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A correlation study between unilateral countermovent jumps, unilateral drop jumps and different sprint distances

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Abstract

Background: Sprinting and jumping is an important physical part of soccer. Games are often won or lost cause of this two factors. Also the ability to sprint, how often you can sprint and how well you can sprint late in a game is what differ between the absolute world class players and other top class players. A players ability to produce power affects the players ability to sprint and jump. Power production can be tested as well as trained with plyometric exercises. Two plyometric exercises commonly used to test players abilities are the counter movement jump and the drop jump which can be performed either unilateral or bilateral. Relationships between bilateral counter movement jump and sprint is well established. But the relationship between unilateral countermovement jumps and unilateral drop jumps and sprint are not as well examined. ***Aim:*** The aim of this study is to examine which one of the two tests, unilateral CMJ and unilateral DJ, that have the highest correlation with short sprinting. ***Method:*** 14 male junior soccer players playing on a high national junior level participated in this study. Two blocks of sprints was performed, 0-15 m and 0-30 m with time measured on every 5 m. Two trials of unilateral countermovement jumps and unilateral dropjumps was performed on the subjects dominant leg. Spearman's two-tailed correlation test was used and a value of > ±0.6 was considered to be a strong correlation. ***Results:*** 10 subjects attended both the sprint and jump trials. No strong correlations was found. The highest relationships was that between unilateral counter movement jump and 0-30 m sprint (r_s = -0,30) and that between unilateral drop jump and time between 20-30 m sprint (r_s = 0,30). No strong correlations was found. ***Conclusion:*** The results showed no strong relationships between the jumps and any of the sprint distances. Therefore neither of the jumps can be said to better predict sprint performance on any distances up to 30 m. Neither can the results from this study be of use to recommend any of the jumps before the other in training as plyometric exercises to improve performance on the acceleration phase or the top-speed phase.

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Introduction

Soccer is the most popular sport in the world with millions of people following and playing it. The demands an absolute top-class player face during a game are far more demanding than those an amateur or near top-class player face. An absolute top-class player performs on average 39 sprints and 69 high-speed runs during a game. The duration of these runs are on average 2.0 and 2.1 s and the players covers about 10-15 m during every sprint. It is during these high-speed runs and sprints that the games often are won why the ability to accelerate are very important in soccer (Bangsbo, Mohr, & Krustrup, 2006; Mohr, Krustrup, & Bangsbo, 2003). Many studies have tried to find a relationships between sprinting and exercises such as countermovement jumps and drop jumps (Alemdaroğlu, 2012; Comfort, Steward, Bloom, & Clarkson, 2013; Habibi et al., 2010; Holm, Stålbom, Keogh, & Cronin, 2008; Markström & Olsson, 2013; Maulder & Cronin, 2005; McCurdy, Walker, Langford, Kutz, Guerrero & McMillan 2010; Meylan, McMaster, Cronin, Mohammad, Rogers, & Deklerk 2009; Vetter, 2007; Wislöff, Castagna, Helgerud, Jones, & Hoff, 2004). But the results have been contradictory and studies done on young soccer players are limited why further studies in this area is needed. Thus further studying to determine which of the exercises counter movement jump and drop jump that have the strongest relationship with sprinting ability is of interest. Both for future use in studies as well as during training.

Background

Soccer contains both aerobic and anaerobic demands in an intermittent way (Bangsbo et al., 2006). A male elite football player covers 8-12 km/game, depending on positions. (Wislöff et al., 2004). More than 70 % of a game rates as low-intensity, but despite this the average oxygen uptake during a game is around 70 % of V02max (Bangsbo et al., 2006). This can partly be explained by the 150-250 short intense sprint actions that a top-class player perform during a game (Bangsbo et al., 2006). Sprinting stands for 1-11 % of the total distance covered during a game and 0,5 to 3,0 % of the effective playing time (Wislöff et al., 2004).

It is established that absolute top-class players are better at performing sprints than amatuer and elite players. Depending on position an absolute top-class player can perform 58 % more sprinting than a professional player of a lower standard (650 m vs 410 m) as well as 28 % more high intensity running (2.43 vs 1,90 km). Attackers sprint the most during a match followed by the full-backs and the midfielders with the centre-backs covering the least amount of distance sprinting and at a high intensity (Mohr et al., 2003).

As in many other ball sports, the ability to accelerate, to perform shorts sprints and to run at top speed for brief periods of time are important qualities for soccer players (Sleivert & Taingahue, 2004 & McCurdy et al., 2010). As a soccer player rarely sprints for more than short distances, it is rare that they sprint for long enough time to go into the deceleration phase (Sleivert et al., 2004), which occurs after between 30-55 m depending on the level of the athlete. Maximal speed occurs after 20-45 m. Novice athletes reach their maximal speed and the deceleration phase earlier than elite atheletes (Baechle & Earle, 2008). For a soccer player the ability to accelerate and to have a high maximal speed is important as that they rarely sprints for longer distances.

Most studies have included distances from 5 m to 30 m (Alemdaroğlu, 2012; Comfort et al., 2013; Cronin & Hansen, 2005; Holm et al., 2008; Maulder et al., 2005; McCurdy et al., 2010; Meylan et al., 2009; Sleivert et al., 2004; Vetter, 2007; Wislöffet al., 2004). Only a few studies have measured distances up to 40 m (McBride, Blow, Kirby, Haines, Dayne & Triplett, 2009; Shalfawi, Sabbah, Kailani, Tønnessen, & Enoksen, 2011) and studies on youth soccer players are scarce and need to be further investigated.

Soccer clubs test soccer players sprinting ability both to evaluate improvements in peformance after specific training programs and to evaluate potential ability in young talents as well as potential new signing. Other tests used to evaluate current and potential abilities are different jump tests (Gissis & Papadopoulos, 2006). Jumping can be performed either strictly horizontal or vertical, as well as directed at any angle between these two extremes. Most jumps are initiated with a downward movement of the body and this is referred to as a counter-movement. This movement can increase jump length by about 10 %. Another factor that can increase jumping performance is the inclusion of an arm swing. Depending on technical skill it can add between 10-20 % to the height of a jump (Grimshaw, Lees, Fowler, & Burden, 2007). Both jumping and sprinting relies on extension of the joints prior to take-off and drive-off as we all as a plantarflexion during the final phase before the jump and swing phase (Baechle & Earle, 2008 & Grimshaw et al., 2007).

Jumping can as well as sprinting be decisive to who wins a soccer game. The ability to sprint faster than your opponent or being able to perform more sprints late in a game can mean that an attacker reaches the boll before the defender and get the opportunity to score. A soccer player that can jump higher than his opponent have a better chance to perform a header which also can mean scoring a goal. Further research about sprint and jumping performance can help coaches to better understand how to train their atheletes to optimize performance during a game.

Muscle contraction

A key determinant in a sprinting and jumping performance of maximal effort is the muscles ability to produce force. The amount of force that can be produced is determined by the the cross-sectional area of the activated muscle and its fiber type distrubition, as well as how many motor units that are recruited. During maximal efforts maximal motor unit recruitment are desirable. To activate a motor unit a motor neuron has to be activated. An action potential from the motor neuron stimulates the muscle cells initiating reactions that leads to movement of the actin and myosin filaments. Cross-bridges are created by actin and myosin and the muscle contract (McArdle, Katch, & Katch, 2010). Movement in the filament and the building of cross-bridges is created fast, but not instantaneously as creation of cross-bridges take some time and so also the muscles ability to create force (Baechle & Earle, 2008). As ground contact time during a sprint is limited, 0.34-0.37 s at the start of a sprint to 0.09-0.11 s at maximal velocity in trained athletes, the involved muscles doesn't have enough time to produce maximal force (Markström et al., 2013). Instead the muscles ability to produce as much force as possible as fast as possible is more interesting, and this is the ability to produce power.

Power

Power is work divided with time and maximal power is the highest level of power achieved in a muscular contraction. When sprinting the aim is to produce as high velocity during the take-off as possible. To achieve this a high amount of power most be produced. The highest possible power that can be produced is called maximal power and it is the greatest immediate power during a single movement performed with the goal to produce maximal velocity (Cormie, McGuigan, & Newton, 2011a).

An important concept regarding power is the force-velocity relationship and the force-power relationship. If an object is very heavy, then it is hard to move it with a high velocity, thus limiting the power. The same thing happens with a light object. You can move it with a high velocity but you can't exert a lot of force when the object is light, thus limiting power. The length-tension relationship is another important concept for power. The sarcomere length is critical when generating force. An optimal overlap between the myosin and the actin filaments is critical for producing force. At rest the muscle length are in general slightly shorter than optimal. Therefore muscular force can be increased with a minor stretch before the contraction of the muscle fibre (Cormie et al., 2011a).

Exposing the muscle of a stretch before it is exposed to a shortening is also the key behind the most common muscle function, the stretch shortening cycle (SSC). The eccentric activity in the muscle before the contraction means that the agonist muscles have longer time to produce force then during a concentric only movement. Another well reported mechanism behind the SSC is the storage of and utilization of elastic energy. When an active muscle and tendon is stretched they can absorb the mechanical energy in the series of elastic components (SEC), this includes the fibre cross-bridges and the tendon. It is believed that the recoil of the SEC can help to produce more power during the following initial concentric phase (Cormie et al., 2011a).

Other factors that influence power production is muscle fibre composition, pennation angle, motor unit recruitment, cross-sectional area, firing frequency, inter-muscular coordination and the time available to produce force (Cormie et al., 2011a).

As all these factors affects the ability to produce power and the ability to produce power affects sprinting and jumping ability, training to improve these factors are desirable.

Training to improve power

There exist a fundamental relationship between power and strength. One can't possess a high level of power without being relatively strong. The ability to produce force along with the ability to use the SSC is what determines the ability to produce power. Some may need to increase their strength to be able to produce more power and some may need to train their SSC. This training is referred to as power training. Ballistic, weightlifting and plyometric exercises are the primary exercises within a power training programme (Cormie, McGuigan, & Newton, 2011b).

Plyometric

"Plyometric exercise refers to those activities that enable a muscle to reach maximal force in the shortest possible time" (Baechle & Earle, 2008, s. 414). In practice plyometric is a powerful and quick movement that are using a pre-stretch or countermovement that involves the SSC. It is a way to increase an athlete's ability to use the SSC to produce power. Studies have showed that plyometric training can increase the ability to produce lower limb power in athletes (Andrejic, 2012; Hewett, Stroupe, Nance, & Noyes, 1996; Roopchand-Martin & Lue-Chin, 2010; Sáez-Sáez de Villarreal, Requena, & Newton, 2010), however in a study done by Lehnert, Hulka, Maly, Fohler and Zahalka (2013) no increase in lower limb power could be measured after a 6-week plyometric training program.

The intensity of plyometric training can vary depening on exercise. From putting very low stress on the body to very high stress. This should be taken into consideration when choosing the exercise (Baechle & Earle, 2008).

Plyometric exercises are used by athletes in training to improve the ability to produce power and subsequently also their sprinting ability. To better understand the relationship between sprinting and jumping studies have been performed to understand which jumps have the strongest relationship to different distances and phases of a sprint. The jump showing the strongest relationship to a specific sprint distance or phase could be the best to use in training to improve performance on this sprint distance or phase. Two commonly used plyometric exercises used both in training and in research are the counter movement jump (CMJ) and the drop jump (DJ) (Alemdaroğlu, 2012; Baechle & Earle, 2008; Comfort et al., 2013; Cronin et al., 2005; Habibi, et al., 2010; Holm et al., 2008; Markström et al., 2013; Maulder et al., 2005; McCurdy et al., 2010; Meylan et al., 2009; Shalfawi et al., 2011; Wislöffet al., 2004; Young & Elliot, 2001). These can be performed either bilateral or unilateral.

Unilateral jumping

Many studies have examined the relationship between bilateral jumps and sprints (Alemdaroğlu, 2012; Cronin et al., 2005; Meylan et al., 2009; Shalfawi et al., 2011; Wislöff et al., 2004). However few studies have examined the relationship between unilateral jumps and sprint. As sprinting is done unilateral with drive-off on one leg, a possible better training effect could be seen when performing jumps unilateral to increase sprinting performance.

Król and Mynarski (2012) have found that trained junior athletes jump higher when performing a DJ than when performing a CMJ (38.7 vs 37.4 cm).

Comfort et al., (2013) assessed the reliability of performance of the bilateral CMJ found a good reliability (ICC=0.99). Shalfawi et al. (2011) also found a good between-trial reliability (ICC=0.98) for bilateral CMJ. Unilateral CMJ have also showed good reliability (ICC=0.86) when Maulder et al. (2005) tested the test-retest reliability. Maulder et al. (2005) tested the test-retest reliability of the dominant leg and the non-dominant leg and found that the dominant leg had better reliability than the non-dominant leg (0.95 vs. 0.86) when performing a unilateral CMJ.

Sprinting has shown good relability in studies. Comfort et al. (2013) found a ICC value for 5 m of 0.87. Meylan et al. (2009) showed that 10 m sprinting showed a good within-trial reliability (ICC=0.91). In Shalfawi et al. (2011) study the between-trail reliability for 20 m sprint was good (ICC=0.99).

Relationships between sprints and jumps

A DJ are using the SSC faster than a CMJ are (Markström et al., 2013) and could have stronger relationship later on in a sprint than a CMJ, after the acceleration phase. Later in a sprint, when getting closer to maximal velocity the ground contact time decreases (Markström et al., 2013) and there is less time available for the SSC along with the regular contractile units to produce force (Cormie et al., 2011a), the SSC is used faster. In line with this McCurdy et al. (2010) found a weak relationship between unilateral and bilateral DJ and 10 m sprint time. Though they found a weak relationship between unilateral and bilateral DJ and 25 m sprint which contradicts the theory about stronger realtionships between DJ and later sprint performance (McCurdy et al., 2010).

Jump displacement (m) as a measure of DJ perfomance (McCurdy et al., 2010) is rarely used in studies. Instead jump displacement (m) divided with ground contact time (s) is more commonly used (Cronin et al., 2005; McCurdy et al., 2010; Young et al., 2001). This is done as the subject should strive for as short ground contact time as possible (Cronin et al., 2005; Holm et al., 2008; Markström et al., 2013; McCurdy et al., 2010). Though even when jump displacement divided with ground contact time is used there have been no strong relationships between DJ and sprinting, neither between bilateral nor unilateral DJ (Cronin et al., 2005; McCurdy et al., 2010). To the authors best knowledgeh only one study have been examining the strength of the relationships between unilateral DJ using jump displacement as a measurment and sprint performance and further research is needed (McCurdy et al., 2010).

More studies have examined the relationship between CMJ and sprinting. Cronin et al. (2005) found a strong negative relationship between bilateral CMJ and 5 m sprints. The relationship between bilateral CMJ and 10 m sprints are well examined and strong relationships have been found (Cronin et al., 2005; Meylan et al., 2009;; Wislöff et al., 2004). McCurdy et al. (2010) examined the relationships between unilateral CMJ and 10 m sprints and found weak positive relationships for the left leg and a weak positive relationship for the right leg. They also examined the relationship between unilateral CMJ and 20 m sprints and found a weak negative relationship for the left leg and a strong negative relationship for the right leg (McCurdy et al., 2010). McCurdy et al. (2010) does not give any distrubutional information about dominant and non-dominant leg of the subject so no theories can be drawn that the dominant leg or the non-dominant leg would better predict sprint performance based on their study. The relationship between bilateral CMJ and 30 m sprint have also been examined and both weak negative relationships have been found (Cronin et al., 2005) and strong negative relationships (Alemdaroğlu, 2012; Wislöff et al., 2004). Bilateral CMJ can be seen to have a strong relationship with short sprinting and especially as short as 10 m sprint. No strong relationships has been seen between unilateral CMJ and sprinting and further studies are needed.

Aim

The aim of this study was to examine which one of the two tests, unilateral CMJ and unilateral DJ, that have the highest correlation with short sprinting performance.

Hypothesis

Up to 10 m the unilateral countermovement jump is hypothesised to have higher negative correlations with sprinting performance than unilateral drop jump has. The longer the sprint the higher negative correlation will be found between the unilateral drop jump and sprinting.

Methods

Subjects

14 local soccer players playing at a high national junior level were recruited. To be included in the study the subjects had to be an active soccer player with experience from physical training. Subjects with any current or previous injury that inhibited the ability to perform any of the test in the study were excluded.

Study design

The subjects attended three test session. At the first session they were introduced to the study and anthropometric data was collected. At the second session sprint tests were performed and at the third session the two jump tests were performed. The subjects were instructed to not participate in any strenuous activities the 24 hours before the second and third session.

Sprint tests

The sprint tests were performed in a gym hall. Before the sprints a standardized warm-up were performed. The subjects did a 15 minute run at 60-70 % of self-estimated maximal heart rate followed by 5 accelerations over 40 m (Shalfawi et al., 2011).

Two trials with two maximal sprint tests were performed (Alemdaroğlu, 2012; McCurdy et al., 2010) with a three minutes rest in between the sprints (Alemdaroğlu, 2012; Habibi et al., 2010; Vetter, 2007). The best result obtained from the two trials was used (Comfort o.aet al., 2013; McCurdy et al., 2010; Vetter, 2007; Wislöff et al., 2004). Sprinting time was measured with MuscleLab's Timing gates (Musclelab, Ergotest, Norge). The photocells was placed at 0 m (start cell), 5 m, 10 m, 15 m (stop cell), 20 m, 25 m & 30 m (stop cell). Only four photocells could be used per sprint why two trials had to be performed. The subjects was instructed to run as fast as they could all the way to the last photocell and to not decelerate until they had passed the last photocell (McBride et al., 2009). They were instructed to have a three-point support before starting the sprint, support from both feet and one hand, thus minimizing the risk for an arm to start the time prematurely (McBride et al., 2009). They started from the start line, to avoid that non-measured initial acceleration were performed. No verbal instructions or encouragement was given during the sprint trials (McBride et al., 2009).

Jump tests

At the second test session after the sprint tests the subjects were allowed two learning jumps for familiarization of the unilateral CMJ and unilateral DJ.

The unilateral CMJ starts from an upright standing position and is initiated with a lowering of the hips. Then a fast transfer from the lowering action to an explosive upward movement is made and the upward movement then ends with a jump. During the unilateral CMJ the subjects were instructed to maximize height and have a quick reversal from the eccentric to the concentric phase. They were instructed to keep their hands on their waist and to not use their swing leg so that only the stance leg was used to drive the body (Alemdaroğlu, 2012; Comfort et al., 2013; Cronin et al., 2005; Habibi et al., 2010; Maulder et al., 2005; McCurdy et al., 2010; Meylan et al., 2009). The subjects were instructed to be in a position that felt natural and normal for them at the end of the eccentric phase and to keep their hands on their waist (Young et al., 2001).

The starting position of a unilateral DJ is up on a 20 cm high box (Holm et al., 2008; McCurdy et al., 2010), the height off the box is dependent on how much load is wanted. The higher the box the higher the load. The jump is initiated with an horizontal step out and then a drop to the ground. When reaching the ground minimal ground contact time should be pursued, then jumping for maximal height (Baechle & Earle, 2008). During the unilateral DJ the subjects were instructed to step out and drop to the floor, minimizing contact time before jumping as high as possible (Cronin et al., 2005; Holm et al., 2008; Markström et al., 2013; McCurdy, o.a et al., 2010; Young et al., 2001).

The jumps was performed during soccer practice and no standardized warm-up was performed. The jumps that were performed was unilateral DJ and unilateral CMJ. First the unilateral CMJ was performed and then the unilateral DJ. Two maximal jumps of every jump were performed with 3 minutes rest between the sessions (Habibi et al., 2010; Markström et al., 2013; Vetter, 2007). The best results was used (Vetter, 2007; Wislöff et al., 2004). The unilateral jumps were only performed on one side. The subjects were asked which foot they preferred when shooting a ball and this side was chosen as their dominant side and was used during the jumps (Maulder et al., 2005; Meylan et al., 2009). Jump height was measured with an IR-carpet (SH sport & Fitness, Mora).

Statistical analysis

The data was tested for normality using Shapiro-Wilks test of normality and the data showed non-normal distribution why non-parametric statistics were used. Descriptive data is presented with median and min-max. To study the correlation between the two jumps and sprinting time the Spearman correlation coefficient was used (r_s). A r_s-value of ≥ 0.6 was considered to be a strong correlation and a r_s-value of < 0.6 was considered a weak correlation (Thomas, Nelson, & Silverman, 2011). For the statistical analysis SPSS v.20 (IBM Corp., Armonk, NY, USA) was used.

Correlations will be calculated between the two jumps, unilateral CMJ and unilateral DJ and the sprints, 0-5 m, 0-10 m, 0-20 m, 0-30 m and 25-30 m. 25-30 m will be used as an more independent measurment of late sprint performance. A negative correlation means that the higher you jump the faster you sprint and vice versa. A positive correlation means that the higher you jump the slower you sprint or the lower you jump the faster you sprint.

Ethical and social considerations

To take part in the study all the subject had to give their consent to take part in the study by signing an informed consent before the tests were performed.

This study was performed on humans, thus some special considerations had to be made regarding the social and ethical aspects. According to law, the integrity of the individual should always be protected so usage and storage of personal data must be done safely. Personal data should therefore never reach a third hand party. Also the individual must give clearance to allow the researcher to use the data and the data that have been collected most be relevant. Clearance to use the data can be given as part of an informed consent. There are also a few demands that has to be met when performing research on humans. The research can only be approved if it can be done with respect for the human value. Human rights should always been taken into consideration and the human welfare should always be more prioritised than the needs of the society and the science. The research should not be approved if it can be done in another way that would put the subjects under less risk. The researchers must have enough scientific expertise (SFS 2010:1969; SFS 2003:460).

Coaches and athletes will be able to use the information from this study to optimize their training. Considering how small the differences are in elite sport every detail can be important and lead to a win instead of a loss.

A sedentary lifestyle have been linked to several diseases, for example cardiovascular diseases (Katzmarzyk, Church, Craig, & Bouchard, 2009). Physical activity is a well known way to reduce the risks that comes with a sedentary lifestyle. It reduces the sedentary and acts agaisnt the diseases that are linked to a sedentarty lifestyle.

Results

14 subjects age 17 to 19 performed the sprint tests while only ten subjects performed all three tests. Four subjects did not attend the jump trials. The subjects are described in table 1.

Table 1. Descriptive statistic of the participants (n=10)

Variable	Median	Min	Max
Age (years)	18	17	19
Weight (kg)	70	61	82
Length (cm)	180	169	190

The results from the sprint and the two jump tests are presented in table 3. The subjects ran 10 m on a median time of 1.96 s and ran 30 m on a median time of 4.58 s The subjects jumped higher during the unilateral DJ than during the unilateral CMJ, with a median of 23.00 vs 21.25.

Table 3. Results from the sprint and the two jump tests.

	Median	Min	Max
Sprints (n=14)			
0-5 m (s)	1.22	1.06	1.35
0-10 m (s)	1.96	1.85	2.22
0-15 m (s)	2.67	2.50	2.94
0-20 m (s)	3.36	3.06	3.66
0-25 m (s)	3.97	3.67	4.23
0-30 m (s)	4.58	4.25	4.89
25-30 m (s)	0.65	0.58	0.76
Jumps (n=10)			
UCMJ (cm)	21.25	18.20	35.40
UDJ (cm)	23.00	35.40	32.30

UCMJ = Unilateral countermovement jump. UDJ = Unilateral drop jump

No strong correlations between the unilateral CMJ or the unilateral DJ and the different sprint distances were found, all correaltions were considered as weak. The correlations between unilateral CMJ and the sprint distances ranged from -0.30 – 0.09 and between the unilateral DJ and the sprint distances from -0.18 – 0.30. All correlations are presented in table 4.

Table 4. Correlations between the different sprint distances and UCMJ & UDJ, presented in r_s.

	UCMJ	UDJ
0-5 m	-0.01	0.07
0-10 m	0.07	0.17
0-20 m	-0.05	-0.18
0-30 m	-0.30	-0.13
25-30 m	0.09	0.30

UCMJ = Unilateral countermovement jump. UDJ = Unilateral drop jump

Neither unilateral CMJ nor unilateral DJ showed a strong negative relationship with short sprinting performance (<10 m) nor maximal speed (>20 m and 25-30 m). Unilateral CMJ did not show a strong negative relationship with short sprinting performance. Unilateral DJ did not correlate higher the longer the sprints were.

Discussion

The aim of this study was to study which of the two jump tests, unilateral CMJ and unilateral DJ, which correlated strongest with sprinting performance. This study showed no strong relationships between any of the two jump tests and any of the sprint distances. The current study indicates that there does not exist any strong relationships between the two jumps, unilateral CMJ and unilateral DJ, and sprinting on distances between 10 m and 30 m.

The strongest relationships was $r_s = 0.30$ and $r_s = -0.30$. As a value above $r = 0.60$ was considered a strong relationship neither of this relationships can be considered to be strong. Considering the explanation factor (r^2), that is how much of the results that can be explained by the existing relationships, is 0.09, meaning 9 %, none of the jump tests can be said to predict sprinting performance or vice versa.

Result discussion

Strong relationships have been found between bilateral CMJ and 5 m sprint (r = -0.60) as well as 10 (r = -0.61 – -0.72) and 30 m (r = -0.56 – -0.60) sprint. An existing strong relationship between these variables are quite well established (Alemdaroğlu, 2012; Cronin et al., 2005; Meylan et al., 2009; Wislöff et al., 2004). Interestingly McCurdy et al. (2010) found a strong negative relationship between unilateral CMJ performed on the right leg and 25 m sprint (r = -071). No strong relationships was found between unilateral CMJ performed on the left leg and 25 m sprint (r = -0.42) as well as no strong relationships between unilateral CMJ, performed on both right and left leg, and 10 m sprints (r = -0.02 and -0.10). The results from this study somewhat reflects the results that McCurdy et al. (2010) got from their correlations with unilateral CMJ, with no strong relationships found in this study. Unilateral CMJ was hypothesised to correlate strong with short sprinting (10 m). This because of the strong relationships between 10 m and both bilateral and unilateral CMJ that previous studies have shown (Cronin et al., 2005; McCurdy et al., 2010; Wislöff et al., 2004). As well as the longer ground contact time that is available in the beginning of a sprint as well as during a CMJ (Markström et al., 2013). This study did not find a strong relationship between 10 m sprint and unilateral CMJ.

In line with earlier research this study did not show any strong relationships between any sprint distances (0-30 m) and unilateral DJ (McCurdy et al., 2010). McCurdy et al. (2010) correlated unilateral DJ with 10 m and 25 m. For 10 m they found a value of r = -0.10 for the left leg and a value of r = -0.02 for the right leg. For 25 m they found a value of r = -0.03 for the left leg and a value of r = -0.12 for the right leg. McCurdy et al. (2010) found slightly stronger negative relationships but this study is in line with their results considering unilateral DJ and sprint. Cronin et al. (2005) tested bilateral DJ from a 40 cm box and jump displacement through ground contact time as the measurement of DJ performance. Between 10 m sprint and bilateral DJ they found a value of r = -0.38 and between 30 m sprint and bilateral DJ they found a value of r = -0.34 (Cronin et al., 2005).

Unilateral DJ was hypothesised to have a stronger negative correlation the longer the sprint distance was. The hypothesis was based on the short amount of time available to produce force both close to maximal speed during sprinting and during a DJ, because of the short ground contact time (Cormie et al., 2011a; Markström et al., 2013). Other factors than ground contact time, technical and physical (Grimshaw et al., 2007), can affect the performance in both sprinting and jumping and it could be that the effect of this other factors are stronger during a DJ then during a CMJ and that is why DJ does not correlate as strong as CMJ does with sprinting. Unilateral jumps have shown to not correlate as strong with sprinting as bilateral jumps despite that during sprinting one leg is used at the time. The reasons behind this needs to be further examined.

The subjects jumped slightly higher in average when performing the unilateral DJ than when performing a unilateral CMJ. This is in line with earlier research (Król et al., 2012).

Comfort et al. (2013) tested well-trained youth soccer players with a mean age of 17,2 years on 5 and 20 m sprint. They sprinted faster than the subject in this current study on both 5 and 20 m (1.00 s vs. 1.22 s and 3.00 s vs 3.36 s). The subjects in Comfort et al. (2013) study had just finished a power mesocycle which can partly explain why they performed better on the sprints compared to the subjects in this current study. Unfortunatly did the subjects in Comfort et al. (2013) study perform bilateral jumps and their jump performance can't be compared with the subjects from this current study.

Method discussion

DJ are a commonly used plyometric exercise that, depending on the height of the box, can put high stress on the practitioner's body and can be regarded as a high level exercise. DJ are used to increase lower body power output which is crucial for performance during sprinting (Baechle & Earle, 2008). Despite the fact that plyometric exercises can increase the ability to produce power (Andrejic, 2012; Hewett et al., 1996; Roopchand-Martin et al., 2010; Sáez-Sáez de

Villarreal et al., 2010), no studies have, to the authors best knowledge, found any strong relationships between vertical DJ and sprinting, no mather if using jump displacement or jump displacement/ground contact time as a value (Cronin et al., 2005; McCurdy et al., 2010; Young et al., 2001).

In line with the results from McCurdy et al. (2010) this study suggest that there does not exist any strong relationship between unilateral CMJ and shorter sprints. Though a few methodological errors has to be taken into consideration and which can have affected the results.

DJ performance are rarely measured in jump displacement in studies, instead jump displacement through ground contact time are more commonly used (Cronin et al., 2005; McCurdy et al., 2010; Young et al., 2001). It may have been better to use this way to measure DJ performance to have more results from previous studies to compare the results from this study with. Jump displacement through ground contact time may have been a more exact measurment of performance. Though this way to measure was not considered before the testings began because of the lack of ability to measure ground contact time with the IR-carpet. But a camera could have been used to record the jumps and then use the recordings to analyze the jumps as a way to measure the ground contact time.

All jumps were performed on only one leg, the dominant, defined as the one the soccer players preferably used to kick the ball. Tests on both the left and the right leg would have been interesting, for example to see if . The dominant leg was used as Maulder et al. (2005) found that the dominant leg was more reliable during unilateral CMJ than the non-dominant leg.

The sprints were performed in a gym hall that had to be shared. As such only half the gym hall could be used for the sprint tests. Even as the hall was used in a diagonal way the goal photo cell (30 m) was pretty close to a wall were a soft mat was put to limit impact in case anyone would not be able to stop. The subjects was told to sprint for the entire distance but it was both visibly observed and noticed in the data that some began to brake before the goal photo cell (30 m). As well-trained atheltes on sprinting most of the subjects should not have reached the deceleration phase before sprinting for 30 m (Baechle & Earle, 2008). As some decelerated before the goal photo cell (30 m) this affected both the 0-30 m time and the 20-30 m time, thus effecting the correlations on these distances.

As the subjects wasn’t experiences with unilateral jump exercises prior to the study, a learning session included to limit errors in the performance. Even with the learning session the subjects were not comfortable with the unilateral jumps. Why two jumps per trial may not have been the best option. Some studies have used a model were the subjects jump until a plateau is reached in performance (Holm et al., 2008; Markström et al., 2013). To limit a potential learning effect this model could have been prefered since the subjects were inexperienced with unilateral jump exercises. As it was performed now the subjects might not have reached their maximal jump height. This could have affected the correlations.

Conclusion

A correlation study was performed to examine the relationship between unilateral CMJ, unilateral DJ and sprint distances between 5 and 30 m. The results showed no strong relationships between the jumps and any of the sprint distances. Therefore neither of the jumps can be said to better predict sprint performance on any distances up to 30 m. Neither can the results from this study be of use to recommend any of the jumps before the other in training as plyometric exercises to improve performance on the acceleration phase nor on the top-speed phase.

References

Alemdaroğlu, U. (2012). The relationship between muscle strength, anaerobic performance, agility, sprint ability and vertical jump performance in professional basketball players. *Journal of Human Kinetics, 31,* 149-158.

Andrejic, O. (2012). The effect of a plyometric and strength training programme on the fitness performance in young basketball players. *Physical Education and Sport, 10*(3), 221-229.

Baechle, T. R., & Earle, R. W. (2008). *Essentials of strength training and conditioning* (3 ed.). Champaign, IL: Human Kinetics.

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *Journal of Sports Sciences, 24*(7), 665-674.

Comfort, P., Steward, A., Bloom, L., & Clarkson, B. (2013). Relationships between strength, sprint and jump performance in well-trained youth soccer players. *Journal of Strength and Conditioning Research, 28*(1), 173-177.

Cormie, P., McGuigan, M. R., & Newton, R. U. (2011a). Developing maximal neuromuscular power Part 1- Biological Basis of Maximal Power Production. *Sports Medicine, 41*(1), 17-38.

Cormie, P., McGuigan, M. R., & Newton, R. U. (2011b). Developing maximal neuromuscular power part 2- training considerations for improving maximal power production. *Sports Medicine, 41*(2), 125-146.

Cronin, J. B., & Hansen, K. T. (2005). Strength and power predictors of sports speed. *Journal of Strength and Conditioning Research, 19*(2), 349-357.

Gissis, I., & Papadopoulos, C. (2006). Strength and speed characteristics of elite, subelite and recreational young soccer players. *Research in Sports Medicine*, *14*, 205-214.

Grimshaw, P., Lees, A., Fowler, N., & Burden, A. (2007). *Sport & Exercise Biomechanics.* New York, NY: Taylor & Francis Group.

Habibi, A., Shabani, M., Rahimi, E., Fatemi, R., Najafi, A., Analoei, H., & Hosseini, M. (2010). Relationship between jump test results and acceleration phase of sprint performance in national and regional 100m sprinters. *Journal of Human Kinetics, 23*, 29-35.

Hewett, T. E., Stroupe, A. L., Nance, T. A., & Noyes, F. R. (1996). Plyometric training in female athletes. *The American Journal of Sports Medicine, 24*(6), 765-773.

Holm, D., Stålbom, M., Keogh, J. W., & Cronin, J. (2008). Relationship between the kinetics and kinematics of a unilateral horizontal drop jump to sprint performance. *Journal of Strength and Conditioning Research, 22*(5), 1589-1596.

Katzmarzyk, P. T., Church, T. S., Craig, C. L., & Bouchard, C. (2009). Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Medicine & Science in Sports & Exercise*, *41*(5), 998-1005.

Król, H., & Mynarski, W. (2012). A comparison of mechanical parameters between the counter movement jump and drop jump in biathletes. *Journal of Human Kinetics, 34*, 59-68.

Lehnert, M., Hulka, K., Maly, T., Fohler, J., & Zahalka, F. (2013). The effects of a 6 week plyometric training programme on explosive strength and agility in professional basketball players. *Acta Gymnica, 43*(4), 7-15.

Markström, J. L., & Olsson, C.-J. (2013). Countermovement jump peak force relative to body weight and jump height as predictors for sprint running performance: (in) homogeneity of track and fields athletes? *Journal of Strength and Conditioning Research, 27*(4), 944-953.

Maulder, P., & Cronin, J. (2005). Horizontal and vertical jump assessment: reliability, symmetry, discriminative and predictive ability. *Physical Therapy in Sport, 6,* 74-82.

McArdle, W. D., Katch, F. I., & Katch, V. L. (2010). *Exercis physiology: nutrition, energy, and human performance* (7 ed.). Baltimore; MD: Lippincott Williams & Wilkins.

McBride, J. M., Blow, D., Kirby, T. J., Haines, T. L., Dayne, A. M., & Triplett, T. N. (2009). Relationship between maximal squat strenght and five, ten and forty yard sprint times. *Journal of Strength and Conditioning Research, 23*(6), 1633-1636.

McCurdy, K. W., Walker, J. L., Langford, G. A., Kutz, M. R., Guerrero, J. M., & McMillan, J. (2010). The relationship between kinematic determinants of jump and sprint performance in division I women soccer players. *Journal of Strength and Conditioning Research, 24*(12), 3200-3208.

Meylan, C., McMaster, T., Cronin, J., Mohammad, N., Rogers, C., & Deklerk, M. (2009). Single-leg lateral, horizontal and vertical jump assessment: reliability, interrelationships and ability to predict sprint and change-of-direction performance. *Journal of Strength and Conditioning Research, 23*(4), 1140-1147.

Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sport Science, 21*, 519-528.

Roopchand-Martin, S., & Lue-Chin, P. (2010). Plyometric training improves power and agility in Jamaica's national netball team. *West Indian Medical Journal, 59*(2), 182-187.

Sáez-Sáez de Villarreal, E., Requena, B., & Newton, R. U. (2010). Does plyometric training improve strength performnace? A meta-analys. *Journal of Science and Medicine in Sport, 13*, 513-522.

Shalfawi, S. A., Sabbah, A., Kailani, G., Tønnessen, E., & Enoksen, E. (2011). The relationship between running speed and measures of vertical jump in professional basketball players: a field-test approach. *Journal of Strength and Conditioning Research, 25*(11), 3088-3092.

Sleivert, G., & Taingahue, M. (2004). The relationship between maximal jump-squat power and sprint acceleration in athletes. *European Journal of Applied Physiologi, 91*, 46-52.

Thomas, J. R., Nelson, J. K., & Silverman, S. J. (2011). *Research methods in physical activity* (Vol. 6). Champaign, IL: Human Kinetics.

Vetter, R. E. (2007). Effects of six warm-up protocols on sprint and jump performance. *Journal of Strength and Conditioning Research*, *21*(3), 819-823.

Wislöff, U., Castagna, C., Helgerud, J., Jones, R., & Hoff, J. (2004). Strong correlation of maximal squat strength with sprint performance and vertical jump height in elite soccer players. *British Journal of Sports Medicine, 38*, 285-288.

Young, W., & Elliot, S. (2001). Acute effects of static stretching, proprioceptive neromuscular facilitation stretching and maximum voluntary contractions on explosive force production and jumping performance. *Research Quarterly for Exercise and Sport, 72*(3), 273-279.

SFS 2003:460. *Lag om etikprövning av forskning som avser människor.* Stockholm: Utbildningsdepartementen

SFS 2010:1969. *Personuppgiftslagen.* Stockholm: Justitiedepartementet

Appendix 1

Vill Du delta i en studie om fotbollsspelares sprintförmåga?

Vi är tre studenter från Biomedicin inriktning fysisk träning på högskolan i Halmstad som ska genomföra en studie som examensarbete inför kommande kandidatexamen. Vi vill studera eventuella samband mellan hopp, sprint och knäböj och resultaten från studien kommer att presenteras i tre olika kandidatuppsatser.

Vi vänder oss till Dig som är aktiv fotbollsspelare med vana av fysträning.

Om du kan tänka dig att delta i vår studie innebär det att du behöver komma till labbet på Halmstad Högskola vid 4 tillfällen.

Testerna som kommer att utföras är två olika typer av knäböj, 2 olika typer av hopp samt korta sprinter. Resultaten av studien kan hjälpa oss att veta vad och hur vi ska träna för att förbättra olika delar av en sprint. Huvudman för studien är Högskolan i Halmstad och ansvariga för utförandet av studien är Eric Emanuelsson, Christoffer Sundell & Patrik Svensson.

Genomförande

Studien kommer genomföras under 4 tillfällen, varav det första tillfället är till för att visa övningar som kommer genomföras i studien samt att varje deltagare kommer få pröva på utförande i respektive övning. Andra tillfället ska vi se vad du har för 1RM i de två olika knäböjen, alltså se vilken som är den maximala vikten du klarar i de två lyften. Vid det tredje tillfället, kommer knäböj vid olika belastningar (30, 50, 70 & 90 % av 1RM) mätas. Vid det avslutande testtillfället kommer 3 stycken 30-meters sprinter och hopptester att utföras. Testtillfällena kommer vara placerade inom 1-2 veckor från varandra.

Förberedelse
Om du vill delta ber vi dig avstå från fysisk träning och koffein de närmsta 24 timmarna innan varje testtillfälle.

Ditt Medverkande är helt frivilligt och kan när som helst avbrytas utan angiven anledning. Vid avbrytande av studien kommer din information raderas och inte räknas med i studiens resultat. All data kommer behandlas konfidentiellt och alla resultat redovisas endast på gruppnivå och identifikationer av individerna kommer inte att vara möjligt. Får att få tillgång till Dina egna resultat eller till kandidatuppsatserna, eller om Du har några frågor, är du välkommen att kontakta någon av oss tre testledare enligt nedanstående kontaktuppgifter. All personlig data kommer att raderas efter avslutat arbete.

Tack för din medverkan!

Kontaktuppgifter

Eric Emanuelsson	Christoffer Sundell	Patrik Svensson
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Informerat samtycke

Nedan ger Du ditt samtycke till att delta i en studie om fotbollsspelares sprintförmåga.

- Jag har tagit del av och förstår innebörden av ovanstående information.
- Jag har fått chans att ställa frågor om studien och jag vet vart jag ska vända mig för att kunna ställa ytterligare frågor angående studien
- Jag deltar i denna studie frivilligt och vet att jag när som helst under studiens gång kan avbryta mitt deltagande utan att behöva förklara varför/ange någon orsak.
- Jag ger mitt medgivande till Högskolan i Halmstad att lagra och bearbeta den information som samlas in under studiens gång

…………………… …………………………… …..…………………………..

Datum Namnteckning
Namnförtydligande

……………………………………… ………………………………………..

Under 18 år, målsmans namnteckning
Namnförtydligande

Undertecknad person har gått igenom och förklarat studiens syfte för ovanstående deltagare samt erhållit deltagarens samtycke. Deltagaren har även fått en kopia av informationen.

………………… ..…………………………… ………………………………….

Datum Namnteckning (Testledare)
Namnförtydligande

My name is Patrik Svensson. I have studied Exercise Biomedicine at Halmstad University.

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