated for the arrival of the athlete. The athlete was given brief instructions reminding them to stay calm and to remain as motionless as possible while inside the BOD POD chamber. They were instructed to sit inside, motionless, and to breathe normal while the instrument determined the raw body volume inside the chamber for two test trials (King, Fulkersonn, Evans, Moreau, McLaughlin, & Thompson, 2006). The raw body volume values should be within 150 ml in order for the ADP software to signal that is ready for the actual testing procedure (King, Fulkersonn, Evans, Moreau, McLaughlin, & Thompson, 2006). Because of a previous study, estimated %BF was not significantly effected by the use of either measured or predicted thoracic lung volume (McCroy, Mole, Gomez, Dewley, & Bernauer, 1998; Vescovj, Hilderbrandt, Miller, Hammer, & Spiller, 2002). After using a predicted measurement for the thoracic lung volume, the athlete was tested twice. The final %BF was recorded from the estimated value through the built in BOD POD software programs.

Statistical Analysis

Pearson product-moment correlations were utilized in determining the relationship between anthropometric measurements and 0kg CMJ JH. Strength of relationships in correlations was assessed using the following criteria: trivial (r = 0.0 to 0.1), small (r = 0.1 to 0.3), moderate (r = 0.3 to 0.5), large (r = 0.5 to 0.7), very large (0.7 to 0.9), and almost perfect

(0.9 to 1.0) (Hopkins W. , 2000; Hopkins W. H., 1999).

CHAPTER 4: RESULTS

The means and standard deviations for all variables can be found in Table 2.

Correlation between 0kg CMJ and %BF

Correlation for the 0kg CMJ and %BF can be found in Table 3. The relationship between 0kg CMJ and %BF was found to be inverse and moderate (r = -0.371).

Correlation between 0kg CMJ and BM

Correlation for the 0kg CMJ and BM can be found in Table 4. The relationship between 0kg CMJ and BM was found to be inverse and trivial (r = -0.034).

CHAPTER 5: DISCUSSION

The subject numbers were low and did not have much variation within the data compared, so this will affect the strength of the relationship. The jump height was low meaning that these athletes were not very good jumpers and that the ability to jump was probably more of a factor compared to BM and %BF. The data was collected throughout the year 2007 on different testing dates, meaning that the ones collected early in the year were the times when the testing scores would be the lowest due to detraining, and the testing dates at the end of the year would measure the heights results, because the athletes have had a year of training. Nevertheless, there were two important findings that resulted from this investigation on female soccer players.

The first finding within this particular group showed a moderate correlation between %BF and 0kg CMJ JH. It has been proven that body composition greatly affects the energy-related physical strength and skill in various sports (Tsunawake, Tahara, Moji, Muraki, Minowa, & Yukawa, 2003). There have been longitudinal studies completed that determined if detailed training programs impacted their body composition. Those studies concluded that training programs play a vital role in the athlete's body composition (McNeal, Poole, & Sands, 1999).

The second finding within this particular study group, showed a trivial correlation between BM and 0kg CMJ JH. Previous studies have shown that changes in body weight don't necessarily affect the vertical jump heights and explosiveness of athletes (Miller, White, Kinley, Congleton, & Clark, 2002). Measuring body density over time could indicate that the strength training program and the aerobic training programs are leading to hypertrophy which will in turn lead to a favorable lean mass to fat mass ratio (Gonzalez-Rave, Arijia, & Clemente-Suarez, 2011). Monitoring female athletes body mass is an easy way for coaches to physically monitor their athletes to make sure that they are remaining healthy and showing positive gains with regard to their body mass.

Summary and Conclusion:

Based on the results of this study, it can be concluded that %BF will have a positive effect on jump height characteristics, compared to the BM of the athlete. From the study it can be suggested that decreasing the %BF of athletes, will improve their power and jumping ability. It is well known throughout sport science that jump height and strength are related, so incorporating strength programs and focusing on %BF in athletes would be beneficial for female soccer programs.

Practical Application:

The overall outcome of this study was to be able to find a relationship between anthropometric measures and jump height in NCAA Division I female soccer players. A lower percentile in body mass or percent fat does not show any significance in determining the jump height or explosiveness of the athletes. It is suggested that coaches should not focus directly on the body fat percentage or body mass of their athletes in relation to strength characteristics; however they should focus on strength training to help improve the jump height capabilities in their athletes.

DATA TABLES

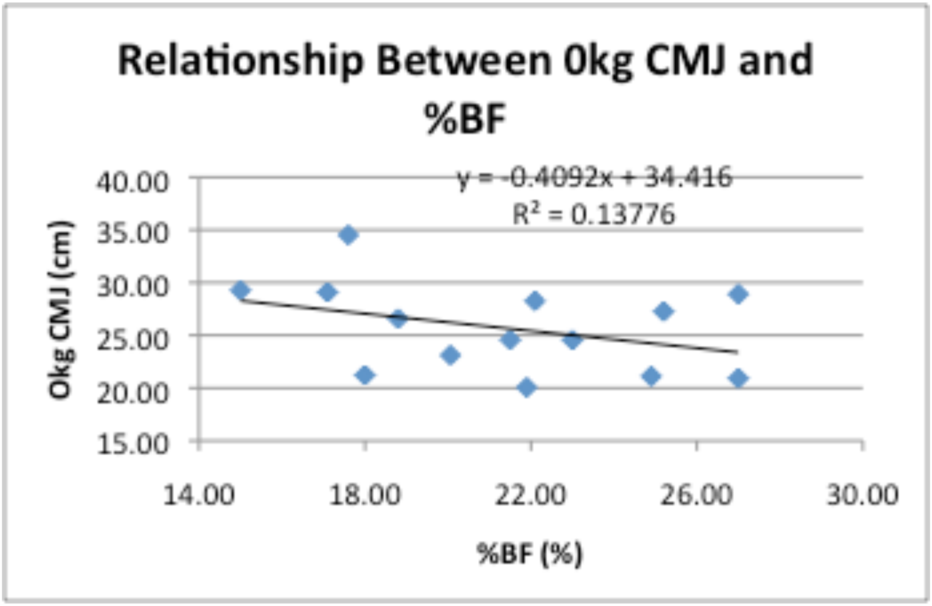
Table 1. Raw Data Set

Code	Age	Height	Mass (kg)	% Fat	CMJ 0kg
WS01	19	168.3	58.0	17.6	34.5
WS02	20.7	170.8	58.9	20.1	23.1
WS03	19.7	163.8	54.8	21.9	20.1
WS04	18.3	159.4	58.1	18.0	21.2
WS05	19.9	168.9	59.9	17.1	29.1
WS06	20.7	162.6	60.7	22.1	28.3
WS07	19	166.4	65.1	24.9	21.1
WS08	18.9	173.2	71.8	25.2	27.3
WS09	20.2	170.2	56.1	15.0	29.3
WS10	18.3	163.8	64.7	27.0	20.9
WS11	19.2	168.9	62.2	27.0	28.9
WS12	20.9	166.4	67.1	18.8	26.6
WS13	20.8	165.7	65.2	23.0	24.6
WS14	19.1	168.9	60.0	21.5	24.6

Table 2. Subject Characteristics; Means and Standard Deviations of Anthropometric Measures, and Unweighted Countermovement Jump Height.

Variables	Mean ± SD
Body Mass (kg)	61.62 ± 4.68
Percent Fat (%)	21.37 ± 3.79
Countermovement Jump 0kg (cm)	25.67 ± 4.18

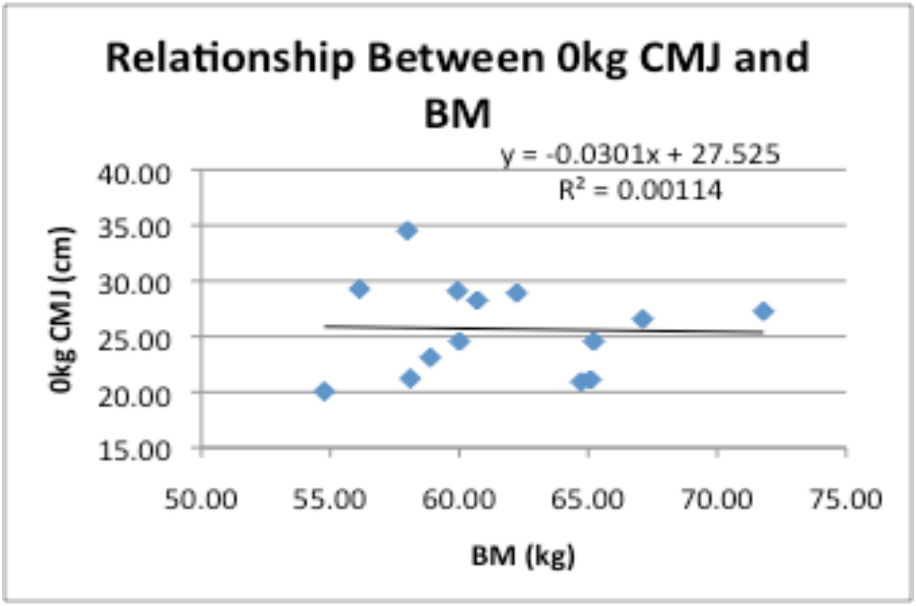
Table 3. Relationship Between 0kg CMJ and %BF.



r = - 0.3711648

* 0kg CMJ unweighted countermovement jump. %BF percent body fat.

Table 4. Relationship Between 0kg CMJ and BM.



r = - 0.0337051

* 0kg CMJ un-weighted countermovement jump. BM body mass.

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