Summer 2011

The Relationship between Lower Body Power and Sprinting Ability in Recreationally Trained College Men

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THE RELATIONSHIP BETWEEN LOWER BODY POWER AND SPRINTING ABILITY IN RECREATIONALLY TRAINED COLLEGE MEN

by

J.KYLE DAVIS

(Under the direction of Stephen Rossi)

ABSTRACT

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College aged males who participate in competitive sports at a recreational level have very unique physical skills and abilities that lead them to compete in untraditional sports such as Ultimate Frisbee. This study examine the relationship between jumping ability and sprinting ability among 22 recreationally trained males who participate on a regionally competitive, club level Ultimate team. The subjects' mean (± SD) age, height, weight, body fat percentage and fat free mass were 21.1±2.26 years, 179.88± 6.53 cm, 73.57± 7.38 kg, 11.26 ± 3.92 percent and 63.62± 12.44 kg respectively. To examine the relationship between jumping and sprinting, researchers measured the members of the Ultimate Frisbee team for 40 yard sprint (with a 10 yard split time recorded), standing broad jump (BJ), and vertical jump (VJ). Researchers used the results to calculate acceleration at 10 yards (10A), velocity at 40 yards (40V), horizontal sprinting power at 10 (10HSP) and 40 yards (40P), vertical jump power (VJP), and power relative to body weight (10bw, 40bw, VJbw), and fat free mass(10ffm, 40ffm, VJffm) for both sprinting power and vertical jump power. Testing took place over three days the week prior to the Regional Tournament and all participants signed a university approved IRB informed consent form before any testing was conducted. Pearson Product Correlations were run to examine the relationships between the variables. Level of significance was set to $p<0.05$. There was a significant negative correlation between BJ and 40 yard sprint time (r=-.436), but there were no significant relationships observed between VJ and 10 and 40 yard sprint or BJ and 10 yard sprint. Significant relationships were observed between VJ and 10P (r=.471), VJP and 10 yard power (r=.823), VJP and 10ffm (r=.499), VJffm and 10ffm (r=.551), BJ and 10P (r=.557), VJ and 40P (r=.493), VJP and 40P (r=.850), and VJffm and 40ffm (r=.598). BJ was related to 40 yard sprint variables in that it correlated with 40V (r=.428), 40P (r=.653), and 40bw (r=.426). The highest correlations were found between measurements of power, so therefore it would be beneficial for recreational athletes to train using methodology that would increase power production in order to better prepare their bodies for vertical jumping, broad jumping and sprinting at distances of 10 and 40 yards. The statistical analysis showed that there is a relationship between jumping ability and sprinting ability in recreationally trained college males, but there is a need for more information pertaining to this relationship among recreational athletes and any physiological information specific to Ultimate Frisbee players.

INDEX WORDS: Ultimate frisbee, Recreationally trained, 40 Yard sprint, 10 Yard sprint, Broad jump, Vertical jump, Power, Relative power

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by

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B.S., Mars Hill College, 2009

A Thesis Submitted to the Graduate Faculty of Georgia Southern University in Partial

Fulfillment

of the Requirements for the Degree

MASTER OF SCIENCE

STATESBORO, GA

2011

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Electronic Version Approved:

July 2011

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

At colleges and universities all across the country, there are students that want to compete in athletics but have not been given the opportunity to compete at an intercollegiate or professional level. Of the students that wish to compete, roughly 75% of them reported that they participate in an intramural sports program (12). Many of these athletes choose to participate in intramural athletic programs or, for a more competitive atmosphere, club level sports. Sports like football that requires a large number of players, funding, and coaching may be adapted into a version of flag football so organization and administration of the sport is more easily facilitated. There is also the opportunity for students to participate in sports that may not be on the list of "traditional" sports and these participants will be forced to take previously attained skills and adapt them to the specific sport. One sport is Ultimate Frisbee, or Ultimate. Intramural and club level Ultimate players are usually individuals that have previously played sports such as soccer, lacrosse, football, and baseball and have now chosen to learn Ultimate's skills and strategies so they can participate at a competitive level. (5)

To be a competitive Ultimate player, one must be able to sprint distances from 5-40 yards, jump for pass completions, be agile enough to escape defenders and have a high level of cardiovascular endurance (5). Other than the sports specific skills involved with Ultimate, these skills are vital at any level of competition. Sprinting occurs during every pass and vertical jumping ability is often tested if the pass is thrown high. The aerobic and anaerobic profile of the sport is very similar to that of soccer due to the need for short bursts of speed and the ability to generate those short bursts over a long period of time with minimal rest (5). Sprinting ability and explosive power production are both vital components in Ultimate (5), and the purpose of this research is to help establish the relationship between these variables among an Ultimate population. There is minimal research examining the relationship between jumping and sprinting in Ultimate players but this relationship has been observed in athletes with similar physiological characteristics (6, 7, 10, 11, 15, 21, 26, 28, 31, 33, 34, 35, 39, 40, 42, 44, 45).

Tests of jumping ability, as well as sprint speed require a great deal of force produced in a very short amount of time, (13, 23). Success in sprinting requires an athlete to accelerate quickly, reach maximum velocity and maintain maximum velocity for the duration of the test in order to improve performance (23). Sprinters that generate greater power have been shown to have increased stride length, because the ability to generate high force in short contact time leads to a more explosive leg lift and the result is a greater stride length (23). Jumping ability is generally a test that tests the muscle’s stretch shortening cycle (SSC) capabilities (15). The SCC utilizes potential energy generated within the muscle and tendon when stretched. Performing a countermovement jump causes the muscle to stretch and increase potential energy so the muscular contraction generates more force. Increased force production leads to better performance in activities such as jumping and sprinting (15).

Among the numerous studies that examine the relationship between jumping and sprinting, the methodology used by the researchers varied. Tests such as the Wingate test (33), unilateral and bilateral depth jumps (15, 31), loaded squat jump (6, 7, 15, 35, 42) and repeated jump tests (28) have been used to assess lower body power and anaerobic capacity while sprinting tests have ranged from an initial acceleration measurement of 5m (13, 39) to measurement of sprinting ability at 300m (40). Vertical jump ability has been used as a standard test of lower body power, as it has been used in multiple research studies (10, 11, 13, 15, 23, 28, 33, 35, 39, 40, 42, 44). Results from these studies have shown that there is a positive relationship between sprinting and vertical jump performance, but the magnitude of this relationship is up for debate.

Wisloff et al. (44) conducted a study to examine this relationship between vertical jump height and sprinting ability among Norwegian National level soccer players and found that vertical jump height significantly correlated with sprinting performance at 10 meters and 30 meters. These results would lead one to assume that the initial portion of the sprint (10m) would require greater force production and therefore be more highly correlated with vertical jumping ability, but Chelly et al (13) found no significant relationship between 5 and 10m sprint performance and vertical jump ability among regional-level junior soccer players. This is one of the few studies that didn't find this relationship to be significant, possibly because of the age and training level of the participants or the sprinting distances and choice of lower body power tests. Several studies have also tested this relationship between vertical jumping ability and sprinting throughout different phases of the sprint trial (11, 21, 42). Smirniotou et al. (42) examined this relationship among a population of competitive sprinters and analyzed the relationship at distances of 10, 30, 60 and 100 meters. Researchers found significant relationships with vertical jump and 10m, 30m, 60m and 100m sprint performance. Through the results of these studies, it is clear that there is a significant correlation between sprinting and vertical jumping ability, but different sprint tests and testing populations throughout the literature have increased confusion relative to the strength of this relationship.

There have been many studies that have examined the relationship between horizontal jumping ability and sprinting (11, 23, 31, 39). Testing standing long jump or standing broad jump, does not seem to be as prevalent in the literature, but this is a test that is used in conditioning programs across the country and is also a featured test each year at the National

Football League's training combine (11). Much like the relationship with vertical jump and sprinting ability, the relationship with standing broad jump and sprinting ability has yielded mixed results. One study that examined this relationship among a group of Division-I college football players found that there was a significant relationship between standing broad jump and sprinting ability. Brechue and colleagues (11) reported a strong correlation between stranding broad jump and sprint acceleration at 10 yards and overall sprint performance in the 40 yard sprint while Seiler and colleagues (39) tested at distances of 5m and 35m and also found a significant relationship. Both studies examined vertical and horizontal jumping abilities, and both studies reported stronger correlations between horizontal jump and sprinting than vertical jump and sprinting. There have also been a couple of studies that have examined this relationship and found that there was not a significant relationship between standing broad jump and sprinting ability (23, 31). McCurdy et al. (23) observed this relationship among college aged female soccer players and used sprinting distances of 10 and 25 meters while Kale (31) and colleagues observed males sprinters at a distance of 100 meters. Although the findings do not show significant relationships, these findings may be due to the population of female soccer players (23) and competitive sprinters (31) that never perform a broad jump movement while they have trained for sprinting through practice and competition. Testing well in the sprinting tests could change the relationship between the variables even though the participants are very powerful and a significant relationship seems to be plausible.

Athletic populations such as American football players have been shown to be anaerobic athletes and do well in tests such as sprinting and jumping (9, 11, 15, 39). Having an increased ability to generate power may help explain why these athletes show a stronger relationship among tests of anaerobic performance than populations that are not specifically trained for short bursts of energy. Although many of the testing populations for this type of research have been elite athletes that participate in one sport, the mixed results may shed light on how this relationship differs among recreationally trained athletes such as club level Ultimate Frisbee players. Testing a population of Ultimate Frisbee players may prove that there is a relationship between jumping and sprinting among a recreationally trained population. Recreationally trained athletes do not generally train specifically for their sport in the same way as an intercollegiate or professional level athlete, and a background in more general athleticism may produce results different than that of elite level athletes. It was the purpose of this study to examine the relationship between vertical jumping ability, horizontal jumping ability (standing broad jump) and sprinting ability at 10 and 40 yards among college aged males who are recreationally trained Ultimate Frisbee players.

Chapter II

METHODS

Subjects

Twenty two club level ultimate players volunteered to participate in this investigation. The subjects' mean (± SD) age, height, weight, body fat percentage and fat free mass were 21.1±2.26 years, 179.88± 6.53 cm, 73.57± 7.38 kg, 10.57± 3.81 percent and 63.62± 12.44 kg respectively. Of the participants, 83.4% participated in intramural sports, 58.33% participated in resistance training, and 50% participated in aerobic training. Those who use resistance training participate in training 2.54±0.85 days per week for and average of 1.64±0.81 hours per session. Of the percentage that participates in resistance training, 85.71% use free weights. Of those who participate in aerobic training, they participate 2.77±1.17 days per week for an average of 1.88±0.82 days per week. Testing took place during the week prior to the sectional tournament and all participants were active members of the team set to compete in the tournament. Prior to the testing days, the lead researcher explained the tests that would be completed, the methodology used to conduct each test, the purpose for testing and how these results would be used in order to help explain the relationship between sprinting and jumping. After explanation of the research, all players signed a University approved informed consent form and completed a short survey (See Appendix C) that outlined each player's training habits. Players were tested prior to the start of practice on two nonconsecutive days with 48 hours rest between testing sessions (Tuesday/Thursday). After explanation of testing procedures, all participants expressed that they were familiar with the tests and had previously performed all tests either with the Ultimate team or a team in the past. Researchers concluded from this information that there was no need for a familiarization session. The study was reviewed and approved by the Institutional Review Board at Georgia Southern University prior to the first day of testing.

Testing Design

Participants began testing on day one by measuring their height (cm), weight (kg) and standing reach height (in). After all participants were measured, the participants were randomly placed into two groups. The first group completed a warm-up regimen that consisted of a 5-7 minute light jog, followed by a 5-7 minute dynamic warm-up. The warm-up was the standard warm-up that is completed every day before practice and games. Team captains conducted the warm-up like a regular practice/game session. After the first group warmed up, the lead researcher briefly explained testing procedure and then they were tested for vertical jump. While the first group was being tested for vertical jump, the second group began their warm-up. As the first group finished vertical jump testing, the second group finished their warm-up and group one moved to broad jump testing while group two began vertical jump testing. After group two finished vertical jump testing, they moved on to broad jump testing. Testing for day one was concluded when both groups had finished broad jump testing. To ensure proper rest and recovery, participants had at least 45 seconds between trials and rest was limited to no more than 5 minutes(11). After a 48 hour rest, participants reported back to be tested again for weight (kg) and body fat percentage using a three site skin-fold. Participants completed both of these tests prior to beginning the same warm-up as conducted on day one. After the warm-up, researchers explained the testing procedure and all participants ran a half speed 10 yard practice trial to ensure that they understood how the timing system worked. Testing on day two was concluded after participants had all ran three successful sprinting trials.

Testing Procedures

Height and weight testing. To measure the participants for height, researchers mounted a 120" cloth tape measure to a flat vertical surface and used a level to ensure that the measuring tape mounted at 90º. After tape was mounted, participants were asked to remove their shoes and any other obstructive attire such as hats or hair/head bands and stand with their back to the wall directly in front of the measuring tape. Participants were asked to put their heels, calves, buttocks, back and the back of their head against to wall and were also instructed to stand up straight and look straight ahead. With the participants feet planted flat on the ground, the researcher placed a 9" Magnetic Torpedo Level (Stanley Hardware, New Britain, CT) level on the crown of the participant's head. Researcher documented the participant's height to the nearest half centimeter.

To measure the participant's weight in kilograms, researchers placed a Continental No. 408 DKF Scale (Continental Scale Corporation, Chicago, Illinois) on a flat, smooth concrete surface. Prior to measurement, the scale was zero checked to ensure accuracy. Before stepping on the scale, participants were asked to remove their shoes and any excess clothing in order to get a more accurate weight. Participants were measured in athletic shorts and t-shirts on both testing days. Once participants stepped on the scale, they were asked to remain still until the scale obtained a measurement. Upon completion of the measurement, researchers told the participant their weight and recorded it to the nearest tenth of a kilogram.

Jackson-Pollock Three site skin-fold test. Using a calibrated Beta Technology Lange Skin Caliper (Santa Cruz, CA), a researcher experienced in skin-fold measurement procedure measured skin-fold thicknesses at the chest, abdominal, and thigh in rotation. Chest measurement was taken at the midpoint between the fold of the axillary (armpit) and the nipple, abdominal measurement was taken one inch lateral from and 0.5 inches below the umbilicus and the hip was measured at the point of the anterior thigh halfway between the inguinal crease and the top of the patella along the midline. After two measurements were taken, if there was a difference greater than 2mm at any site, a third measurement was taken. Researchers used an average measurement at each site for statistical analysis. The sum of the three skin-folds were used to measure body density using Jackon and Pollock's (22) body density equation. Body density measurements were then put into the Siri (1) equation to determine body fat percentage in Caucasian participants and a modified body fat calculation formula was used for African American participants (30). No other races were represented in the testing population. Each participants body fat percentage was then used to calculate the total fat mass of the participant in kilograms. Fat mass was subtracted from total body weight to measure fat free mass. Total mass and fat free mass were both used to express testing results in relative terms.

Vertical Jump Height. Prior to testing the participant's vertical jumping ability, all participants completed an adequate dynamic warm-up routine as administered by the team captains as part of their normal practice/game warm-up. To measure vertical jump height, researchers began by measuring each participant's standing reach height. Ferreira et al. (13) examined different methods of measuring the standing reach height, and compared to vertical jump height evaluated using force plates, timing mats, and video analysis and determined that standing reach height is most accurately measured for vertical jump height testing using the dominant hand to reach maximal height while the corresponding foot is plantar flexed. Reach height was measured using a Vertec (Sports Imports; Columbus, Ohio, USA). To measure maximal jumping height, participants performed a countermovement jump. The jump was initiated from a standing, stationary position with participant's dominant hand nearest to the Vertec. Jumps were initiated with a downward countermovement followed by an upward arm swing. Participants then reached with their dominant hand and displaced the highest vane possible on the Vertec. Each participant was allowed three maximal effort jumps with at least 45 seconds rest between jumps to ensure a full recovery. Participants completed one jump at a time and then moved to the back of the testing line. Testing procedure ensured that none of the participants waited more than 5 minutes between testing trials. Vertical jump height was assessed as the difference between maximal jumping reach height and maximal standing reach height. The best of the three jumps was used for data analysis. To measure the power output of each individual's best vertical jump, researchers used Sayers' equation (38). To obtain relative measurements for data analysis, researchers calculated Watts per kilogram of body weight (vertical jump power (W) / body weight (kg)), and Watts per kilogram of fat free mass (vertical jump power (W) / fat free mass (kg)).

Standing Broad Jump. Standing broad jump was observed as the maximum horizontal distance covered in one countermovement jump. Prior to testing, all participants completed an adequate dynamic warm-up routine as administered by the team captains as part of their normal practice/game warm-up and completed vertical jump testing. Researchers began by securing a measuring tape to a non-slip surface. Participants began each jump with a downward countermovement and an explosive arm swing. Upon landing, the athletes were instructed to keep their feet still until the researchers could mark the point of landing. This was to ensure that the measurement was accurate with the actual landing spot and any movement after the landing did not skew the results in any way. Any jump where the participant fell backwards or couldn't keep their feet planted until researchers could attain a measurement was not documented and the participant had to complete another jump after at least a 45 second recovery period. Participants performed three successful jumps. Testing procedure ensured that none of the participants waited more than 5 minutes between testing trials. Each participant's best jump was recorded and used for data analysis.

Sprint Testing. Sprinting ability was tested by measuring speed over distances of 10 yards (9.1m) and 40 yards (36.6m). Performance in the 10 yard sprint was used to test the acceleration phase of the sprint while performance in the 40 yard sprint tested sprinting velocity (4). All participants completed an adequate dynamic warm-up routine as administered by the team captains as part of their normal practice/game warm-up. To assess sprinting ability, researchers used a Test-Center (TC) electronic wireless timing system (Brower Timing Systems, Draper, Utah, USA). Researchers placed TC-Start Pod at the sprint starting line. Participants were required to begin each trial in either a two or three point stance. If participants chose to start in a three point stance, they were required to start with the down hand placed directly on the TC-Start Pod's timing mat. Timing began when the hand was removed from the timing mat. If the participant chose to begin in a two point stance, they were instructed to start with both feet behind the start line with the TC-Start Pod's timing mat in their hand. Upon initiation of the sprint, participants were asked to compress the fibers inside the timing mat and release mat upon first movement. If a participant initiated the sprint and then released the timing mat too late, researchers stopped the trial and the participant had to restart the trial. Successful starting technique was observed by two researchers and restarts were assigned according to their judgment. TC PhotoGates were placed 10 and 40 yards from the starting line to collect data from start to 10 yards as well as time from start to 40 yards. TC PhotoGates (A & B) were placed ten meters apart, five meters from the center of the sprinting surface, to ensure each timing gate was out of the sprinting path of the participants and to ensure that the participants were not "reaching" for the finish line and breaking the timing plane prematurely. TC PhotoGates were set to approximately waist height. . Participants completed a half speed 10 yard start trial to ensure they understood the correct way to start and how the times would be recorded. Participants then completed three 40 yard (36.6m) sprints at maximal effort with times recorded at 10 yards (9.1m) and 40 yards (36.6m). To ensure proper recovery time, participants completed one trial at a time and then went to the back of the line. This time spent waiting allowed the participants to recover for at least 5 minutes between trials. Verbal encouragement was given to all participants. The researchers used the fastest 40 yard sprint trial for data analysis of both tests. For statistical analysis, researchers calculated average velocity at 10 and 40 yards (velocity= distance / time) expressed as meters per second, acceleration at 10 yards (acceleration = 10 yard average velocity / time) expressed as meters/second^2, and power at 10 and 40 yards (horizontal sprinting power = velocity (m/s) / body weight (kg)) expressed in kilograms per meters per second (48). Power was then converted to watts by multiplying kg/m/s by 9.80665 (1 Watt = 9.80665 kg/m/s). To obtain relative values for horizontal sprinting power, researches determined watts (W) per kilogram of body weight (Power (W) / body weight (kg)), and watts per kilogram of fat free mass (Power (W) / fat free mass (kg)).

Statistical Analysis

All data was checked for normality and presented as mean ± SD. Researchers used Pearson's product moment correlation (r) to determine the relationship between the measures of jumping and sprinting ability. Level of significance of for all data analysis was set to $p<0.05$.

Chapter III

RESULTS

Testing results for the Ultimate participants (n=22) was used to examine the relationship between jumping and sprinting among a club level population. Vertical jump and broad jump variables are reported in mean ± SD and shown in table 1. Sprinting variables at 10 yards can be found in table 2 while table 3 shows descriptive results for 40 yard sprinting variables.

Table 1. Descriptive statistics for jumping tests with corresponding calculations for power and relative power. Each variable expressed as mean and standard deviation.

Test	Mean	Standard Deviation
Vertical Jump Height	51.72 cm	5.61 cm
Vertical Jump Power	4417.09 W	576.66 W
Vertical Jump Power/kg Body Weight	59.98 W/kg	4.25 W/kg
Vertical Jump Power/kg Fat Free Mass	67.06 W/kg	5.92 W/kg
Broad Jump	240.44 cm	17.78 cm

Table 2. Descriptive statistics for 10 yard sprinting tests with corresponding calculations for acceleration, power and relative power. Each variable expressed as mean and standard deviation.

Test	Mean	Standard Deviation
10 Yard Time	1.72 sec.	0.08 sec.
10 Yard Acceleration	5.29 m/s^2	0.24 m/s^2
10 Yard Power	3824.08 W	472.27 W
10 Yard Power/kg Body Weight	51.90 W/kg	2.33 W/kg
10 Yard Power/kg Fat Free Mass	58.03 W/kg	3.84 W/kg

Table 3. Descriptive statistics for 40 yard sprint tests with corresponding calculations for velocity, power and relative power. Each variable expressed as mean and standard deviation.

Test	Mean	Standard Deviation
40 Yard Time	5.04 sec.	0.16 sec.
40 Yard Velocity	7.27 m/s	0.24 m/s
40 Yard Power	5248.03 W	592.98 W
40 Yard Power/kg Body Weight	71.28 W/kg	2.37 W/kg
40 Yard Power/ kg Fat Free Mass	79.67 W/kg	4.36 W/kg

Correlation analysis revealed significant relationships between vertical jump and 10 yard sprint performance (Table 4). Specifically, Pearson's product-moment correlations showed a significant relationship between vertical jump and 10 yard power and vertical jump power and 10 yard power relative to fat free mass. The strongest relationships were found between 10 yard power and vertical jump power and vertical jump power relative to fat free mass and 10 yard power relative to fat free mass. All correlations between 10 yard sprint performance and vertical jump variables were positive.

Table 4. Coefficients of correlation between 10 yard sprinting variables and all testing variables and corresponding calculations.

Test	10Yard	10ACC	10P	10P/BW	10P/FFM
VJ	-.301	.295	.471*	.292	.361
VJP	-.387	.383	.823**	.382	.499*
VJP/BW	-.221	.217	.202	.2151	.224
VJP/FFM	-.256	.247	.344	.244	.551**
BJ	-.196	.195	.557**	.196	.058
40Yard	.766**	-.755**	-.497*	-.757**	-.524*
40V	-.761	.750**	.484*	.753**	.511*
40P	-.538**	.535*	.972**	.536*	.587**
40P/BW	-.765**	.755**	.485*	.757**	.515*
40P/FFM	-.580**	.565**	.579**	.565**	.897**
10Yard	1	-.999**	-.656**	-.999**	-.774**
10ACC		1	.656**	1**	.767**
10 Yard Power			1	.657**	.673**
10P/BW				1	.766**
10P/FFM					1

VJ= Vertical Jump Height, VJP= Vertical Jump Power, VJP/BW= Vertical jump power per kilogram of bodyweight, VJP/FFM= Vertical jump power per kilogram of fat free mass, BJ= Broad Jump, 10Yard= 10 yard sprint time, 10ACC= Average acceleration for 10 yard sprint, 10P= Horizontal sprinting power in 10 yard sprint, 10P/BW= Horizontal Sprinting power in 10 yard sprint per kilogram of body weight, 10P/FFM= Horizontal sprinting power in 10 yard sprint per kilogram of fat free mass, 40Yard= 40 yard sprint time, 40V= Average velocity for 40 yard sprint, 40P= Horizontal sprinting power in 40 yard sprint, 40P/BW= Horizontal Sprinting power in 40 yard sprint per kilogram of body weight, 40P/FFM= Horizontal sprinting power in 40 yard sprint per kilogram of fat free mass.
*- Denotes significance at the 0.05 level
**- Denotes significance at the 0.01 level

There were also significant positive relationships between vertical jumping variables and 40 yard sprinting variables (Table 5). Correlations showed significant relationships between vertical jump height and 40 yard power, vertical jump power and 40 yard power and vertical jump power in relation to fat free mass as well as 40 yard power in relation to fat free mass. Results also showed a significant relationship between 40 yard sprinting parameters and broad jump performance. There was a significant negative correlation between broad jump length and 40 yard sprint time in addition to significant positive correlations between broad jump performance and 40 yard average velocity and 40 yard power in relation to body weight. The strongest positive relationship was found between broad jump length and 40 yard power.

Table 5. Coefficients of correlation between 40 yard sprinting variables and all testing variables and corresponding calculations.

Test	40Yard	40V	40P	40P/BW	40P/FFM
VJ	-.316	.309	.493*	.311	.386
VJP	-.352	.339	.850**	.340	.503
VJP/BW	-.265	.264	.216	.266	.252
VJP/FFM	-.225	.215	.351	.218	.598**
BJ	-.436*	.428*	.653**	.426*	.176
40Yard	1	-.999**	-.530*	-.999**	-.623**
40V		1	.517*	1.00**	.612**
40P			1	.517*	.594**
40P/BW				1	.613**
40P/FFM					1

VJ= Vertical Jump Height, VJP= Vertical Jump Power, VJP/BW= Vertical jump power per kilogram of bodyweight, VJP/FFM= Vertical jump power per kilogram of fat free mass, BJ= Broad Jump, 10Yard= 10 yard sprint time, 10ACC= Average acceleration for 10 yard sprint, 10P= Horizontal sprinting power in 10 yard sprint, 10P/BW= Horizontal Sprinting power in 10 yard sprint per kilogram of body weight, 10P/FFM= Horizontal sprinting power in 10 yard sprint per kilogram of fat free mass, 40Yard= 40 yard sprint time, 40V= Average velocity for 40 yard sprint, 40P= Horizontal sprinting power in 40 yard sprint, 40P/BW= Horizontal Sprinting power in 40 yard sprint per kilogram of body weight, 40P/FFM= Horizontal sprinting power in 40 yard sprint per kilogram of fat free mass.
*- Denotes significance at the 0.05 level
**- Denotes significance at the 0.01 level

Correlations between 40 yard sprinting variables and 10 yard sprinting variables showed a significant negative relationship between 40 yard sprint time and 10 yard sprint time, 10 yard acceleration, 10 yard power, 10 yard power in relation to body weight, and 10 yard power in relation to fat free mass. There was a significant negative relationship between 40 yard average velocity and 10 yard time while the relationship between 40 yard velocity and 10 yard acceleration, 10 yard power, 10 yard power in relation to body weight, and 10 yard power in relation to fat free mass was positive. A significant negative relationship was found between 40 yard power and 10 yard time, 40 yard time and 40 yard velocity while the relationships between 10 yard acceleration, 10 yard power, 10 yard power in relation to body weight, and 10 yard power in relation to fat free mass, were positive. Results showed that 40 yard power in relation to body weight was significantly related to 10 yard time, 10 yard acceleration, 10 yard power, 10 yard power in relation to body weight, and 10 yard power in relation to fat free mass, 40 yard time, 40 yard velocity and 40 yard absolute power. The relationships between 40 yard power in relation to body weight and 10 yard time, 40 yard time, 40 yard velocity and 40 yard absolute power were negative while all other relationships were positive. There were also significant negative relationships found between 40 yard power in relation to fat free mass and10 yard time, 40 yard time, 40 yard velocity, 40 yard power and 40 yard power in relation to body weight while significant positive correlations were reported between 40 yard power in relation to fat free mass and 10 yard acceleration, 10 yard power, 10 yard power in relation to body weight, and 10 yard power in relation to fat free mass.

The analysis showed that there is also a significant relationship between broad jump and vertical jump height and vertical jump power (Table 6). Vertical jump height was shown to be significantly related to vertical jump power, vertical jump power in relation to body weight as well as in relation to fat free mass. Vertical jump power was found to be significantly related to power in relation to body weight and fat free mass. There was also a significant relationship between vertical jump power in relation to body weight and power in relation to fat free mass. All significant relationships observed between jumping variables were positive. There were no significant relationships between broad jump and any relative measures of vertical jumping power.

Table 6. Coefficients of correlation between vertical jumping height, power, and relative power and broad jump performance.

Test	VJ	VJP	VJP/BW	VJP/FFM	BJ
VJ	1	.857**	.948**	.894**	.435*
VJP		1	.654**	.718**	.609**
VJP/BW			1	.609**	.291
VJP/FFM				1	.180
BJ					1

VJ= Vertical Jump Height, VJP= Vertical Jump Power, VJP/BW= Vertical jump power per kilogram of bodyweight, VJP/FFM= Vertical jump power per kilogram of fat free mass, BJ= Broad Jump
*- Denotes significance at the 0.05 level
**- Denotes significance at the 0.01 level

CHAPTER IV

DISCUSSION

The primary purpose of this investigation was to examine the relationship between jumping ability and sprinting ability in college aged men that participate in club level athletics. The findings from this study showed that there were no significant relationships among vertical jump height and 10 yard sprint time or 40 yard sprint time but there was a significant relationship found between broad jump distance and 40 yard sprint time. Researchers also calculated vertical jump absolute power and power relative to bodyweight and fat free mass and found that absolute vertical jump power is significantly related to absolute sprinting power at 40 yards (r=0.850) and 10 yards (r=0.823). These findings would seem to show that vertical power production is significantly related to horizontal power production among a club level, college aged male population. Evaluation of the relationship between broad jump distance and sprinting variables showed that there were significant relationships, but those relationships were moderate. Moderately significant relationships were found between broad jump distance and 10 yard power as well as 40 yd velocity, absolute power, and power in relation to bodyweight. Although these relationships were moderately significant, it would appear that there is a significant relationship between one's performance in the broad jump and performance in the 40 yard sprint because these two variables were the only two absolute variables that significantly correlated.

Vertical Jump

The data collected from the vertical jump test during the present study shows that the Ultimate participant's results (51.72 ± 5.61) are higher than results from past studies that have included recreational level athletes. Several studies (2, 10, 25, 37) have used the vertical jump to test jumping ability and anaerobic power production in recreationally trained participants. Past results have ranged from 42.16 ± 4.32 among college aged males who participate in multiple recreational level sports (37) to 51.84 ± 6.68 among college aged physical education students (2). The results from the current study compare favorably among previous tests for recreational athletes, but results seem to vary among more highly trained athletes. Studies that have examined international level soccer players have reported vertical jump values that are 10-15cm less than the values observed in the present study (3, 36) while multiple studies (11, 16, 19) have presented vertical jump data that is 15-20cm higher than the data presented in this study. It is clear that soccer players are physiologically different than football players, but recreational level Ultimate players from the current study vertical jump test werehigher than international level soccer players but lower than Division-I collegiate football players.

Researchers also calculated vertical power generated during the jump. Vertical jump power has been determined in other studies (9, 14, 33, 39, 40) and the results are much like values for vertical jump height. Studies that observed power in recreational athletes (33, 40) are much lower than the results from more highly trained athletes (9, 39) and the results from the present study showed that the Ultimate participants in the study performed at a level that was higher than the recreational athletes but was clearly lower than studies that tested more highly trained athletes. Past studies involving recreational athletes (33, 40) consisted of a group of volunteer physical education students who may have limited experience in vertical jumping while the group of Ultimate participants have been previously tested, and performed explosive jumping movement during each practice and/or game. Although the Ultimate participants are more highly trained to jump then most physical education students, their training background is not as in depth as more highly trained athletes who on average train more than 4 times per week

(11). Researchers also observed power in relation to bodyweight (kg) and in relation to fat free mass (kg) and although power per kilogram of bodyweight is a common variable, there is limited information on relative vertical jump power production among recreational athletes. The results from this study showed that the participants had a higher than average power production during vertical jump, but with a body mass and fat free mass comparable to recreational athletes, the relative power of the present study is greater than reported in other studies (33, 40.

Broad Jump

Results from broad jump data showed that the participants from the current study jump longer than recreational participants from past studies (2). Almuzaini and Fleck (2) tested thirty eight recreationally trained collegephysical education students and found that their average jumping distance was 213.7 ± 19.19cm while the results from the current study showed a distance of 240.44 ± 17.78cm. Brechue et al. (11) tested an entire team of NCAA Division-I football players and observed broad jumping distances of 252.2 +/- 22.9 while another study (23) examined a group of the best Turkish sprinters, according to Cup1 and 2 results, and found distances greater than 270cm.

Much like the data for vertical jump height, the participants from the current study performed better than recreational athletes but more highly trained athletes jumped further. The physiological profile of Ultimate players has not been studied in-depth like American football players and sprinters who train to produce a great deal of force in a very short amount of time (9, 11, 15, 16, 19, 23). Being able to broad jump requires the participant to generate a lot of power very quickly and this ability can be improved through jump training, resistance training, or other types of explosive training (10). The current study showed that Ultimate players performed well in explosive type tests when compared to other recreational athletes (2), but their power production was less than more highly trained athletes (11, 23). There could be many reasons for this difference, but it is clear that the participants in the current study train less than and train differently than more highly trained athletes (11) and that may be a reason for the difference. More research on Ultimate training is needed to fully understand how these athletes would benefit from a training routine that is comparable to that of more highly trained athletes.

Sprint Tests

Sprinting tests were conducted to collect data for time and acceleration at 10 yards and time and velocity at 40 yards. Testing at these distances is fairly common in athletes (11, 17), but are not normal in a recreational population. There are many distances ranging from first step speed (13,14) to 10 meters (15) when measuring acceleration and velocity ismeasured at distances from 20-400 meters. The researchers for the present study chose to measure 10 and 40 yard sprint times because it's a very common measure that can be easily compared to all types of athletes (11). Deane and colleagues (17) reported values ranging from 1.83-2.07 seconds in the 10 yard dash while participants from the current study recorded a mean time of 1.72±0.08 seconds. This is comparable to the 1.73 second average time posted by a group of Division-I football players (11). Times for the 40 yard dash are also competitive with recreational athletes, but more highly trained athletes have much faster than the participants in the current study. Recreational mean times from past studies have ranged from 5.21-5.67 seconds (17, 32) while more highly trained athletes have posted mean scores as low as 4.72 seconds (16). With a mean time of 5.04±0.16 seconds, the current participants posted faster times than most recreational athletes but slower than more highly trained athletes. These differences could be due to the nature of Ultimate when compared to other competitive team sports.

Ultimate requires short bursts of energy for periods of a few seconds to several minutes (5). The results from the present study show that Ultimate players perform better in 10 yard tests than in 40 yard sprinting tests as compared to previous studies (11, 16, 17, 32). Athletes that are more highly trained, like American football players have a lot of experience with the 40 yard dash, and their playing time is dependent on their 40yd sprint time (11). Because of this, they train to perform well in the test. Although the participants inthe current study had all previously been tested for 40 yard sprint ability, success in their sport performance is based on shorter sprints which require less technique and this may be why 10 yard times t were similar to Division-I football players and why 40 yard times were much slower.

It has been observed in the past that there is a clear relationship between 10 yard sprint times and 40 yard sprint times (11), and although the participants posted better times in the 10 yard sprint, the current studied confirmed those findings. There was a significant positive correlation between 10 yard sprint and 40 yard sprint times, a significant negative correlation between 40 yard time and 10 yard acceleration, and a significant positive correlation between 10 yard acceleration and 40 yard velocity (Table 4). Brechue and colleagues (11) examined the relationship between 10 yard acceleration and 40 yard velocity and also found a significant relationship, but the finding from that study showed the relationship to be stronger. As previously stated, this is most likely due to those participants performing well in both the 10 yard sprint and the 40 yard sprint while current participants performed better in the 10 yard sprint possibly because they are not trained to run a 40 and have limited experience performing this test.

Relationship between Vertical Jumping and Sprinting

Results from the present study showed that there was no relationship between vertical jump height and 10 yard sprint or 40 yard sprint. These findings are similar to that of Chelly et al. (13) in that they found no significant relationship between the initial portion of the sprint and vertical jump height among a group of junior national soccer players. Chelly et al. (13) also examined the relationship between velocity and vertical jump, vertical jump power and sprinting ability, and vertical jump power relative to bodyweight and sprinting ability. Much like the present study, they found no significant relationship among those variables. The present study did find a significant relationship between vertical jump height and horizontal power produced during a 10 yard sprint. The relationship between vertical jump power and horizontal sprinting power at 10 yards was found to be the strongest. These findings showed that power production during a 10 yard sprint relates significantly to the vertical jump power. The ability to produce force is a key component of power production in vertical and horizontal power tests. The high forces produced during sprinting (13, 23) and vertical jumping may help explain the relationship between horizontal sprinting power and vertical jumping power.

The relationships found between vertical jump and 40 yard sprint were similar to those relationships found in the 10 yard sprint results. There was once again no relationship between vertical jump height and 40 yard sprint time, but relationships were found when results were put in the terms of horizontal and vertical power production. Significant relationships among the participants were found between vertical jump height and 40 yard horizontal power production and vertical jump power production and 40 yard horizontal power production. The lack of a relationship between 40 yard sprint and vertical jump height is unlike many past studies. Previous research examining trained sprinters (42), Division-I football players (11), and rugby players (21) reported that vertical jump height was highly correlated to sprinting distances of 35-

40 meters. Brechue et al. (11) examined this relationship among Division-I football players and reported a significant relationship between 40 yard velocity and vertical jump height. As previously discussed, there was a clear difference in acceleration characteristics (10 yards) and velocity characteristics (40 yards) among the tested population. Their performance in the 40 yard sprint was not comparable to studies involving more highly trained participants, but their performance in the 10 yard sprint was similar to that of more highly trained athletes. It has been shown that velocity and acceleration are significantly related to muscular strength (10), and the differences between recreational athletes and upper level athletes may be related to the differences in resistance training programs. Training programs are different in every team sport, but it has been reported that more highly trained athletes train at least 4 times per week for as long as 2.5 hours (13). Only 60.8% of the participants in the present study reported that they trained using resistance training, both machines and free weights, with an average of 2-3 training sessions per week. A lower training load and lack of proper instruction and training volume and intensity may help explain why more highly trained athletes perform better on tests of velocity and acceleration.

Relationship between Broad Jumping and Sprinting

There were several significant relationships found between broad jump distance and 10 yard and 40 yard sprinting variables. Among the 10 yard variables, broad jump distance significantly correlated with 10 yard horizontal power production but not 10 yard time, velocity, or relative power measurements. These findings were different than Brechue et al. (11) who found a significant relationship between broad jump distance and 10 yard velocity. This difference may be explained in that participants from the current study posted 10 yard times comparable to Brechue's study (11) but that study found a mean broad jump distance of

252.2±22.9cm while the present study found a mean distance of 240.44±17.78cm. The difference between broad jump distances may help explain the lack of a significant relationship among the variables.

Broad jump distance was significantly correlated with 40 yard time, velocity, power, and power relative to body weight. Much like the relationship between vertical jump and 40 yard sprint, the highest correlations were found between broad jump and 40 yard power production. Past studies have also found significant relationships between broad jump and 40 yard sprint variables. Brechue et al. (11) found broad jump to be significantly related to 40 yard time and 40 yard velocity. McCurdy and colleagues (31) also reporteda significant relationship between 40 yard velocity and broad jump. Kale and colleagues (23) examined the relationship in trained sprinters between broad jump and 100m sprinting time and velocity. The authors reported no significant relationship between sprint time and time or velocity. Sprinting 100m and sprinting 40 yards require very different strategy and technique. A successful 100m sprinter must be able to produce a great deal of force in order to get a good start, must have a high maximum velocity, and be able to sustain that maximum velocity for a long period of time (23). With 40 yard sprinting tests, one must be able to generate enough force to start quickly and reach maximum velocity early in the sprint in order to post a good time (15). Broad jump is a measure of force and power production and a better performance in that seems to be more highly related to distances of 5-40 yards (11). Ultimate participants are never required to sprint more than 40 yards, and often only sprint at maximum effort for 10-20 yards and therefore their physiological adaptations have made them more apt to shorter sprints with greater force and power production (5).

Conclusion

Any athlete, whether they are a professional athlete or only participate in recreational sports, want to be better at what they do. Ultimate is a sport that requires a great deal of skill in order to play, but once the skills are attained it is important to train one's body to perform at the highest level. From the results of past studies and the results of the current study, it is clear that there is some relationship between jumping and sprinting among many different types of athletes. Club level athletes, like the group tested in this study, often do not have access to team training facilities, quality strength and conditioning coaches, or exercise/sports scientists that can help them reach their personal and team goals. . These findings showed that power production is important in both jumping and sprinting and it would be beneficial for club athletes to train using methods such as plyometics and incorporate the Olympic lifts into their conditioning programs to increase power. Although the findings within this study may help to understand performance variables in recreational and club level athletes (especially Ultimate players), there is a need for more information pertaining to the performance qualities of athletes that do not compete at the highest level. There are a lot more athletes across the world that compete at a recreational level than at a professional level and information that would help explain their abilities could help a great number of people. Ultimate is a sport that is quickly growing in popularity and increasing the scientific information dealing specifically with the performance variables of the sport may help it expand past a recreational and club level.

Practical Applications

Ultimate is a game that requires a unique set of skills along with a unique set of physiological adaptations. Speed, jumping ability and power production were tested in the current study and findings show that Ultimate players are fast and powerful athletes as compared to recreational athletes and more highly trained athletes. One may conclude from the current results that the Ultimate team that was tested is more physically capable than an average group of recreationally trained athletes and therefore Ultimate may not need to be considered recreational. With a proper training regime have the potential to test at a very high level. It is also clear from the present results that testing an Ultimate player in the 40 yard sprint and possibly the broad and vertical jumps may not be the best indicator of performance. To further complete a physiological profile of these athletes, one should look at cardiovascular endurance, repeated sprinting ability, and agility. It would seem that Ultimate players would have a high Vo2 max, but further testing needs to be completed to understand the cardiovascular needs of Ultimate players. Results also show that the 40 yard sprint test may not translate as well as a 10 yard sprint in game play, and the ability to sprint at top speed repeatedly may be a better indicator of sprinting ability relative to Ultimate. Finally, agility is a key to any sport and a test for agility would also help understand how these players move and how important being agile is to actual game play. There is a large need for physiological information on Ultimate and hopefully the current study and further tests of endurance, repeated sprinting ability and agility will help players and coaches better understand the needs associated with Ultimate. Physiological knowledge of Ultimate can only enhance the sport and hopefully help push it in a more mainstream light with some of the more traditional sports.

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APPENDIX A

EXTENDED INTRODUCTION, RESEARCH QUESTIONS, ASSUMPTIONS, LIMITATIONS, DELIMITATIONS, AND CLINICAL SIGNIFICANCE OF THE STUDY

Extended Introduction

At colleges and universities all across the country, there are students that want to compete in athletics but have not been given the opportunity to compete at an intercollegiate or professional level. Of the students that wish to compete, roughly 75% of them reported that they participate in an intramural sports program (12). Many of these athletes choose to participate in intramural athletic programs or, for a more competitive atmosphere, club level sports. Sports like football that require a great deal of players, funding, and coaching may be adapted into a version of flag football so organization and administration of the sport is more easily facilitated. There is also the opportunity for athletes to participate in sports that may not be on the list of "traditional" sports and these athletes will be forced to take previously attained skills and adapt them to the specific sport. One sport of such nature is Ultimate Frisbee, or Ultimate. Intramural and club level Ultimate players are usually individuals that have previously played sports such as soccer, lacrosse, football, and baseball and have now chosen to learn Ultimate's skills and strategies so they can participate at a competitive level. (5)

To be a competitive Ultimate player, one must be able to sprint distances from 5-40 yards, jump for pass completions, be agile enough to escape defenders and have a high level of cardiovascular endurance (5). Other than the sports specific skills involved with Ultimate, these skills are vital at any level of competition. Sprinting occurs during every pass and vertical jumping ability is often tested if the pass is thrown high. The aerobic and anaerobic profile of the sport is very similar to that of soccer due to the need for short bursts of speed and the ability to generate those short bursts over a long period of time with minimal rest. Sprinting ability and explosive power production are both vital components in Ultimate, and the purpose of this research is to help establish the relationship between these variables among an Ultimate population. There is minimal research examining the relationship between jumping and sprinting in Ultimate players but this relationship has been observed in athletes with similar physiological characteristics (6, 7, 10, 11, 15, 21, 26, 28, 31, 33, 34, 35, 39, 40, 42, 44, 45).

Tests of jumping ability, as well as sprint speed require a great deal of force produced in a very short amount of time, (13, 23). Success in sprinting requires an athlete to accelerate quickly, reach maximum velocity and maintain maximum velocity for the duration of the test in order to improve performance (23). Sprinters that generate greater power have been shown to have increased stride length, because the ability to generate high force in short contact time leads to a more explosive leg lift and the result is a greater stride length (23). Jumping ability is generally a test that tests the muscle's stretch shortening cycle (SSC) capabilities (15). The SCC utilizes potential energy generated within the muscle and tendon when stretched. Performing a countermovement jump causes the muscle to stretch and increase potential energy. Upon muscular contraction, the stored energy is then released and the corresponding contraction generates more force. Increased force production leads to better performance in activities such as jumping and sprinting (15).

Many studies have examined the relationship between jumping performance and sprinting performance among different populations (6, 7, 10, 11, 15, 21, 26, 28, 31, 33, 34, 35, 39, 40, 42, 44, 45). Although the general purpose of those studies was to relate running ability and lower body power production, the methodology used by the researchers varied. Tests such as the Wingate test (33), unilateral and bilateral depth jumps (15, 31), loaded squat jump (6, 7, 15, 35, 42) and repeated jump tests (28) have been used to assess lower body power and anaerobic capacity while sprinting tests have ranged from an initial acceleration measurement of 5m (13, 39) to measurement of sprinting ability at 300m (40). Vertical jump ability has been used as a standard test of lower body power, as it has been used in multiple research studies (10, 11, 13, 15, 23, 28, 33, 35, 39, 40, 42, 44). Results from these studies have shown that there is a positive relationship between sprinting and vertical jump performance, but the magnitude of this relationship is up for debate.

Wisloff et al. (44) conducted a study to examine this relationship between vertical jump height and sprinting ability and found that vertical jump height significantly correlated with sprinting performance at 10 meters and 30 meters. These results would lead one to assume that the initial portion of the sprint (10m) would require greater force production and therefore be more highly correlated with vertical jumping ability, but Chelly et al (13) found no significant relationship between 5 and 10m sprint performance and vertical jump ability. This is one of the few studies that didn't find this relationship to be significant, possibly because of the testing population or methodology. Several studies have also tested this relationship between vertical jumping ability and sprinting throughout different phases of the sprint trial (11, 21, 42). Smirniotou et al. (42) examined this relationship among a population of competitive sprinters and analyzed the relationship at distances of 10, 30, 60 and 100 meters. Researchers found significant relationships with vertical jump and10m, 30m, 60m and 100m sprint performance. Through the results of these studies, it is clear that there is a significant correlation between sprinting and vertical jumping ability, but different sprint tests and testing populations throughout the literature have increased confusion relative to the strength of this relationship.

There have been many studies that have examined the relationship between horizontal jumping ability and sprinting (11, 23, 31, 39). Testing standing long jump or standing broad jump, does not seem to be as prevalent in the literature, but this is a test that is used in conditioning programs across the country and is also a featured test each year at the National Football League's training combine (11). Much like the relationship with vertical jump and sprinting ability, the relationship with standing broad jump and sprinting ability has yielded mixed results. Two studies that examined this relationship among college football players found that there was a significant relationship between standing broad jump and sprinting ability. Brechue and colleagues (11) reported a strong correlation between stranding broad jump and sprint acceleration at 10 yards and overall sprint performance in the 40 yard sprint while Seiler and colleagues (39) tested at distances of 5m and 35m and also found a significant relationship. Both studies examined vertical and horizontal jumping abilities, and both studies reported stronger correlations between horizontal jump and sprinting than vertical jump and sprinting. There have also been a couple of studies that have examined this relationship and found that there was not a significant relationship between standing broad jump and sprinting ability. McCurdy et al. (23) observed this relationship among college aged female soccer players and used sprinting distances of 10 and 25 meters while Kale (31) and colleagues observed males sprinters at a distance of 100 meters. Although the findings do not show significant relationships, this could be due to the population tested or even the different sprint distances used.

Athletic populations such as American football players have been shown to be anaerobic athletes and do well in tests such as sprinting and jumping (9, 11, 15, 39). Having an increased ability to generate power may help explain why these athletes show a stronger relationship among tests of anaerobic performance than populations that are not specifically trained for short bursts of energy. Although many of the testing populations for this type of research have been elite athletes that participate in one sport, the mixed results may shed light on how this relationship differs among recreationally trained athletes such as club level Ultimate Frisbee players. Testing a population of Ultimate Frisbee players may prove that there is a relationship between jumping and sprinting among a recreationally trained population. Recreationally trained athletes do not generally train specifically for their sport in the same way as an intercollegiate or professional level athlete, and a background in more general athleticism may produce results different than that of elite level athletes. It was the purpose of this study to examine the relationship between vertical jumping ability, horizontal jumping ability (standing broad jump) and sprinting ability at 10 and 40 yards among college aged males who are recreationally trained Ultimate Frisbee players.

Research Questions

1) Is there a significant relationship between jumping and sprinting in college aged recreational athletes?

- Is there a significant relationship between 10 yard sprinting ability and vertical jumping ability among college aged recreational athletes?
- Is there a significant relationship between 10 yard sprinting ability and horizontal jumping ability among college aged recreational athletes?
- Is there a significant relationship between 40 yard sprinting ability and vertical jumping ability among college aged recreational athletes?
- Is there a significant relationship between 40 yard sprinting ability and horizontal jumping ability among college aged recreational athletes?

Assumptions

1) All participants will give full effort during each test

2) Participants have not been training specifically for sprinting and/or jumping tests

3) Participants will answer all questions on the questionnaire honestly

Limitations

1) Researchers are only observing this relationship among Ultimate Frisbee players who participate on the club team at Georgia Southern University.

2) Players will run sprinting tests on a grass surface that may change throughout the testing session.

3) There is no reward or benefit for completing testing, and that may cause a lack of motivation in the participants.

Delimitations

1) Researchers are only observing this relationship among college aged males who do not participate in NCAA, semi-professional or professional competition.

2) Researchers are observing sprinting ability at distances of 10 yards and 40 yards.

3) Vertical jumping ability will be measured with a Vertec jumping device that measures the distance between standing reach and peak vertical jump reach.

4) Standing broad jump will be used to measure horizontal jumping ability.

Clinical Significance of the Study

Ultimate Frisbee is a sport that has been growing in popularity since its advent in the 1960's. It has grown from a small game that college students play for recreational purposes to an international game that is represented by clubs and Ultimate organizations in many countries.

Although Ultimate is one of the most popular sports in the world, there is limited research that deals with the physiological and biomechanical profile of competitive Ultimate players. These athletes must be explosive, agile, fast, strong, fit and must do all of this while performing the intricate throws and catches that make up competitive Ultimate strategy. Jumping and sprinting are key components to a game and it is the purpose of this study is to help understand how these two components relate to each other among club level Ultimate Frisbee players. It is also the purpose to help understand this relationship among recreational athletes. The Ultimate participants that partook in the study compete and train at a recreational level and it is the hopes of the researchers that the results will not only help understand Ultimate athletes, but recreational athletes as well. Recreational athletes often do not have the funds available to have full time coaches, strength and conditioning coaches or facilities to correctly train for maximum performance and this study hopes to help understand how these limitations create differences between recreational athletes and more elite level athletes.

APPENDIX B

EXTENDED REVIEW OF LITERATURE

Collegiate athletes often receive a scholarship to participate in a single sport and because of this their strength and conditioning programs are focused around the specific goals associated with that single sport. Achieving theses goals optimize one's performance in a particular sport, but how do athletes train when they are not on an intercollegiate team and not forced to focus their training to perfect one skill set? These athletes that compete recreationally may participate in as many as ten sports throughout the year and they still are required to be trained correctly in order to do well. Recreationally trained athletes often focus their training on more generalized goals such as running faster, jumping higher and becoming more agile. The purpose of this literature review is to review the information that has been focused on the relationship between generalized performance variables such as sprinting and jumping ability. More specifically, it is the goal of this literature review to establish the relationship between sprinting ability and jumping ability, both horizontal and vertical, among recreationally trained college men.

Sprint Testing

Sprinting ability is a performance variable that has been tested numerous times in order to establish a relationship with lower body muscular power. Although the act of sprint testing may be constant, the methodology of the sprint testing has varied greatly throughout the literature. A sprint test consists of both an initial acceleration phase and a maximum velocity phase (2, 9), so researchers have often chosen to perform sprint tests at two distinct distances in order to get data for both acceleration and velocity. Baker and colleagues looked at the strength/power/speed relationship on two separate occasions with elite rugby players and to examine the sprinting aspect of the study they tested participants at distances of 10m and 40m (2, 3). Many other researchers have also used two separate distances to test sprinting ability. Common sprinting distances include; 10m and 25m (32), 15m and 35m (14) and 10m and 30m(17, 18) when researchers wish to run two separate tests to look at acceleration and max velocity.

Other researchers have used the multiple stage testing approach so that multiple data points can be collected with only one sprinting trial (5, 7, 10, 11, 13, 21, 26, 31, 35, 37, 40). Data collection of this type requires photocell equipment that has the capabilities of measuring multiple distances from a starting line while still obtaining data for the overall time required running the trial. Researchers who collect data with multiple data points also wish to document different aspects of the trial, such as collecting data 5 yards from the starting line to measure first step quickness, 10 yards from the starting line to document acceleration, and finally obtaining data at 40 yards to look at maximum velocity (31). Measurements range from the first step quickness measurement, to the measurement of a 40 yard sprint with data points every 10 yards (7), and some researchers even measure sprinting ability up to 100m when looking at elite sprinters (5, 21, 40).

In other cases, sprinting measurement has been very simplistic and simply looked at a single distance to determine sprinting ability (4, 6, 12, 20, 25, 36, 41, 44). These tests ranged from 15m (36) to 40 yards (4, 12). Methodology behind testing only one sprint test distance allows for a more simplistic and applicable approach that can be used with ease through multiple data collection sessions and is also a test that can be utilized by more researchers and coaches due to the simplicity of the data collection.

Sprinting Acceleration/Velocity Relationship

When examining sprinting ability, it is important to understand the relationship between the initial acceleration phase of the sprint and the maximum velocity phase that is reached. To explain this relationship, several researchers have compared the acceleration and max velocity phases of sprinting tests among different populations and have found that there seems to be a moderately strong relationship between the two variables (7, 11, 18, 33). Brechue and colleagues (7) looked at sprinting ability among college football players at distances of 9.1m, 18.3m, 27.4m, and 36.6 and completed a Pearson product-moment correlation to find if performance between each of these distances were related. The results showed that there were very strong relationship (r=-0.87 to -0.99) between 9.1m performance and performance at all other distances. Although the data showed that there were at least low-moderate relationships among all variables, the 36.6m sprint performance proved to be most highly related (r=-0.875) with the initial acceleration phase of the test.

Other research projects have also shown there to be a relationship between the acceleration phase and max velocity phase of sprinting. Cronin et al (11) found strong relationships between 10m and 30m sprint (r=0.78), 5m and 10m sprint (r=0.92), and finally between 5m and 30m sprint (r=0.73). Harris et al also showed a strong relationship (r=0.87) between time from 0-10 m was highly related to time from 30-40m. Finally, Nesser and colleagues (33) showed that there was a strong relationship (r=0.885) between 10m and 40m sprint performance among men. All of these studies show that there is a significant relationship between the initial phase of a sprint and the final result. This would imply that it would be beneficial to train for both acceleration and velocity when training for maximal speed, due to their close relationship shown throughout the literature.

Electronic Timing Gates

With all the advances in technology over the last several years, it is more common practice to use data collection techniques that are very sophisticated and expensive. Many devices used to collect data require a great deal of “know how” and technological aptitude, but among all of the advances in data collection, the usage of electronic timing gates to record sprinting times is now very widely accepted as the “gold standard”. It has always been the goal of exercise science researchers to collect data that is reliable and consistent, but with so much pressure being placed upon coaches and athletes to perform well in sprinting tests (30), it is in the best interest of everyone that data collection be conducted without the factor of human error. Studies have reported several different levels of human error when sprint timing is completed by hand (19, 30), some being as much as 0.2 seconds different than times collected with electronic timing devices.

It is very clear in the research that electronic timing is the chosen method of accurate sprint timing due to the fact that every article reviewed used some type of electronic timing system to collect data. A couple of articles(19, 30) outlined the reliability and accuracy of both single-split and multi-split electronic timers and both articles found that electronic timing is a very reliable way to gather sprinting data (ICC>0.90). When comparing the results of sprint testing with data collected manually and electronically, a study (30) conducted on American college football players showed that electronic timers were significantly slower than those times recorded by hand held timers. Results showed the mean difference to be around 0.2 seconds between hand held and electronic timing. Results from these studies show that both hand held and electronic timing devices (single and multiple split) are highly reliable and accurate ways to measure sprinting performance, but limiting the human error associated with hand held timers can prove to be more reliable and yield data that can be better analyzed and interpreted.

Vertical Jump Testing

The vertical jump test is a test that has been used many, many times to measure jumping ability and lower body power in almost every population dealing with performance variables. Even though the vertical jump test is a very simple measure of power and jumping ability, the methods for testing can be very diverse. The first method of measuring vertical jump, and also known as the "gold standard" (27), is video analysis. This method uses motion capturing software and allows researchers to observe the difference in center of mass height while standing and center of mass height while at the peak of the jump. This equipment can be expensive and therefore there is limited research that utilizes this method. Another type of vertical jump testing is the method of measuring the time that the participant is in the air (5, 10, 11, 21, 25, 26, 40, 43). By measuring flight time, researchers can utilize the Bosco (21) formulas to find the vertical displacement of the participant and use that data to calculate an applicable vertical jump height. Another way of measuring vertical jump is to assess the ground reaction forces created during a vertical jump (9, 35, 36). The participant performs a vertical jump while standing on a force platform and the force that is created is then used to calculate the height of the vertical jump. McCurdy et al (32) used an accelerometer to measure vertical jump height in women soccer players. Using an accelerometer allows researchers to observe the displacement of a certain segment of the body; in this case it was the hip, and using that information to calculate vertical jumping height.

The last and most classic form of vertical jump testing is known as the Sargent Jump Test (29, 38). Testing vertical jump in this fashion requires researchers to first measure the standing reach height of the participant. Ferriera et al (15) conducted a research study with the purpose of determining the most accurate way of measuring standing reach, and the researchers concluded that reaching with the dominant hand while plantar flexing the foot on the same side leads to the most accurate measurement of vertical jump as compared to video analysis. Once standing reach height is obtained, the participant jumps as high as possible and reaches at the peak of the jump. The difference in peak reach height and standing reach height is documented as the standing broad jump (29). Researchers have used this method of measurement as a more practical way to measure vertical jump when more sophisticated equipment may not be available (7, 33, 37, 38). To standardize this process, these researchers used a Vertec jumping device to measure both reach heights.

Relationship between Vertical Jumping and Sprinting

Testing participants for vertical leaping ability has been done for many reasons throughout the literature. For this particular review of literature, the purpose is to find the relationship between sprinting ability and lower body power, and there have been several studies (5, 7, 9, 11, 21, 26, 33, 36, 37, 38, 40, 43) that have used the vertical jump as a primary way to examine this relationship. To examine this relationship, researchers have recorded data for both sprinting ability and vertical jump height and correlated the data to see if these two tests were significantly related to each other. Although a countermovement jump is used to observe vertical jump height, the information attained from this test can yield many different types of data. Chelly et al (9) used a countermovement jump performed on a force plate to obtain measurements of countermovement jump height, power in watts, relative power in watts and peak force produced by the jump. This information was then analyzed with data collected from sprint testing to establish the relationship between the velocity of the first step and velocity at 5m during a 10m sprint test among soccer players. Results showed that there were no significant relationships ($p<0.05$) between any of the countermovement jump variables and sprinting variables. On the other hand, Wisloff et al (43) looked at a similar relationship among soccer players and found that vertical jump height performance correlated with both 10m sprint time(r=0.72, p<0.001) and 30m sprint time (r=0.60, p<0.01).

Other studies have also found evidence to support the idea that sprinting ability and vertical jumping ability are related. One study published in 2005 looked at this relationship among professional rugby players (11). Researchers for this study used basic countermovement jump height to assess vertical jumping ability and used Pearson correlation coefficients to determine that there was a low-moderate relationship between sprinting ability and vertical jumping ability. Results showed that the countermovement jump was significantly related (p<0.05) to performance in the 5m sprint (r=-0.60), 10m sprint (r=-0.62) and 30m sprint (r=-0.56). These results may not show the greatest amount of significance possible, they seem to be concurrent with other studies that are similar in nature. Requena et al (36) completed similar research that examined the relationship between power and speed among soccer players. This research also used a countermovement jump to measure vertical jump height, but the distance of the sprint test was only 15m. The results for this study also showed that there is a moderate relationship among the variables (r=-0.64).

With the implications from these studies being based around the physiology of anaerobic capacity and power production, it would only seem correct for athletes that are trained for anaerobic performance to show a greater relationship between power and speed, but this relationship seems to have no boundaries among populations. For example, two studies that examined the relationship between sprinting and vertical jump used competitive sprinters as their populations (21, 40). Specifically, theses sprinting populations specialized in the shorter distance races (100m) and this would seem to indicate that their training is based upon maximum force and power production in order to generate maximum velocity in a short distance. The results from the first study (21) showed that there were low-moderate relationships between vertical jump and 100m sprint time (r=-0.46) and maximum velocity achieved during the 100m sprint (r=0.55). The second study (40)looking at sprinters looked more in depth at the different phases of the 100m sprint and how each related to vertical jump performance. When looking at sprint time at different distances throughout the 100m sprint, vertical jump was significantly ($p<0.05$) correlated with time at 10m (r=-0.614), 30m (r=-0.683), 60m (r=-0.599) and 100m (r=-0.565). The same researchers also looked at the maximum velocity achieved during different phases of the sprint and how it related to vertical jump performance. The results showed that vertical jump was significantly correlated ($p<0.05$) with maximum velocity achieved from 0-10m (r=0.608), 10-30m (r=0.530), 30-60m (0.511), and 60-100m (0.467). Results from this study seem to indicate that vertical jump performance is more highly related to the first parts of the sprinting phase in 100m sprinters. This could possibly be due to the increased need for power production in order to reach maximum velocity while maintaining maximum velocity requires less force and power production.

Another population of generally anaerobic athletes that are trained to perform well on tests such as the vertical jump and sprint testing is American football players. One research study by Brechue et al (7) looked at numerous tests of anaerobic power and how each related to sprinting ability at different distances. Researchers tested 61 football players in the 40 yard sprint and examined both the acceleration and velocity achieved at every 10 yard interval. Using this data of acceleration and velocity, they compared each data point to vertical jumping ability and found differing results throughout. Data collected at 10 yards showed that the vertical jump was significantly ($p<0.05$) related to both acceleration (r=0.79) and velocity (r=0.82), but other data points showed less significant relationships. Although vertical jump was significantly related to overall 40 yard time (r=-0.78), only velocity was significantly related to any other data collection points and these relationships where of much less significance (r= 0.37-0.44). Another study looking at football players looked at the relationship between vertical jump and sprinting ability at 5m and 35m distances (37). Researchers found there to be significant ($p<0.05$) relationships among the variables, but the results showed there to be less significance among the relationship at 5m (r=0.54) than at 35m (r=0.74). Much like the 40 yard(36.6m) sprint in Brechue's (7) study, there was a high correlation between vertical jump and the total outcome of the sprint test, but there seemed to be less significance at the shorter distances. This would lead one to believe that acceleration among American football players seems to be more accurately measured at approximately 9m and that there is a more significant relationship between vertical jump and acceleration at this distance as opposed to shorter distances. It may also be applicable to observe the relationship between vertical jumping and sprint performance at approximately 40 yards as one of great significance. This would lead one to believe that an American football player that performs well on a vertical jump test will also perform well on a sprint test of 40 yards.

On the other side of the energy spectrum, Sinnett and colleagues (38) conducted testing on a group of trained distance runners (10km) to also try to understand the relationship between power and running ability. Unlike the other tests which utilized sprinting distances of 5-100m, methodology used for this study tested participants at distances of 50m and 300m. Even though the participants were trained differently than most populations tested for this relationship, the results also showed a relationship between vertical jumping and sprinting ability. Results for all participants (both men and women) showed moderate relationships between vertical jump performance and 50m sprint (r=-0.596) and 300m sprint (r=-0.511). The researchers also used the data collected to observe this relationship among male participants only, and they found that the relationships were still significant ($p<0.05$), but much less significant than data for the entire group. The results for male participants only showed low correlations between vertical jump and 50m sprint ($r=-0.444$) and 300m sprint ($r=-0.388$). The overall results from this study show that regardless of the type of athlete being tested for this relationship, vertical jump performance is generally related to one's performance in sprinting tests.

Testing for the power and speed relationship has seemingly been reserved for athletic populations such as elite level soccer and rugby players, American football players, and competitive 100m sprinters, but it is also important to understand this relationship as it relates to a more general population. Populations such as college physical education students are very readily available for testing at many major universities, but it seems that there is limited information on this population regarding the speed/power relationship. Two studies (5, 26) did set out to better understand this relationship among recreational college aged participants. The first study by Kukulj and colleagues (26) in 1999 measured students for a variety of performance tests that would help outline the relationship between strength, power and sprinting performance. To measure sprinting performance, they tested 24 college aged physical education students in a 30m sprint test with photocells placed at 0.5m, 15m, and 30m. Data was collected in the form of time from 0.5-15m and 15-30m and this data was correlated with vertical jump performance. Results showed that there was no significant ($p<0.05$) relationship between vertical jump and time from 0.5-15m, but there was a moderate ($r=0.48$) relationship found from 15-30m. Berthoin and colleagues (5) also used college physical education students to test this relationship, but they chose to test participants in the 100m sprint with data being collected at 20, 50, and 100m from the starting line. Results for this study showed that that there were significant ($p<0.05$)

relationships between vertical jump and maximum acceleration (r=0.48), acceleration after 2 seconds (r=0.73), maximum velocity (r=0.56), time at 20m (r=-0.58), time at 50m (r=-0.66) and time at 100m (r=-0.65). The results from these two studies show that the relationship between vertical jump and sprinting ability is present in college physical education students at different sprinting distances.

Overall, it is clear that there is a significant relationship between vertical jump and sprinting ability within multiple populations. Different sprint distances and different types of data collection can lead one to achieve many different conclusions, but the final result shows that there is a relationship between how well someone can jump and how well that same person will perform on a sprinting test.

Horizontal Jump Measurement

Most jumping variables measured in the research are vertical in nature. Countermovement vertical jump tests are great for measuring vertical power displacement, but to measure horizontal movement, it may be valuable to look at the standing broad jump or standing long jump. Several research studies have used the standing broad jump to analyze horizontal jumping ability (7, 21, 32, 37). Brechue et al (7) used the standing broad jump along with vertical jump and standing triple jump in order to measure lower body power and jumping ability among American college football players. The information gained from the standing broad jump was used to observe the relationship between sprinting variables and different sprinting variables among the participants. Kale and colleagues (21) also measured horizontal jumping ability, but along with standing broad jump and triple jump, they also looked at the standing quintuple jump and standing 10-stride jump. These horizontal jumping measurements were used to help understand the relationship between sprinting performance and jumping ability among elite sprinters. McCurdy et el (21) and Seiler et el (37) are both studies that used the standing broad jump as well. Both looked at the standing broad jump as a way to measure lower body power and/or anaerobic capacity (37). The standing broad jump is a test that is not often used to measure lower body power, possibly because of the easy availability of vertical jump test, but it is a test that should be utilized more. The NFL training combine utilizes the standing broad jump as a measure of lower body explosive power (7) and seems to be reserved for the testing of athletic populations that require a great deal of lower body explosive power.

Relationship between Horizontal Jumping and Sprinting

Horizontal jumping performance testing has shown up in limited research related to the relationship between jumping ability and sprinting ability. The majority of studies deal with vertical jumping displacement when researching this relationship, but there are a few studies (7, 21, 32, 37) that have used horizontal jumping to examine the relationship between jumping and sprinting. In one study conducted in 1990, Seiler and colleagues (37) examined 41 American college football players and their ability of several anaerobic performance variables. Researchers used the standing broad jump as a way to measure lower body power and related the performance in that test to the performance in a 5m sprint test and a 35m sprint test. Data showed that the standing broad jump was significantly ($p<0.05$) related to both the 5m sprint ($r=0.64$) and 35m sprint (0.89). This research showed that there was a stronger relationship among standing broad jump and the sprint tests than with the vertical jump test results and sprint testing.

Another study that used the standing broad jump as a test for lower body power is the 2010 study of Brechue and colleagues (7). Researchers in this study used multiple jump tests to examine the relationship, and found that the standing broad jump was significantly related to sprint performance. The results showed that standing long jump was significantly ($p<0.05$) related to velocity at 9.1m ($r=0.80$), acceleration at 9.1m ($r=0.81$), and was highly correlated with the overall performance of the participants in the 40 yard (36.6m) sprint ($r=-0.80$). Much like the Seiler's (37) study, the results showed that there was a more significant relationship found between standing broad jump and sprint tests than between vertical jump performance and sprint tests. The results from these studies would lead one to believe that someone who is more competent at the standing broad jump is going to perform better in a sprint test.

On the other hand, there have been a couple of studies that have examined this same relationship and found opposing results. A 2010 study by McCurdy and colleagues (32) tested a group of female college soccer players for performance in standing broad jump and sprint tests. Researchers looked at multiple parts of sprint performance, including sprint time, stride length and stride frequency, and found that there were no significant relationships ($p<0.05$) between sprint time and performance in the standing broad jump. Times were obtained in the 10m sprint and 25m sprint, and neither test showed a significant relationship with any of the horizontal jumping variables. Much like this research, Kale et el (21) conducted research that observed the relationship between the 100m sprint and standing broad jump and also found no significant relationships. Researchers looked at sprint time at 100m as well as maximum velocity that was attained during the 100m sprint and found that neither of these variables was significantly related to performance in the standing broad jump.

Although several studies have attempted to outline the relationship between horizontal jumping ability and sprinting ability it is clear that results are mixed and further research may be needed. The methodology of the standing broad jump is virtually the same over all research studies, but the type of sprinting may prove to be the reason for differing results. Both studies that showed a strong correlation between the two variables utilized sprint distances of around 40 yards as well as shorter, more explosive, distance of 5-10m. These are distances that are often used for testing among populations such as football and rugby (2, 3, 7) and the relation of these tests to standing broad jump may actually be due to the trained population that is completing the testing. Testing of this relationship among less trained, recreational athletes may prove to yield even more differing results.

Relationship between Horizontal and Vertical Jumping Ability

Vertical jumping and horizontal jumping tests have both been used throughout the research to better understand lower body explosive power. It seems that both of these tests can be related to sprint performance (7, 37), and in similar research, neither test is significantly ($p<0.05$) related to sprinting performance (9, 21, 32). The majority of the research compares one or both of these tests to a sprinting variable, but there is less information on the relationship between vertical and horizontal jumping performance. One study (37) in the review did use data for both the vertical jump and the standing broad jump to obtain a relationship between the two tests. After data was collected for both tests, the correlation matrix outlined that there was a fairly significant ($p<0.05$) relationship between vertical jump and broad jump ($r=0.82$). This relationship shows that vertical jumping ability is highly related to horizontal jumping ability. These two tests are very closely related and it may seem simple to say that someone who can jump vertically should be able to jump horizontally, but with limited data on in this area, further research my need to include this correlation in the findings in order to help relate these two tests.

Further Research

It has been established in this literature review that there have been multiple studies that have looked at the relationship between measures of power and speed among multiple populations. Many different methodologies have been used to measure sprinting ability, vertical jump height and standing broad jump, and therefore the results have been fairly mixed when trying to understand the magnitude of the relationship between these performance variables. Different populations have been used to test these methods, and once again, the diversity of the populations tested has led researchers to mixed results. Throughout this review, further research needs have been addressed in areas such as different populations, observing the relationship between horizontal and vertical jumping ability, looking at different sprinting distances when determining the relationship between speed and power, and using the broad jump along with the vertical jump to assess this relationship. There is a great need for information pertaining to this relationship among a population that is recreationally trained to participate in multiple sports throughout the year and not trained with only one set of performance variables in mind. Further research should work to attain information that can further the literature on the relationship between vertical jumping, horizontal jumping tests, and sprinting ability so that coaches, athletes, scientists and trainers can develop and implement programs that will lead to athletes that are faster and more explosive.

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APPENDIX C

INSTRUMENTATION

Sporting and Exercise Questionnaire

Please answer each of the following questions regarding your personal sports and exercise participation. These questions will be used only for descriptive purposes and your answers are confidential. Please answer honestly.

Do you participate in intramural sports at Georgia Southern University? (Circle One)
Yes No
If Yes, what sport would you consider to be your primary sport that you participate in on a regular basis?

____
Do you participate in club sports at Georgia Southern University? (Circle One)
Yes No
If yes, what sport would you consider to be your primary sport that you participate in on a regular basis?

____
How many hour per week do you participate in your sport? Either in practice or in game play.
____ Days Per Week
During each session in sports participation, how long do you participate on average?
____ Hours Per Workout
Other than participation in your sport, do you exercise on a regular basis? (Circle One)
Yes No
If yes, do you participate in resistance/strength training? (Circle One)
Yes No
If yes, what type of resistance do you use primarily? (Circle One)
Free weights Machines
How many days per week do you participate in resistance/strength training?
____ Days Per Week
How many hours per resistance/strength workout?
____ Hours Per Workout
Do you participate in aerobic training? (Circle One)
Yes No
If yes, what do you do as your primary source of aerobic activity?

____
How many days per week do you participate in aerobic activity?
____ Days Per Week
How many hours per aerobic workout?
____ Hours Per Workout
How many total hours per week do you participate in exercise outside of sporting games or practice?
____ Total Hours Per Week
Is the focus of your exercise (other than sporting activities) primarily to improve sport performance or for other personal benefit? (Circle One)
Sports Performance Personal Benefit

APPENDIX D

INSTITUTIONAL REVIEW BOARD FORMS

Georgia Southern University
Office of Research Services & Sponsored Programs

Institutional Review Board (IRB)

Phone: 912-478-0843

Fax: 912-478-0719

IRB@GeorgiaSouthern.edu

Veazey Hall 2021
P.O. Box 8005
Statesboro, GA 30460

To:	Jonathan Kyle Davis Stephen Rossi Department of Health and Kinesiology
CC:	Charles E. Patterson Vice President for Research and Dean of the Graduate College
From:	Office of Research Services and Sponsored Programs Administrative Support Office for Research Oversight Committees (IACUC/IBC/IRB)
Initial Approval Date:	March 22, 2011
Expiration Date:	June 30, 2011
Subject:	Status of Application for Approval to Utilize Human Subjects in Research

After a review of your proposed research project numbered **H11182** and titled **"The Relationship between Lower Body Power and Sprinting Ability in Recreationally Trained College Men,"** it appears that (1) the research subjects are at minimal risk, (2) appropriate safeguards are planned, and (3) the research activities involve only procedures which are allowable. You are authorized to enroll up to a maximum of **80** subjects

Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that the Institutional Review Board has approved your proposed research.

If at the end of this approval period there have been no changes to the research protocol; you may request an extension of the approval period. Total project approval on this application may not exceed 36 months. If additional time is required, a new application may be submitted for continuing work. In the interim, please provide the IRB with any information concerning any significant adverse event, **whether or not it is believed to be related to the study**, within five working days of the event. In addition, if a change or modification of the approved methodology becomes necessary, you must notify the IRB Coordinator **prior** to initiating any such changes or modifications. At that time, an amended application for IRB approval may be submitted. Upon completion of your data collection, you are required to complete a *Research Study Termination* form to notify the IRB Coordinator, so your file may be closed.

Sincerely,

Eleanor Haynes (esc)

Eleanor Haynes
Compliance Officer

INFORMED CONSENT

The Relationship between Lower Body Power and Sprinting Ability in Recreationally Trained College Men.

1. **Principal Investigators**: Kyle Davis, B.S., Graduate Assistant, 706-889-2676, jd02931@georgiasouthern.edu, Stephen Rossi, Ph.D, Assistant Professor, 478-0775, srossi@georgiasouthern.edu, Jim McMillan, Ed.D., Associate Professor, 478-1926, jmcmillan@georgiasouthern.edu, Jody Langdon, Ph.D., Assistant Professor, 478-5378, jlangdon@georgiasouthern.edu, Department of Health and Kinesiology, P.O. Box 8076, Statesboro, GA 30460.

2. **Purpose of the Study:** The purpose of this study is to analyze the relationship between lower body power and sprinting ability in recreationally trained college men.

3. **Procedures to be followed:** You will complete a battery of tests that will measure lower body power and sprinting ability. Tests will include: vertical jump height to measure lower body power, standing broad jump to measure lower body power, and a 40 yard sprint with a 10 yard split to measure sprinting velocity and sprinting acceleration respectively. You will also be measured for height, weight, and body fat percentage using a Jackson-Pollock 3-site skin-fold test. You will also be asked to fill out a physical activity survey to help investigators understand the amount of physical activity that you participate in regularly.

4. **Discomforts and Risks**: There is a small risk that a muscle strain and/or ankle sprain could occur during the performance tests. This risk will be minimized by proper warm-up and use of appropriate testing procedures.

5. **Benefits:** The present study hopes to further the literature related to the relationship between measures of lower body power and sprinting ability in recreationally trained athletes.

6. **Duration/Time:** Testing will be scheduled by the principle investigator during a time that will allow for the greatest number of volunteers will be able to participate. Warm-up, testing and cool-down will take approximately an hour. To ensure that the testing process goes smoothly, participants will go through testing in groups of no more than 20, with each group taking approximately an hour to complete the battery of tests. The number of groups will depend upon the number of participants that volunteer for the study.

7. **Statement of Confidentiality:** All scientific and personal data collected on subjects for presentation purposes will be kept confidential and stored in a locked file drawer in Hollis 2121A. This information will be available only to the principal investigators. Your identity will not be revealed in publications or presentations that result from this study so as to protect your privacy and confidentiality. All data will be reported as means and standard errors.

8. **Right to Ask Questions:** You have the right to ask questions and have those questions answered. If you have questions about this study, please contact Kyle Davis, B.S., Graduate Assistant, 706-889-2676, jd02931@georgiasouthern.edu, Dr. Jim McMillan, Ed.D, Associate Professor, 478-1926, jmcmillan@georgiasouthern.edu, Stephen Rossi, Ph.D, Assistant Professor, 478-0775, srossi@georgiasouthern.edu or Jody Langdon, Ph.D., Assistant Professor, 478-5378, jlangdon@georgiasouthern.edu. For questions concerning your rights as a research participant,

contact Georgia Southern University Office of Research Services and Sponsored Programs at 912-478-7758.

9. **Compensation:** There is no compensation for participating in the present research project.

10. **Voluntary Participation:** Your participation in this study is entirely voluntary. If you decide to participate, you are free to withdraw your consent and to stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.

11. **Penalty:** If you decide not to participate, you will not be penalized, and you will not lose any benefits or services to which you are otherwise entitled.

12. You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date below.

You will be given a copy of this consent form to keep for your records.

Title of Project: The Relationship between Lower Body Power and Sprinting Ability in Recreationally Trained College Men.

Principal Investigators: Kyle Davis, B.S., Graduate Assistant, 706-889-2676, jd02931@georgiasouthern.edu, Stephen Rossi, Ph.D, Assistant Professor, 478-0775, srossi@georgiasouthern.edu, Jim McMillan, Ed.D., Associate Professor, 478-1926, jmcmillan@georgiasouthern.edu, Jody Langdon, Ph.D., Assistant Professor, 478-5378, jlangdon@georgiasouthern.edu, Department of Health and Kinesiology, P.O. Box 8076, Statesboro, GA 30460.

____________________________________ ____________________
Participant Signature Date

I, the undersigned, verify that the above informed consent procedure has been followed.

____________________________________ ____________________
Investigator Signature Date

CERTIFICATION OF INVESTIGATOR RESPONSIBILITIES

By signing below I agree/certify that:

1. I have reviewed this protocol submission in its entirety and I state that I am fully cognizant of, and in agreement with, all submitted statements and that all statements are truthful.

2. This application, if funded by an extramural source, accurately reflects all procedures involving human participants described in the proposal to the funding agency previously noted.

3. I will conduct this research study in strict accordance with all submitted statements except where a change may be necessary to eliminate an apparent immediate hazard to a given research subject.
a. I will notify the IRB promptly of any change in the research procedures necessitated in the interest of the
safety of a given research subject.
b. I will request and obtain IRB approval of any proposed modification to the research protocol or informed
consent document(s) prior to implementing such modifications.

4. I will ensure that all co-investigators, and other personnel assisting in the conduct of this research study have been provided a copy of the entire current version of the research protocol and are fully informed of the current (a) study procedures (including procedure modifications); (b) informed consent requirements and process; (c) anonymity and/or confidentiality assurances promised when securing informed consent (d) potential risks associated with the study participation and the steps to be taken to prevent or minimize these potential risks; (e) adverse event reporting requirements; (f) data and record-keeping requirements; and (g) the current IRB approval status of the research study.

5. I will not enroll any individual into this research study: (a) until such time that the conduct of the study has been approved in writing by the IRB; (b) during any period wherein IRB renewal approval of this research study has lapsed; (c) during any period wherein IRB approval of the research study or research study enrollment has been suspended, or wherein the sponsor has suspended research study enrollment; or (d) following termination of IRB approval of the research study or following sponsor/principal investigator termination of research study enrollment.

6. I will respond promptly to all requests for information or materials solicited by the IRB or IRB Office.

7. I will submit the research study in a timely manner for IRB renewal approval.

8. I will not enroll any individual into this research study until such time that I obtain his/her written informed consent, or, if applicable, the written informed consent of his/her authorized representative (i.e., unless the IRB has granted a waiver of the requirement to obtain written informed consent).

9. I will employ and oversee an informed consent process that ensures that potential research subjects
understand fully the purpose of the research study, the nature of the research procedures they are being asked to undergo, the potential risks of these research procedures, and their rights as a research study volunteer.

10. I will ensure that research subjects are kept fully informed of any new information that may affect their willingness to continue to participate in the research study.

11. I will maintain adequate, current, and accurate records of research data, outcomes, and adverse events to permit an ongoing assessment of the risks/benefit ratio of research study participation.

12. I am cognizant of, and will comply with, current federal regulations and IRB requirements governing human subject research including adverse event reporting requirements.

13. I will notify the IRB within 24 hours regarding any unexpected study results or adverse events that injure or cause harm to human participants.

14. I will make a reasonable effort to ensure that subjects who have suffered an adverse event associated with research participation receive adequate care to correct or alleviate the consequences of the adverse event to the extent possible.

15. I will notify the IRB prior to any change made to this protocol or consent form (if applicable).

16. I will notify the IRB office within 30 days of a change in the PI or the closure of the study.

Kyle Davis ______________________________ 1/19/2010

Principal Investigator Name (typed) Principal Investigator Signature Date

Dr. Stephen Rossi ______________________________ 1/19/2010

Faculty Advisor Name (typed) Faculty Advisor Signature* Date

***Faculty signature indicates that he/she has reviewed the application and attests to its completeness and accuracy**

Cover Page
Georgia Southern University
Institutional Review Board

<u>For electronic submission</u>*:* Your proposal narrative should already be completed and saved. Next complete cover page and "Save As" a word document to your computer or disk named "Coverpage_Year_Month_Date_lastname, First initial.doc". Then open and complete Informed Consent Checklist.

Application for Research Approval

Name of Principal Investigator: Jonathan Kyle Davis	Email: jd02931@georgiasouthern.edu	**For Office Use Only:** IRB ID__________ Date Received_________ BY__________________
Phone: 706-889-2676	Address: PO Box 8076	
Department: Health and Kinesiology	Project Start Date: March 2011 Project End Date: May 2011	
*Date of IRB education completion:8/25/2009 (attach copy of completion certificate) Check one: ☒Student ☐Faculty/Staff **If student project please complete advisor's information below**:		
Advisor's Name: Dr. Stephen Rossi	Advisor's email: srossi@georgiasouthern.edu	
Advisor's phone: 912-478-0775	P.O. Box: 8076	
Department: Health and Kinesiology	**All applicants please complete all fields below:**	

Project Information:	
Title: The Relationship between Lower Body Power and Sprinting Ability in Recreationally Trained College Men.	
Project Duration (in months): 3	Number of Participants: 60-80
Brief (less than 50 words) Project Summary: The purpose of this study is to analyze the relationship between jumping ability with sprinting ability in recreationally trained college men.	
Please fill in if applicable:	
Name of Georgia Southern or External Funding Source: Personnel and/or Institutions Outside of Georgia Southern University:	
Compliance Information:	
Please indicate if the following are included in the study:	**<u>IRB Use Only</u>**

<table>
<tr><td colspan="2">☐ Informed Consent Document
☐ Greater than minimal risk
☐ Research Involving Minors
☐ Deception
☐ Generalizable knowledge (results are intended to be published)
☐ Survey Research
☐ At Risk Populations (prisoners, children, pregnant women, etc)
☐ Video or Audio Tapes
☐ Medical Procedures, including exercise, administering drugs/dietary supplements, and other procedures</td><td>Type of Review
( ) Full Board
( ) Expedited
( ) Exempt

1st Reviewer:
X:_____________ Date: _________

2nd Reviewer:
X:_____________ Date: _________</td></tr>
<tr><td>NOTE: All thesis and dissertation work by definition is to create generalizable knowledge.</td><td colspan="2"><u>IRB Use Only</u>
Comments:</td></tr>
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X:</td><td>Date:</td></tr>
<tr><td colspan="2">Signature of Advisor(if student) /
Dept. Chair(if faculty)

X:</td><td>Date:</td></tr>
</table>

Please submit this protocol electronically to the Georgia Southern University Institutional Review Board, c/o The Office of Research Services & Sponsored Programs, P.O. Box 8005. The application should contain a summary of the project, informed consent form(s), instruments, questionnaires, etc. Questions or Comments can be directed to 486-7758 or oversight@georgiasouthern.edu

GEORGIA SOUTHERN UNIVERSITY INSTITUTIONAL REVIEW BOARD
INSTRUCTIONS FOR PREPARATION OF PROPOSAL NARRATIVE

The application should be submitted electronically or 2 duplicate copies sent to the Office of Research Services and Sponsored Programs, at P. O. Box 8005, Statesboro, GA 30460, and should contain, in this order: a signed cover page, the informed consent checklist page, the project proposal narrative, and the informed consent that you will use in your project. Additional information, such as copies of survey instruments, advertisements, or any instruments used to interact with participants should be attached at the end of the proposal clearly designated as an Appendix.

Personnel
Kyle Davis, B.S., Graduate Assistant, 706-889-2676, jd02931@georgiasouthern.edu, Stephen Rossi, Ph.D, Assistant Professor, 478-0775, srossi@georgiasouthern.edu, Jim McMillan, Ed.D., Associate Professor, 478-1926, jmcmillan@georgiasouthern.edu, Jody Langdon, Ph.D., Assistant Professor, 478-5378, jlangdon@georgiasouthern.edu, Department of Health and Kinesiology, P.O. Box 8076, Statesboro, GA 30460.

Purpose
The purpose of this study is to analyze the relationship between lower body power with sprinting ability in recreationally trained college males. The present study hopes to further the literature on the relationship between measures of lower body power and sprinting ability in recreationally trained athletes. Recreationally trained athletes are forced to use multiple skills sets in order to participate in a variety of sports and activities and a better understanding of their physical capabilities would help others prepare their own bodies for multiple recreational activities. These findings will hopefully help others understand the type of power/speed relationship that is present in multi-activity athletes and further the literature that is available for recreationally trained college males.

Describe your subjects.
Approximately 75 recreationally trained college age males, aged 18 – 22 years, will perform physiological tests of lower body power and sprinting ability. All participants train for and/or participate in athletic competition at a recreational level and are not part of any intercollegiate, semi-professional, or professional athletics program at the time of testing. Recreational athletes can consist of participants from campus intramural sports, community sponsored athletic programs or any other program that promotes structured athletic programs. Recreationally trained athletes participate in a wide range of sporting activities annually and type of activity will be recorded by researchers and used for descriptive data. All recreational male athletes will be used for data collection and the nature of the sporting activity will not be delimited within the study. Participants will be recruited from physical activity classes and their participation will be strictly on a voluntarily basis. There will be no penalty and/or reward for participating in the battery of testing. Participants will not receive academic reward and/or penalty for their choice to participate in the study. All volunteers for the testing have proven to be capable of performing moderate to vigorous physical activity during the bi-weekly physical activity classes. Many participants also compete regularly in a variety of intramural sports and activities.

Methodology (Procedures)
Participants will complete a battery of tests that will test both lower body power and sprinting ability. Physiological tests include: vertical jump height and standing broad jump to measure power and a 40 yard sprint with a 10 yard split to measure maximum velocity and acceleration respectively. Testing sessions will begin with a dynamic warm-up and stretching routine prior to

any testing procedures to minimize chance of injury as well as promote optimal performance. Prior to physical activity is initiated, participants will be measured for height using a stadiometer and weight using an electronic scale. Participants will also be tested for body density using the Jackson-Pollock 3 site skin-fold test. This test will measure each participant's body fat percentage. A brief physical activity survey will also be given in order to help understand the amount and type of physical activity that each participant completes on a regular basis. Participants will begin the testing process by measuring their standing reach height and then their vertical jump height. After vertical jump height is recorded, participants will complete the standing broad jump test and finally finish the testing session by participating in the 40-yard sprint test. Upon completion of testing, participants will again stretch and cool down to promote proper recovery. The principle investigators of this research will facilitate all procedures of warm-up, data collection, cool-down, and data analysis. Researchers will gather and analyze data in order to determine the relationship between sprinting and jumping variables.

Time line for testing: Prior to data collection participants will be asked to read and sign a university approved informed consent form. All participants will be recruited from physical activity classes. This ensures that each participant is physically active at least two days per week and has proven to be capable of moderate to vigorous physical activity. Participants will complete the testing during a time allotted by the researchers that will allow for maximum participation from the volunteers willing to participate in the testing process. Testing will take place during several sessions, with a maximum of 20 participants in each testing session. Testing sessions will be conducted over two days. Participants will be complete the physical activity survey and be measured for height, weight, vertical jump and broad jump on day one and 40 yard sprint with a 10 yard split on the second collection day. Testing will be conducted on Monday and Wednesday with at least 48 hours between testing sessions. This will ensure proper rest and recovery between data collection periods. All scientific and personal data collected on participants for presentation purposes will be kept confidential and stored in a locked file drawer in Hollis 2121A. All data will be stored for 6 years, at which time hard copies will be shredded and electronic copies deleted. Subject identity will not be revealed in publications or presentations that result from this study so as to protect subject privacy and confidentiality. All data will be reported as means and standard errors.

Description of tests:

Jackson-Pollock Three site skin-fold- Using a calibrated skin-fold caliper, researchers will measure skin-fold thickness at three sites along the right side of the body. Researchers will take measurements of skin-fold thickness of the chest, abdominal, and thigh. To measure fold thickness of the chest, researchers will find and mark the midpoint between the fold of the axillary (armpit) and the nipple. This point will be pinched using the thumb and index finger in the same direction of the line and measured with the skin-fold caliper. To measure the fold thickness of the abdominal, researchers will find and mark the point one inch lateral from and 0.5 inches below the umbilicus and pinch a horizontal skin-fold using the thumb and index finger. To measure fold thickness of the thigh, researchers will find and mark the point of the thigh halfway between the inquinal crease and the top of the patella along the midline. A vertical fold will be made at this point. To ensure accuracy, another measurement will be taken at each point in the same order. The sum of the three skin-folds will be used to measure body density using Jackon and Pollock's (1978) body density equation. *Body Density = 1.1093800 - 0.0008267*sum + 0.0000016*sum*^{2} *- 0.0002574*age.* Body density measurement will then be used in the Siri (1961) equation to determine body fat percentage. *Body Fat = [(495/Body Density)-450] *100.* Body fat measurement will be used as descriptive data to help describe the testing population.

Vertical Jump Height – Vertical jump height will be measured using a Vertec (Sports Imports; Columbus, Ohio, USA). Participants will be measured for standing reach height on the Vertec by reaching upward as high as possible with dominant hand while plantar flexing the corresponding foot. Participants will then perform a maximal effort vertical jump initiated with a countermovement and upward arm swing. Participants will reach as high as possible at the peak of vertical jump and the difference between maximum jumping reach height and standing reach height will be observed as vertical jump height. All participants will complete a 5-10 minute stretching and dynamic warm-up prior to attempting a vertical jump trail. There will be a 3-5 minute rest period between jump trials to ensure participants are not fatigued.

Standing Broad Jump – To test standing broad jump, researchers will secure a measuring tape to a non-slip surface and measure the maximum horizontal distance that each participant can cover in one countermovement jump. Participants will initiate each jump with a countermovement and arm swing prior to horizontally jumping with maximum effort. Researchers will measure the distance from the starting line to the participant's point of contact closest to the starting line. All participants will complete a 5-10 minute stretching and dynamic warm-up prior to attempting a standing broad jump trail. There will be a 3-5 minute rest period between jump trials to ensure participants are not fatigued.

40 Yard Sprint w /10 Yard Split -Sprinting performance will be measured electronically using a Test-Center (TC) electronic wireless timing system (Brower Timing Systems, Draper, Utah, USA). Participants will begin in a three point stance with their down hand placed on the TC Start Pad. Trial begins when weight is taken off the starting pad and times will be recorded at 10 yards and 40 yards when the participant breaks the inferred barrier created by the TC PhotoGates. Participants will run two sprinting trials. The best 40 yard time will be used to analyze both 10 yard and 40 yard sprint data. All participants will complete a 5-10 minute stretching and dynamic warm-up prior to attempting a sprinting trail. There will be a 3-5 minute rest period between sprints to ensure participants are not fatigued.
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Data Analysis: Data will be presented as mean ± SD. Researchers will use Pearson's product moment correlation (r) to determine the relationship between the measures of power and sprinting ability. Level of significance of for all data analysis will be set to $p<0.05$. All statistics will be calculated with SPSS 17.00 (SPSS Inc. Chicago, IL).

Deception
No deception will be used in this study.

Medical procedures
No medical procedures will be used in this study

Risk.
Risks associated with participation in data collection are minimal. There is possible risk of straining muscles or spraining an ankle during testing. These risks will be minimized by using proper warm up and flexibility protocols.

Cover page checklist. Please provide additional information concerning these risk elements. If none, please state "none of the items listed on the cover page checklist apply." *Click here* to go to cover page for completion.