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The Relationship Between Jumping and Sprinting Performance in Collegiate Ultimate Athletes

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ABSTRACT

The purpose of the present investigation was to examine the relationship between jumping and sprinting among members of a regionally competitive club-level ultimate team. Twenty-two subjects (mean $\pm$ SD; 21.1 $\pm$ 2.26 year) volunteered to participate in two testing sessions the week before the team's regional tournament. Testing sessions included body-composition measurement, a 40-yard sprint (with a 10-yard split time recorded), a standing long jump (LJ) and a vertical jump (VJ). Pearson product-moment correlations revealed a significant negative correlation between LJ and 40-yard sprint time. Significant positive relationships were observed between VJ height and 10-yard power, VJ power and 10-yard power, VJ power and relative 10-yard power, relative VJ power and relative 10-yard power, BJ distance and 10-yard power, VJ height and 40-yard power, VJ power and 40-yard power, and relative VJ power and relative 40-yard power. BJ distance related significantly to 40-yard velocity, 40-yard power and 40-yard relative power. There appears to be a relationship between jumping ability and sprinting in this population, but more studies with this population are needed to confirm these results.

Key Words: power, 40yd sprint, vertical jump, long jump

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The sport of ultimate is gaining popularity in the United States and throughout the world. In the United States, ultimate is played at the national, collegiate, club, beach and youth levels. Ultimate at the collegiate level began in 1984 and involves more than 12,000 student-athletes and more than 700 teams (USA Ultimate, 2010). The sport requires a high level of aerobic fitness, as athletes cover a 70-by-40-yard playing field, trying to complete passes into the opponent's end zone and defend their own end zone. In addition to being aerobically fit, ultimate athletes must be able to sprint, jump, and throw and catch a disc. Sprinting and explosive power production are both vital components in ultimate (Baccarini, & Booth, 2008). Very little research examining ultimate athletes exists, but several studies examine athletes participating in sports that require similar physical demands and skills (Baker & Newton, 2008; Brechue, Mayhew & Piper, 2010; ; Kin-Isler, Ariburun, Ozkan, Aytar & Tandogan, 2008; McCurdy, Walker, Langford, Kutz, Guerrero & McMillan, 2010; Nimphius, McGuigan & Newton, 2010).

Tests such as the vertical jump (Cronin & Hansen, 2005; Kale, Asci, Bayrak & Acikada, 2009), Wingate Test of Anaerobic Power (Nesser, Latin, Berg & Prentice, 1996), unilateral and bilateral depth jump (Cronin & Hansen, 2005, McCurdy, et al., 2010), loaded squat jump (Baker & Nance, 1999; Baker & Newton, 2008; Cronin & Hansen, 2005; Requena, Gonzalez-Badillo, De Villareal, Erelina, Garcia, Gapeyeva & Paasuke, 2009; Smirniotou, Katsikas, Paradisis, Argeitaki, Zacharogiannis & Tziortzis, 2008) and repeated jump test (Smirniotou, et al., 2008) have been used to assess lower-body power. Sprint tests have ranged from an initial acceleration measurement of 5m (Chelly, Cherif, Amar, Hermassi, Fothloun, Bouhlef, Tabka & Shephard, 2010) to measurement of sprinting at 300m (Sinnott, Berg, Latin & Noble, 2001). Results from those studies have sometimes shown a positive relationship between sprinting and vertical-jump performance. Wisloff and colleagues (2004) examined the relationship between vertical-jump height and sprinting among Norwegian national-level soccer players and found that vertical-jump height correlated significantly with sprinting performance at 10m and 30m. However, Chelly, et al. (2010) reported no relationship between 5m and 10m sprinting and vertical-jump height among regional-level junior soccer players.

Much as with the relationship between vertical jump and sprinting, studies of the relationship between standing long jump and sprinting has yielded mixed results. Brechue and colleagues (2010) and Seiler and colleagues (Seiler, Taylor, Diana, Layes, Newton & Brown, 1990) reported a strong correlation between standing long jump and sprint acceleration at 10yd, 5m and overall sprint performance in the 40yd and 35m sprint test in collegiate football players. Interestingly, both studies also reported weaker correlations between vertical jump and sprinting. While some data suggest that vertical jump and sprinting are sometimes correlated in other sports, there is limited information on this relationship in ultimate athletes. This information would be helpful to those engaged in the sport, because of the reliance of jumping and sprinting inherent in the game itself. Therefore, the purpose of the present investigation was to examine

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the relationship between jumping and sprinting within members of a regionally competitive, collegiate-level ultimate team.

Methods

Design

Researchers compared jumping and sprinting by collecting vertical-jump height using a Vertec Jump Training System (Sports Imports; Columbus, Ohio), long-jump distance using a marked nonslip surface, and sprinting at 9.1 meters and 36.6 meters using a Brower Test Center (TC) electronic wireless timing system (Brower Timing Systems, Draper, Utah).

Subjects

Twenty-two male collegiate club ultimate players participated in the present study. All participants completed a written informed consent in accordance with university ethical-review-committee guidelines. Subjects were screened for contraindications to exercise with the use of a health-history questionnaire.

Data Collection

Subjects' height, body mass and body composition were measured before testing (see Table 1). Height was calculated using a wall-mounted tape measure and level device; mass was measured on a calibrated scale (Continental Scale Corp., Chicago, Ill.). Body composition was determined using a three-site skinfold measure (Jackson & Pollock, 1978). Participants' height (cm), mass (kg) and standing-reach height (in) were measured on day one.

Participants were placed randomly into two groups. The first group completed a standard warm-up regimen that consisted of five to seven minutes of light jogging, followed by five to seven minutes of dynamic warm-up. Following the warm-up, the first group was tested for vertical-jump height, and the second group began its warm-up. Standing-reach height was determined by participants' reaching to maximal height with the dominant hand while the corresponding foot was plantar-flexed (Chelly, et al., 2010). To measure maximal jumping height, participants performed a counter-movement jump. The jump was initiated from a standing, stationary position, with each participant's dominant hand nearest to the Vertec. Jumps were initiated with a downward counter-movement, followed by an upward arm swing. Participants then reached with the dominant hand and displaced the highest vane possible on the Vertec. Each participant was allowed three maximal-effort jumps, with at least 45 seconds of rest between jumps. The best attempt was used for data analysis.

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Table 1
Subject Characteristics

Variable	Mean	Standard Deviation
Age (y)	21.1	2.26
Height (cm)	179.88	6.53
Body mass (kg)	73.57	7.38
Body fat (%)	10.57	3.81
Lean body mass (kg)	63.62	12.44

As the first group finished vertical-jump testing, the second group finished its warm-up. Group one then moved to long-jump testing, while group two began vertical-jump testing. Standing long jump was recorded as the maximum horizontal distance covered in one counter-movement jump. Participants began each jump with a downward counter-movement 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. Any jump after which the participant fell backward or couldn't keep his 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. Each participant performed three successful jumps. All participants' jumps were recorded, with the best jump used for data analysis.

After a 48-hour rest, participants reported to be tested for body mass (kg), body-fat percentage, using a three-site skinfold measurement, and sprinting at distances of 10 yards (9.1m) and 40-yard s (36.6m). The three-site skinfold measurement was used as a time-saving and less-intrusive data-collection method, based on Baumgartner, Jackson, Mahar and Rowe's (2006) assertion that both measures are highly correlated ($r=.97$). 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 (Aragon-Vargas, 2000).

Following body-composition testing, participants completed the same standardized warm-up conducted on day one. After the warm-up, the testing procedures for the 40-yard sprint test were explained. Participants then ran a practice trial at half speed to ensure that they understood how the timing system worked. Participants began each trial in a three-point stance, with the down hand placed directly on the TC-Start Pod's timing mat. Timing began when the participant removed the hand from the timing mat.

Participants then completed three 40-yard (36.6m) sprints at maximal effort, with times recorded at 10 yards (9.1m) and 40-yard s (36.6m). To ensure proper recovery time, participants completed one trial at a time with at least five minutes between trials. Verbal encouragement was given to all participants. The researchers used the fastest 40-yardsprint trial with the associated 9.1 m time for data analysis.

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Instrumentation

The TC electronic wireless timing system (Brower Timing Systems, Draper, Utah) was used to collect sprint times. TC PhotoGates were placed 10 yards and 40-yard s from the starting line to collect data from start to 10 yards and from start to 40-yard s. TC PhotoGates (A & B) were placed 10 meters apart, five meters from the center of the sprinting surface, to ensure that each timing gate was out of the participants' sprinting path and that the participants were not "reaching" for the finish line and breaking the timing plane prematurely. TC PhotoGates were set to approximately waist height. For statistical analysis, researchers calculated average velocity at 10 yards and 40-yard s (velocity = distance/time), expressed as meters per second, acceleration at 10 yards (acceleration = 10-yard average velocity/time) expressed as meters/second², and power at 10 yards and 40-yard s (horizontal sprinting power = velocity (m/s)/body weight (kg)), expressed in kilograms per meters per second. Power then was 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, researchers 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

Pearson product-moment correlations were calculated to examine the relationship between variables that have been reported previously in the scientific literature as major determinants of sprinting and jumping ability. An alpha level of $p \leq 0.05$ was used to determine correlation significance. All data were checked for normality and presented as mean $\pm$ SD. A histogram frequency analysis revealed all data to be distributed normally. All statistics were calculated with SPSS 14.0 (SPSS Inc., Chicago, Ill).

Results

Vertical-jump test and long-jump test results are reported in Table 2. Results for the 10-yard and 40-yard sprint tests are reported in Table 3. Pearson's product-moment correlations showed significant relationships between vertical-jump and long-jump variables and 10-yard and 40-yard sprint variables, which are presented in Tables 4 and 5. Researchers found significant relationship between 10-yard and 40-yard sprint variables, which are presented in Table 6, and between vertical-jump variables and long-jump variables, which are presented in Table 7. Long-jump distance was not significantly related to vertical-jump relative power.

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Table 2
Descriptive Statistics for Jumping Tests

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
Long Jump	240.44 cm	17.78 cm

Table 3
Descriptive Statistics for 10- and 40-Yard Sprinting Test

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
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-yardPower/ kg Fat Free Mass	79.67 W/kg	4.36 W/kg

Table 4
Pearson-Product Moment Correlations Between VJ and 10-Yard Sprint

Test	10-Yard	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**

VJ= Vertical-jump height, VJP= Vertical-jump power, VJP/BW= Vertical-jump power per kilogram of body weight, VJP/FFM= Vertical-jump power per kilogram of fat-free mass, 10 Yard= 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.

* Significance at the 0.05 level

** Significance at the 0.01 level

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Table 5

Pearson-Product Moment Correlations Between VJ and 40-Yard Sprint

Test	40-Yard	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**

VJ= Vertical-jump height, VJP= Vertical-jump power, VJP/BW= Vertical-jump power per kilogram of body weight, VJP/FFM= Vertical-jump power per kilogram of fat-free mass, 40-Yard= 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.

* Significance at the 0.05 level

** Significance at the 0.01 level

Table 6

Pearson-Product Moment Correlations Between 40- and 10-Yard Sprint

Test	10-Yard	10ACC	10P	10P/BW	10P/FFM
40-Yard	.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**

40-Yard= 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.

* Significance at the 0.05 level

** Significance at the 0.01 level

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Table 7

Coefficients of Correlation Between Vertical Jumping Height, Power and Relative Power and Long-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 body weight, VJP/FFM= Vertical-jump power per kilogram of fat-free mass, BJ= Long jump.

* Significance at the 0.05 level

** Significance at the 0.01 level

Previous research has reported vertical jump heights of 42.16 ± 4.32 to 51.84 ± 6.68 cm in male college students (Almuzaini & Fleck, 2008; Sassi, Darouri, Yahmed, Gmada, Mahfoudhi & Gharbi, 2009). In the present study, the ultimate athletes' vertical-jump power was higher than previously published data on recreational athletes but lower than that on more highly trained athletes (Nesser, et al., 1996; Sinnett, et al., 2001). That might be a result of the ultimate athletes' experience with vertical-jump testing, as well as performing explosive jumping movements during practice and games. However, their strength-and-conditioning program was not designed toward improving jumping ability, as are those of collegiate or professional American football athletes, who train, on average, more than four times per week using exercises that improve strength and power (Brechue, et al., 2010).

Similar to their vertical-jump performance, the participants in the current study performed better on the long jump than did recreational trained athletes, but worse than highly trained athletes. The speed and force production of ultimate players has not been studied in depth, as they have with American football players and sprinters who train to produce a great deal of force in a very short amount of time (Berg & Latin, 1995; Brechue, et al., 2010; Cronin & Hansen, 2005; Davis, Barnette, Kiger, Mirasola & Young, 2004; Garstecki, Latin & Cuppett, 2004; Kale, et al., 2009). The long jump requires participants to generate power very quickly, and that ability can be improved through jump training, resistance training or other types of explosive training (Berthoin, Gregory, Mary & Gerbeaux, 2001). The present study found that ultimate players performed well in jump tests when compared to recreational athletes (Almuzaini & Fleck, 2008), but their power production was lower than that of more highly trained athletes (Brechue, et al., 2010; Kale, et al., 2009). There could be many reasons for this difference. One could be that the participants in the present study train less and train differently than do more highly trained athletes (Brechue, et al., 2010). Only 60.8% of the participants in the present study reported that they resistance-trained, with an average of two to three training sessions per week. They also reported that they did not participate in a supervised program created by a strength-and-conditioning specialist.

The 10-yard and 40-yard sprint test is common measure of speed in athletes (Brechue, et al., 2010). Deane and colleagues (Deane, Chow, Tillman & Fournier, 2005) reported values ranging from 1.83-2.07 seconds in the 10-yard dash. The athletes in the present study recorded a mean time of 1.72 ± 0.08 seconds, which is similar to the average time reported in a group of NCAA Division I football players (Brechue, et al., 2010). Mean 40-yard dash times in recreational athletes ranged from 5.21-5.67 seconds (Deane, et al., 2005; Moore, Decker, Baarts, DuPont, Epema, Reuther, Houser & Mayhew, 2007) while more highly trained athletes have posted mean scores as low as 4.72 seconds (Davis, et al., 2004). With a mean time of 5.04 ± 0.16 seconds, the ultimate athletes posted faster times than those of recreational athletes, but slower times compared to highly trained athletes. 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 (Brechue, et al., 2010; Davis, et al., 2004; Deane, et al., 2005; Moore, et al., 2007). Athletes who are more highly trained, such as American football players, have a lot of

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experience with the 40-yard dash, and their playing time can depend on their 40-yard time (Brechue, et al., 2010). Although the participants in the present study all had been tested previously for 40-yard sprinting, success in their sport is based on shorter sprints.

It appears that a relationship exists between 10-yard sprint times and 40-yard sprint times (Brechue, et al., 2010), and, although participants posted comparatively better times in the 10-yard sprint, the present study confirmed the relationships. The present study revealed a significant positive correlation between 10-yard 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). A likely cause of the difference in the strength of the relationship is that the participants in the Brechue, et al. (2010) study performed well in both the 10-yard sprint and the 40-yard sprint, while participants in the present study performed well in the 10-yard sprint, but not the 40-yard sprint. As stated previously, that most likely is due to previous participants' performing well in both the 10-yard sprint and the 40-yard sprint, while participants in the present study did not.

Results from the present study revealed no relationship between vertical-jump height and 10-yard sprint or 40-yard sprint performance. These findings are similar to that of Chelly, et al. (2010), who reported no significant relationship between the initial portion of the sprint and vertical-jump height among a group of junior national soccer players. The present study revealed a significant relationship between vertical-jump height and horizontal power produced during a 10-yard sprint but found no relationship between vertical-jump height and 40-yard sprint time; but significant relationships were observed between vertical-jump height and 40-yard horizontal power production and vertical-jump power production and 40-yard horizontal power production. Previous research examining trained sprinters (Smirniotou, et al., 2008), NCAA Division I football players (Brechue, et al., 2010) and rugby players (Harris, Cronin, Hopkins & Hansen, 2008) reported that vertical-jump height correlated highly to sprinting distances of 35 to 40 meters.

Several significant relationships were observed between long-jump distance and 10-yard and 40-yard sprint variables. Among the 10-yard variables, long-jump distance significantly correlated with 10-yard horizontal-power production but not 10-yard time, velocity or relative power measurements. That difference might be explained by the similar 10-yard times in the Brechue et al. (2010) study and the present study, but shorter mean long-jump distance in the ultimate athletes. Long-jump distance correlated significantly with 40-yard time, velocity, power and power relative to body weight. Brechue, et al. (2010) reported long jump to be related significantly to 40-yard time and 40-yard velocity. McCurdy and colleagues (2010) also observed a significant relationship between 40-yard velocity and long jump in women soccer players.

Posting a good time in sprint tests requires the ability to generate enough force to start quickly and reach maximum velocity early in the sprint (Cronin & Hansen, 2005). Long jump is a measure of force and power production and appears to be related to sprint distances of five to 40 yards (Brechue, et al., 2010). Ultimate participants rarely sprint more than 40 yards, and

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often sprint only 10 to 20 yards and, therefore, seem to perform the shorter sprints with greater force and power production (Baccarini & Booth, 2008).

Conclusions

The results of the present study are in agreement with past studies and appear to confirm the relationship between jumping and sprinting. Therefore, ultimate athletes would benefit from exercises that promote both speed and power to improve performance. Many athletes competing in collegiate club sports often do not have access to sport training facilities, high-quality strength-and-conditioning coaches, or exercise/sport scientists who can help them reach their personal and team goals. The current findings suggest that power production is important in both jumping and sprinting, and ultimate athletes would benefit by including plyometric training and Olympic lifts in their strength-and-conditioning programs to increase power (Arabatzis, Kellis, Saez-Saez De Villarreal, 2010).

Overall, results from this study suggest that jumping and sprinting are related to success in ultimate athletes. The authors suggest that future research in this and similar populations should include more performance tests, such as the repeated anaerobic sprint test protocol (RAST), and agility tests, such as the pro agility test, as these might prove to be useful screening tools. From a practical standpoint, results from these tests also can provide an evaluation of the athletes, as well as the efficacy of strength-and-conditioning programs. Also, these are field-based tests that require little equipment and expertise and can be administered in a relatively short time, so it would be practical to incorporate the testing within normal practice times.

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