ANTHROPOMETRIC VARIABLES AND VERTICAL JUMP IN MALE FRISBEE PLAYERS DUE TO GAME'S POSITION

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Abstract

The vertical jump is one of the necessary variables in performing offence and defence skills in ultimate frisbee. The purpose of this study was (1) to compare vertical jumps among frisbee players based on the game's position (2) to determine the relationship between anthropometric variables and vertical jumps. A total of 16 male ultimate Frisbee players from a top team in Malaysia were recruited as participants, and at least they played for two years for that team (23.19 ± 2.07 years old, 3.44 ± 2.45 years' experience). The data was collected in two sessions. Eleven anthropometric variables: stature, body mass, tronchanterion-tibiale lateral, tibiale lateral height, leg length, foot length, mid-thigh girth, calf girth max acromiale-radiale, radiale-stylion radiale, and midstylion-dactylion were measured using SECA tailor tape. The jumping height was measured with a VERTEC jumping apparatus and converted into peak power output using Sayers Equation. One-way ANOVA was utilized to determine differences in the mean vertical jump of the handler, mid, and deeper, and the Pearson correlation coefficient was used. Peak power output significantly correlated with body mass, leg length, radiale-stylion radiale, and midstylion-dactylion on three game positions. Results show vertical jump mean score (48.00 ± 1.00cm) of the deepers position was significantly different from handlers' position (44.17 ± 3.19cm), considering to game's position seems to be necessary for ultimate Frisbee players to catch and tap the disc successfully.

Keyword: Power, Vertical Jump, Anthropometric, Ultimate Frisbee, Player Position

Introduction

Ultimate frisbee is a relatively new sport which rapidly grown and played in more than 42 countries in recent years (Solomon, Banerjee, and Horn, 2014; Yu, 2014). This game was created by the Frisbie Baking Company of Bridgeport, CT, which supplied pie tins to Yale students with baked goods. From there on, students discovered that these pie tins were fun to throw, inspiring Walter Morrison to build an improved plastic prototype in the 1940s (Solomon et al., 2014). Ultimate is a team sport played on a 100m by 37m field with two

teams of seven players catching and passing a single disc against each other, similar to American Football or basketball. (Sasakawa & Sakurai, 2008).

Throwing, catching, running, and jumping are the components that are integrated into frisbee's sport. In addition, frisbee, relatively related to volleyball, had fast movements, jumping, landing, and sudden shifts that needed high power and strength for optimized performance (Almeida & Soares, 2003; Yu, 2014). However, the most crucial component highlighted is jumping and catching, where both were utilized most in the end zone (the zone where players catch the disc and count as score). In other words, lower limb explosive power is needed for players that often have to jump or dive to catch or intercept the disc (Yu, 2014). Thus, lower limb explosive power and jumping had been linked to sprint speed. Hence power is essential to ultimate frisbee performance (Hoff, 2005).

Power is defined as a rate of performing mechanical work or the product of force acting upon an object and the object's velocity (Markovic, Mirkov, Nedeljkovic, & Jaric, 2013). While Candra (2018) define power as the outcome of a combination of speed and strength and to do maximum work within a very short time. Maximal power represents the most significant instantaneous power during a single movement performed to produce maximal velocity at take-off, release, or impact (Kraemer & Newton, 2000; Newton & Kraemer, 1994). These encompass generic movements such as sprinting, jumping, changing direction, throwing, kicking, and striking, which apply to the vast majority of sport

Evaluating vertical jump is a standard method used to assess the expression of lower body muscular force and power expression and serves to practically predict performance outcomes. Thus, the maximum vertical jump has been one of the most often applied movements in training and testing particular physical abilities (Markovic et al., 2013). In addition, vertical jump testing is reliable and valid in its estimation of explosive muscular power, power development and as an indicator of performance. Vertical jumps may be done in a variety of methods. The methods such as depending on the position (static or following a run-up), take-off (from one foot or both feet), arm movement (with or without an arm-swing), and legs movement (counter-movement or squat).

The body's centre of gravity must be as high above the ground as feasible to achieve maximum vertical height, with the greatest vertical velocity during take-off. (Cordova, Ingersoll, Kovaleski, & Knight, 1995). Kreighbaum (1990) stated that external forces (ground reaction force) are formed when the jumper pushes against the ground to overcome inertia in speeding the body upward due to segmental rotation moving the body's centre of gravity upward in a rectilinear route. According to Newton's second law, the vertical displacement of the body's centre of gravity may be altered by changing the components of the vertical ground reaction force. Thus, the relationship between impulse and momentum needs to be considered when performing a vertical jump. The impulse-momentum relationship exists because the applied force and time (impulse) product determine the change of momentum an object possesses (Kreighbaum, 1990). Because the vertical impulse is a function of force and time that depicts the interplay between force and time created during the jump (Cordova & Armstrong, 1996). As a result, changes in force or time affect vertical impulse. Therefore, during the propulsion phase of the jump, the vertical impulse is the product of force and time (an accelerating force where a change in momentum occurs on the body) (Kreighbaum, 1990).

Another factor affecting jumping performance could be explained using Newton's Third Law. For every action, there is an equal and opposite reaction. For example, a vertical force is exerted when the foot makes contact with the ground, and the ground then reacts with an equal and opposite force. (ground reaction force – GRF). During jumping, a force was applied with both vertical and horizontal components. The force from the earth is gained by applying a large force against the earth, which then applies an equal and opposite reaction

force against the jumper. Therefore, large vertical forces or lower body mass are needed to maximize jump height.

Despite using performance tests, no research has analyzed the performance-related aspects of Ultimate, especially on the vertical jump for different game positions (Yu, 2014). Therefore, the purpose of this study was to compare vertical jumps among frisbee players based on the game's position and to determine the relationship between anthropometric variables and vertical jumps

Methodology

Participants

Sixteen male ultimate Frisbee players were recruited from a top team in Malaysia, which at least played for two years for that team (23.19 ± 2.07 years old, 3.44 ± 2.45 years' experience).

Procedure

The data collected in two sessions. The first session began with all participants completed the inform consent form and participant demographic form (name, position and years of experience). After that, the anthropometric variables were measured using SECA tailor tape. Eleven anthropometric variables were stature, body mass, tronchanterion-tibiale lateral, tibiale lateral height, leg length, foot length, mid-thigh girth, calf girth max, acromiale-radiale, radiale-stylion radiale, and midstylion-dactylion.

In second session, the jumping height was measured with a VERTEC jumping apparatus. Before testing, the participants were given 10 minutes to warm up and stretch. Once the participants' reach heights were determined using their dominant arm, they performed a vertical counter-movement jump with the arm swing. With their dominant arm, they touched the highest level possible. The arm movements and depth of knee flexion (counter-movement) were self-determined. There is no preparatory run or jab step was permitted. The researchers defined the distance between the reach height and the highest point touched as vertical jump height during the jump. The best vertical jump high score of three trials is recorded. The jumping height was measured in centimetres and converted into peak power output by using Sayers Equation (Sayers, Harackiewicz, Harman, Frykman, & Rosenstein, 1999).

The Sayers Equation (Sayers et al., 1999) was used to calculate peak power output (Peak Anaerobic Power output or PAPw). All the variables needed to estimate peak power output from the vertical jump data were jumping height in centimetres (cm), body mass in kilograms (kg), and stature in centimetres (cm).

Formula:

PAPw (Watts) = [60.7 × jump height (cm)] + [45.3 ×body mass (kg)] – 2055

Statistical Analysis

The collected data were analyzed using the SPSS version 25.0. One-way ANOVA was used to determine differences in the mean vertical jump of the handler, mid, and deeper. In addition, Pearson Correlation Coefficient was used to determine the Correlation between peak power output and anthropometric variables. The significant level was set at $p \leq 0.05$.

Result

Among the participants, 37.5% were handlers, 31.3% were mids, and 31.3% were deepers. The mean and standard deviation of participants' vertical jump and peak power output is shown in **Table 1**. According to **Table 1**, deepers have the highest vertical jump and peak

power output. Meanwhile, handlers have the lowest vertical jump and peak power output.

Table 1 Descriptive Statistics for Vertical Jump and Peak Power Output

Game Position	N	Percentage	Mean ± Std. Deviation	
			Vertical Jump (cm)	Peak Power Output (w)
Handlers	6	37.5%	44.17 ± 3.19	4642.22 ± 252.05
Mids	5	31.3%	45.40 ± 1.52	4350.75± 160.66
Deepers	5	31.3%	48.00 ± 1.00	4859.69 ± 364.07
Total	16	100%	45.75 ± 2.65	4619.10 ± 326.98

A one-way ANOVA statistical test was conducted to compare the vertical jump among three different positions in frisbee. The result was presented in **Table 2** and **Table 3**. There was a significant difference of vertical jump at the $p \leq 0.05$ for the three difference positions [$F(2, 13) = 4.16$, $p = 0.04$]. Bonferroni post hoc comparisons of three game's positions indicate that the vertical jump means score of the deepers position ($M = 48.00$, $SD = 1.00$) was significantly different than the handler's position ($M = 44.17$, $SD = 3.19$). However, the vertical jump means the score for mids position ($M = 45.40$, $SD = 1.52$) did not show statistically significant at $p \leq 0.05$ from the handlers and deepers position.

Table 2 Results of One-Way Variance Analysis of Participants' Vertical Jumps

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	64.01	2	32.01	4.16	.04*
Within Groups	100.05	13	7.70		
Total	164.06	15			

*Significant difference $p \leq 0.05$

Table 3 Results of Bonferroni Tests According to Game's Position

Game position	Mean difference (cm)	Std. Error	Sig.
Handlers jump ----- Mids jump	-1.54	1.68	1.00
Handlers jump ----- Deepers jump	-4.79*	1.68	.04
Mids jump ----- Deepers jump	-3.25	1.75	.26

*The mean difference is significant at the 0.05 level

Table 4 shows the Pearson Correlation Coefficient of peak power output with selected anthropometric parameters. Peak power output significantly correlated with body mass, leg length, radiale-stylion radiale, and midstylion-dactylion. The correlations were significant at the 0.05 and 0.01 levels (2-tailed).

Table 4 Correlation Between Peak Power Output and Anthropometric Parameter

	Peak Power Output (W)	
	Correlation Coefficient	Sig. (2-tailed)
Body Mass (kg)	.67**	.005
Leg length (m)	.06*	.045
Radiale-stylion radiale (m)	.56*	.024
Midstylion-dactylion (m)	.68**	.004

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

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

Discussion

The crucial prerequisites component in executing successful sports skills was physical fitness and influenced by the anthropometric variables (Stamm, Veldre, Stamm, Thomson, Kaarma, Loko, & Koskel, 2003). For example, ultimate frisbee, a power and intermittent sport, requires repetitive jumping for players to catch and defend the high disc. Thus, jumping skill is an essential physical fitness component of ultimate Frisbee players through assessing lower limb power.

To our knowledge, this study was the first conducted to assess the relationship between vertical jump and anthropometric variables upon games position of ultimate Frisbee players; it is impossible to compare the findings. However, the result of the study was in line with the previous finding in different sports, which found the Correlation between anthropometric variables and vertical jump. The power of the jump of elite karate athletes significant correlation with body weight (Spigolon et al.,2018). Fattahi, Ameli, Sadeghi, and Mahmoodi (2012) among male elite volleyball players also found a significant correlation between vertical jump and anthropometric variables such as foot length, shank length and calf circumference.Davis, Briscoe, Markowski, Saville, and Taylor (2003) conducted a study on vertical jump among recreational male athletes found a significant correlation with height, body weight, percentage of body fat, tight girth, and lower limb flexibility. A study by

According to Pocek et al. (2021), the difference in jumping ability among athletes can be explained due to player specialization or the player's position. The differences in the vertical jump between handlers and deeper were noticeable. The discrepancies in variables may be explained by the players' positions in the game. When attacking and defending, ultimate Frisbee players achieve greater height when challenging the opponent to get the disc in the air. Nowadays, players that can achieve greater height are identified as the most valuable skill compared to other players with the ability of higher jumping (Hong-lin, 2006). The deeper position is crucial in the ultimate Frisbee team because they have the highest possibility to score during a match.

According to Davies and Jones (1993), Harman, Rosenstein, Frykman, and Rosenstein (1990), and Khalid, Amin, and Bober (2008), arm swing may cause a 10-27 per cent increase in jump height, depending on the type of jump and the athletes being evaluated. Furthermore, more significant increments of vertical ground reaction impulse (VGRI) were produced when arm swing played a role in increasing tension placed on each jump segment (Harman et al., 1990; Khalid et al., 2008). This allows for the improved stretch-shortening cycle (SSC) functioning in leg extensors. Depending on the take-off phase time, an arm swing may put the muscles of the take-off legs under quicker eccentric and slower concentric circumstances, which is helpful when considering the force-velocity connection of muscular contraction. (Harman et al., 1990). In depths, Harman et al. (1990) stated when the arm decelerates near the end of the swing, it makes the quadriceps and gluteal contract at a more rapid speed. Apart from that, arm swing may also contribute to an increased vertical jump height by increasing pre-take-off total body center of mass displacement.

Body mass might negatively influence the vertical performance if any gain in the mass is not associated with strength. The preferable muscle contraction type is fast-twitch, which dominates most in jumping (powerful action). The capacity to produce force during a maximal voluntary contraction is determined by the relevant muscles' cross-sectional area and activation ability (Van Soest, Roebroeck, Bobbert, Huijing, & Van Ingen Schenau, 1985). While greater leg length and foot length in jumpers cause a greater torque for reaction force in the ankle joint, more lever length and more transmitted force all contribute to the final velocity of the jumping (Fattahi et al., 2012).

Conclusion

The maximum vertical jump is necessary to look into during attacking (catching disc) and defending (tapping disc) skills in ultimate frisbee. According to the study, peak power output significantly correlated with body mass, leg length, radiale-stylion radiale, and midstylion-dactylion in three-game positions: handlers, mids, and deepers. Results also show that the vertical jump means score of the deepers position was significantly different from the handlers' position. Therefore, in planning a training program specifically for ultimate Frisbee players, anthropometric variables and training methods should be considered based on the player's position. On the other hand, coaches can also use anthropometric variables such as body mass, leg length, radiale-stylion radiale, and midstylion-dactylion to determine talent identification for ideal Frisbee players. However, the finding only can be generalized among male athletes only. Thus, a future study was suggested to investigate the relationship between anthropometric variables and vertical jump among female Frisbee players. Future findings might differ due to innate physiological differences between males and females.

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Conflict of interests

The authors with this declare that there is no conflict of interests with any organization or financial body for supporting this research

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