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Research article

THE RELATIONSHIP BETWEEN JUMP PERFORMANCE, SPEED AND COD SPEED IN ELITE FEMALE SOCCER PLAYERS

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Abstract. *The purpose of this study was to present the physical performance of elite female soccer players and to analyze the relationship between jump performance, speed and COD ability. Sixteen elite female soccer players (age: 20.05±2.85; height: 166.47±4.83cm; body weight: 60.52±8.30kg, BMI 21.88±2.86) from a women's club who played the highest rank of the competition took part in this study. The jump, speed and COD abilities of each player were determined using: (1) the Squat jump (SJ), (2) Countermovement Jump (CMJ), countermovement jump with arm swing (CMJA), (2) running speed at 30-m with passing time at 10m and 20m, (3) the pro agility test (pro), (4) zig-zag test (zig-zag), (5) 9-6-3-6-3 sprint (9-6-3-6-9). The results of Pearson's correlation indicated moderate significant relationships between the 10m running speed and pro agility test (r=0.59; p<0.01), as well as the zig-zag test (r=0.55; p<0.01), and also between the 30m and all COD tests (pro agility r=0.66; p<0.01, zig-zag r=0.59; p<0.01 and 9-6-3-6-9 r=0.58; p<0.05). A small correlation (r=0.49; p<0.03) was noticed between the 10m running test and 9-6-3-6-9 agility test, and also between the CMJA (r=0.45; p<0.05) and the 9-6-3-6-9 agility test. The findings of the present study indicated a significant correlation between speed and all of the COD tests, additionally between the CMJA and 9-6-3-6-9 COD test. Therefore, elite female soccer players with higher maximum acceleration rates and speed tend to perform better in change of direction tests. On the other hand, jump performance does not significantly correlate with COD ability.*

Key words: *Team Sport, Agility, Field-Testing, Explosive Power*

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INTRODUCTION

In the last two decades, women's soccer has developed significantly in terms of quality, which includes better fitness performances and more attractive moves, and quantity, regarding the higher number of matches played during the season and players involved (Hovden, 2012). Therefore, the demands of women's soccer have risen sharply (Martínez-Lagunas, Niessen, & Hartmann, 2014). Today, female soccer players are required to perform more explosive movements, cover greater distances, make changes in intensity and direction (Datson et al., 2017; Milanović et al., 2017). According to Fields, Esco, Merrigan, White, & Jones (2020) the primary goal of training in women's soccer is to achieve optimal performance improvement.

Explosive actions such as jumping, accelerating, deceleration, various sprints with changes of direction (Marcelino et al., 2016) and the ability to repeat these actions identically in competition are key to success in team sports such as soccer (Romero-Moraleda et al., 2021). Furthermore, these explosive actions, such as sprinting, jumping, tackling, and change of direction (COD) have a direct effect on the result of the match (Loturco, Jeffreys, et al., 2020).

COD is a complex skill which is usually defined as the ability to make sudden changes of direction (Chaouachi et al., 2012) and it is conditioned by a large number of different factors, such as linear speed, running technique, strength, and the quality and strength of the leg muscles (Dos'Santos, Thomas, Comfort, & Jones, 2018). Most high-intensity activities take place during crucial moments, such as competitions, offensive and defensive actions, as well as goal-scoring opportunities (Griffin et al., 2020; Strauss, Sparks, & Pienaar, 2019). During one soccer match, players perform numerous sprints with different COD, as well as a large number of jumps and sprints (Trewin, Meylan, Varley, & Cronin, 2018). The ability to change direction is essential for an athlete's success in being able to respond to tasks at different stages of development and in different positions in the game (Brughelli, Cronin, Levin, & Chaouachi, 2008; Goral, 2015; Mujika, Santisteban, Impellizzeri, & Castagna, 2009).

During the performance of COD movement, there are two different types of muscular actions as the body quickly slows down (eccentric action) and accelerates (concentric action) during movement (Chaabene, Prieske, Negra, & Granacher, 2018). Given the possibility of sudden changes of direction, it is considered that COD is a valid way to assess the fitness of soccer players of different ages, genders, and competitive levels (Reilly, Bangsbo, & Franks, 2000). It is known that professional athletes are able to make better use of their linear sprint capacity over curvilinear paths, possibly through optimized inner leg performance and a superior ability to cope with high centripetal forces (Filter et al., 2020; Loturco, Pereira, et al., 2020). Also, muscle strength and the ability to accelerate can determine COD in a population of elite soccer players (Chaouachi et al., 2012). The relation between these abilities may be explained by the fact that sprinting and jumping both require the application of considerable amounts of vertical force onto the ground to rapidly accelerate the body vertically or forward (Colyer, Nagahara, Takai, & Salo, 2018).

There are several studies that analyzed the relationship between different parameters and COD ability in men's soccer (Çinarli, Kafkas, & Kafkas, 2018; R. Hammami, Granacher, Pizzolato, Chaouachi, & Chtara, 2017; Loturco, Jeffreys, et al., 2020; Raya-González et al., 2020), while few authors investigated female soccer players (Kobal et al., 2021; Lockie, Dawes, & Jones, 2018; Pardos-Mainer et al., 2021) or other female athletes, such as volleyball, handball, basketball, and softball players (Banda, Beitzel, Kammerer, Salazar, & Lockie, 2019; Lockie, Dawes, & Callaghan, 2020; Nimphius, Mcguigan, & Newton, 2010; Pereira et al., 2018). The results of the mentioned studies had inconsistent and heterogeneous results. Lockie et al. (2018) investigated how linear speed and leg power may influence COD ability in NCAA Divisions I and II women soccer players and found divergent results. In the Division I players, the modified T-test (MTT) did not significantly relate to the 10m sprint or any of the jump variables (r=0.18), while the 505 test positively correlated with the 10m sprint (r=0.35), and negatively correlated with jump height (r=0.65). For the Division II players, the MTT had large relationships with the 10m sprint and jump (r=0.66). The 505 had large relationships with the 10m sprint (r=0.55) and all the jump variables (r=0.66). Kobal et al. (2021) studied the relationships between linear sprint, curve sprint, COD, and jump performances in elite female soccer players. They reported that jumping ability was significantly correlated with linear sprint (r=0.45-0.55) and curve sprint performance (r=0.56-0.64), but not with COD performance, where only one COD test (r=0.21-0.32) was used.

However, the mentioned studies used one or a small number of tests to determine COD ability and a wide range of participants. In addition, they did not have an elite sample. In this regard, some authors believe that COD has multiple qualities, including more physical and technical aspects where, affected by performance in addition to the production of force (Dos' Santos, McBurnie, Thomas, Comfort, & Jones, 2020).

Therefore, the purpose of this study was to present the physical characteristics of elite female soccer players and to analyze the relationship between jump performance, speed and COD ability, as well as the correlation between these abilities and COD ability. It was hypothesized that the analysis would show a moderate to strong relationship between jump performance, speed and COD ability.

METHODS

Participants

Sixteen elite female soccer players (age: 20.05±2.85; height: 166.47±4.83cm; body weight: 60.52±8.30kg, BMI 21.88±2.86) from a women's club who played the highest rank of the competition took part in the study. Prior to examination, the participants were informed about the protocol both in writing and verbally, about the possible risks and benefits of the study, as well as about the possibility of withdrawing at any time during the study. All the players and their guardians gave written consent for voluntary participation in the testing. The study was approved by the local university (code: 04-921) and followed the ethical standards of The Declaration of Helsinki for the study of humans. Players who were recruited had at least 5 years of experience in playing soccer; had a general training history (more than four times per week) in the previous 12 months; were currently training soccer (more than 7 h per week); and did not have any existing medical conditions that would compromise their participation.

Procedures (Study Design)

All the athletes were informed about the complete procedure. On every occasion, all tests were performed on an open field with a natural, grassy surface of the mentioned club in the morning hours (9am-11am). Prior to the tests, the athletes had a warm-up that included a general and a specific part which lasted 20 minutes. The first part was running for 10 minutes, then 5 minutes of stretching, and then a specific part in the form of progressive running, change of direction, and plyometrics that lasted 7 minutes. The order of the tests was as follows: (1) the Squat jump (SJ), (2) Countermovement Jump (CMJ), countermovement jump with an arm swing (CMJA), (2) running speed at 30m with passing time at 10m and 20m, (3) the pro agility test (pro), (4) zig-zag test (zig-zag), and (5) 9-6-3-6-3 sprint (9-6-3-6-9).

Measurement

Anthropometry

Height and body weight were measured to the nearest 0.1cm using a Martin anthropometer (GPM in Switzerland), and to the nearest 0.1kg using a calibrated balance beam (Avery Ltd, Model 3306 ABV).

Vertical Jumps (SJ, CMJ, CMJA)

Vertical jumps were assessed by using the squat and countermovement jumps. The squat jump (SJ) consisted of a standing position with knees flexed at 90 degrees, hands on the waist. With no help of the upper limbs, the player should jump and extend the legs, falling in the same place. The players waited 3s in the squat position before each jump. The countermovement jump (CMJ) started in a standing position with hands on the waist, realized with flexion of the legs and simultaneously with the jump, the legs will be extended and fall in the same place. While the CMJA jump procedure was the same as for the previous jump, only the hands were free during all the phases of the maximum jump. For each movement, three trials were executed, with a rest period of 30s between them. The SJ, CMJ, and CMJA were tested with an optical measurement system consisting of a transmitting and receiving bar (Optojump, Microgate, Bolzano, Italy). The outcome extracted in each trial was the jump height (cm). For each measure, the highest jump was taken into consideration for data analysis. The validity and reliability of these tests have been confirmed in research (Glatthorn et al., 2011).

Speed (running 0-30m)

The running speed of the players was determined using the time at 10, 20, and 30m using infrared timing gates, 30m sprint effort with photocell gates (Microgate, Polifemo Radio Light, Bolzano, Italy) placed 0.4m above the ground, with an accuracy of 0.001s. The timer was automatically activated as the participants crossed the first gate at the starting line with split times at 10m and 20m. The players were instructed to run the 30m distance as quickly as possible from a standing start (crouched start positioned 0.5m behind the timing lights). Acceleration was evaluated using the time to cover the first 10m of the 30m test. The participants performed two trials with at least 3 minutes of rest between them. The best performance of the two tests was used for further analysis. The 30m sprint was previously used to estimate linear speed in a study by Nimphius, Callaghan, Spiteri, & Lockie (2016).

COD ability (Pro agility, Zig-zag, 9-6-3-6-9)

Pro Agility Test

The Pro agility or 5-10-5m test measures the ability to change direction laterally to the right and left. A player assumes the starting position, legs spread laterally on the midfield. Each participant had the choice to choose a side for the sprint (right or left) on the first attempt. In the second attempt, the opposite direction was used. The test starts with a player sprinting 5m and touching the line with their foot, turning 180 degrees, and sprinting 10m to the second outside line and touching it with their foot. The test was completed by performing another 180-degree turn and sprinting back over the midline. The validity and reliability of the test were confirmed in research (Mann, Ivey, Mayhew, Schumacher, & Brechue, 2016).

9-6-3-6-9 Sprint (with 180 degrees turns)

The distance the players covered during this test was 21m. The players started after the signal and ran 9m. Touching the line with one foot, they made a turn of 180 degrees to the left or right. The players then ran 3m to the next line, made another 180-degree turn, and ran 6m forward. Then they made another 180-degree turn and ran another 3m forward, before making the last turn and the final 9m to the finish. The validity and reliability of the test were confirmed in research (Sporis, Jukic, Milanovic, & Vucetic, 2010).

Statistical Analysis

All statistical analyses were performed using SPSS v. 20 (IBM Corporation; Armonk, NY, USA). Descriptive statistics were calculated for all the previously mentioned data. Pearson's correlation coefficient was used to determine the correlation between all the tests. The magnitude of the correlations was interpreted using the following criteria: <; 0.1, trivial; 0.1–0.3, small; 0.3–0.5, moderate; 0.5–0.7, large; 0.7–0.9, very large; and > 0.9 almost perfect. The level of significance for the correlation analysis was set at $p \leq 0.05$ (Hopkins, Marshall, Batterham, & Hanin, 2009).

RESULTS

Table 1 shows the descriptive data of the physical tests performed by the female soccer players. Table 2 shows Pearson’s correlation coefficients, the p value among the jump and speed tests (SJ, CMJ, CMJA, 10m, 20m, 30m) and COD tests (pro agility, zig-zag, 9-6-3-6-9). Moderate significant relationships were shown between the 10m running and pro agility test ($r=0.59$; $p<0.01$), as well as the zig-zag ($r=0.55$; $p<0.01$), and between the 30m and all COD tests (pro agility $r=0.66$; $p<0.01$, zig-zag $r=0.59$; $p<0.01$ and 9-6-3-6-9 $r=0.58$; $p<0.05$). A small correlation ($r=0.49$; $p<0.03$) was noticed between the 10m running test and 9-6-3-6-9 agility test, and also between the CMJA ($r=0.45$; $p<0.05$) and the 9-6-3-6-9 agility test. All significant correlations for the jump performance and COD tests were negative, which indicated a faster time in the particular sprint test related to a superior jump performance. There were no significant relationships between the COD variables and SJ or 20m running speed.

Table 1 Descriptive data of the tested variables

	Mean ± SD
SJ (cm)	24.24 ± 2.60
CMJ (cm)	25.80 ± 2.86
CMJA (cm)	28.95 ± 3.27
10m (s)	1.90 ± 0.27
20m (s)	3.37 ± 0.17
30m (s)	4.71 ± 0.22
Pro agility (s)	5.17 ± 0.18
Zig-zag (s)	5.81 ± 0.30
9-6-3-6-9 (s)	8.36 ± 0.30

Legend: SJ-squat jump, CMJ-countermovement jump, CMJA-countermovement with free arms, 10m-running speed at 10m, 20m-running speed at 20m, 30m-running speed at 30m, 9-6-3-6-9-agility test (9-6-3-6-9)

Table 2 Pearson's correlation coefficients between jumps, speed, and COD

Variables (n=19)		Pro agility test	Zig-Zag test	9-6-3-6-9
10m	r	0.59	0.55	0.49
	p	0.01	0.01	0.03
	Magnitude	Large	Large	Moderate
20m	r	0.30	0.37	0.34
	p	0.20	0.12	0.16
	Magnitude	Small	Moderate	Moderate
30m	r	0.66	0.59	0.58
	p	0.01	0.01	0.01
	Magnitude	Large	Large	Large
CMJ	r	-0.38	-0.25	-0.42
	p	0.10	0.29	0.05
	Magnitude	Moderate	Small	Moderate
CMJA	r	-0.29	-0.24	-0.45
	p	0.21	0.31	0.05
	Magnitude	Small	Small	Moderate
SJ	r	-0.18	-0.12	-0.23
	p	0.46	0.61	0.34
	Magnitude	Small	Small	Small

Legend: SJ-squat jump, CMJ-countermovement jump, CMJA-countermovement jump with free arms, 10m-running speed at 10m, 20m-running speed at 20m; 30m-running speed at 30m, 9-6-3-6-9-agility test (9-6-3-6-9), p-significant value ($p \leq 0.05$), r-Pearson's correlation.

DISCUSSION

The aim of this study was to analyze the relationships between jump performance, speed, and COD performances in elite female soccer players. The main findings indicated that (1) a moderate relationship were noticed between the 30m running speed and all the COD tests (the Pro agility test r= 0.66, p≤0.01; Zig-Zag test r= 0.59, p≤ 0.01; 9-6-3-6-9 r= 0.58, p≤ 0.01), also between the 10m running speed and all the COD tests (the Pro agility test r= 0.59, p≤ 0.01; Zig-Zag test r= 0.55, p≤ 0.01; 9-6-3-6-9 r= 0.49, p≤ 0.03); (2) players faster in linear speed displayed greater COD; however, no significant relationship was found between the 20m running speed and the COD tests (the Pro agility test r= 0.30, p≤

0.20; Zig-Zag test r= 0.37, p≤ 0.12; 9-6-3-6-9 r= 0.34, p≤ 0.16), the relationship was even close to the mentioned speed tests; (3) only the CMJA was significantly correlated with one COD test (9-6-3-6-9 r= -0.45, p≤ 0.05); however, contrary to the study's hypothesis, there were no significant relationships between the jump tests and pro agility (CMJ r= -0.38, p≤ 0.10; CMJA r= -0.29, p≤ 0.21; SJ r= -0.18, p≤ 0.46) and zig-zag test (CMJ r= -0.25, p≤ 0.29; CMJA r= -0.24, p≤ 0.31; SJ r= -0.12, p≤ 0.61. These results have several implications for the strength and speed of female soccer coaches, which will be discussed below.

There are many actions in soccer that are realized with high intensity, such as jumping, sprinting, and changing direction (Bishop et al., 2021; Gonzalo-Skok et al., 2017). As previously acknowledged, several studies have detailed significant relationships between jump performance and speed with COD (Kobal et al., 2021; Lockie et al., 2018; Pardos-Mainer et al., 2021). Interestingly, the results from our study provided support for some studies (Freitas et al., 2020; Pardos-Mainer et al., 2021), as each jump test is not significantly correlated with the pro agility and zig-zag tests, while we reported only countermovement jump height with free hands to be related to 9-6-3-6-9. However, our findings are inconsistent with previous research reporting the importance of maximum power and reactive power for the COD performance in female athletes (Nimphius et al., 2010; Young, James, & Montgomery, 2002). In this regard, our findings match the results of Pardos-Mainer et al. (2021) and Freitas et al. (2020) who reported that there was no relationship between CMJ and COD. All correlations for the jump performance and COD tests were negative, which indicated a faster time in the particular sprint test related to a superior jump performance. There were no significant relationships between COD variables and the CMJ, SJ or 20m running speed. The power of the lower-body and reactive strength are considered to be the base when defining COD ability (Lockie et al., 2018). To be able to perform an effective direction change, it is necessary to have eccentric strength in order to decelerate the body, which must be followed by concentric force development for reacceleration in the new intended direction (Spiteri et al., 2015). We reported only a relationship between CMJA and 9-6-3-6-9 tests. A possible reason for this result is using hands in both cases. Furthermore, the use of hands would resemble hand coordination in COD, which corresponds to movements patterns in these tests. More precisely, similar manipulation of the hands is performed when executing a jump and when performing a turn during the mentioned agility test (Braz et al., 2017).

As we have already mentioned, the jumping performance is an important component of a player's ability, because it plays a huge role in defense as well as in offense actions during a soccer match (Wing, Turner, & Bishop, 2020). Although several studies (Lockie et al., 2018; Loturco, Pereira, et al., 2020; McFarland, Dawes, Elder, & Lockie, 2016; Vescovi & Mcguigan, 2008) have found strong relationships between jumping performance and COD, that was not the case in our study. There is no relationship between SJ and any COD tests, which supports the study results of Kobal et al. (2021) who also reported no significant relationship between the zig-zag and SJ (r=0.32). This finding could be explained by the differences in the performance which are thought to reflect an effective utilization of the stretch-shortening cycle (Hammami, Gaamouri, Suzuki, Shephard, & Chelly, 2020). It is concluded that the difference in performance may primarily be related to the higher uptake of muscle slack and stimulation increase throughout the countermovement in a CMJ, as well as elastic energy (Gerodimos et al., 2008). Furthermore, one of the possible reasons for this is that each player has different levels of physical abilities and skills that may be linked to the distance used in the sprint tests (Lockie et al., 2014). These results enhance the complex nature of the connection between tests of physical performance (Raya-González et al., 2020).

Mastering the skill to change direction during sprint is considered to be a very important characteristic in female soccer (Emmonds, Nicholson, Begg, Jones, & Bissas, 2019). The relationship between sprint and agility performance have been also examined by a very few studies (Little & Williams, 2003; Lockie et al., 2018; Loturco et al., 2019). We found a moderate relationship between the 30m sprint and all COD tests (pro agility r=0.66, zig-zag r=0.59, 9-6-3-6-9 r=0.58). Although there was no study with female participants, Sporiš, Milanović, Trajković, & Joksimović (2011) analysed male soccer players and also found moderate correlation between the 30m sprint and zig-zag test (r=0.56). In this regard, Popowczak et al. (2019) reported relationships between the 30m sprint and the COD (r=0.60). In addition, our results, along with the mentioned ones, are not in accordance with Freitas et al. (2020), who did not find a significant relationship (r=0.23) between speed and COD tests. A possible reason for our result is the similar duration of running speed at 30m and the duration of COD tests. In order to reach a greater speed over short periods of time, athletes must be able to effectively accelerate over short distances, which could lead to performing with significant amounts of force to the ground to be able to overcome the total moment of inertia (Loturco et al., 2019). As a result, it is expected that players who showed higher maximum acceleration rates would be more likely to achieve better quality performances in linear sprints up to 30-m.

Brown, Ferrigno, & Santana (2005) have described acceleration as a change in velocity in a unit of time. In other words, it is essential to produce maximum force in a minimum period of time (Haff & Triplett, 2015), which can be seen in soccer - like any other sport (Dalen, Jørgen, Gertjan, Havard, & Ulrik, 2016; Ingebrigtsen, Dalen, Hjelde, Drust, & Wisløff, 2015; Mara, Thompson, Pumpa, & Morgan, 2017). Our study reported a relationship between 10m and all COD tests (pro agility r=0.59, zig-zag r=0.55, 9-6-3-6-9 r=0.49), which are among those reported in the literature to date (r=0.39–0.82). In agreement with the results of the current study, Lockie et al. (2018) reported a positive relationship between the 10m sprint and 505 test, as well as the modified T test, in a group of Collegiate soccer players. In a group of professional male soccer players, Little & Williams (2005) reported a weak but significant correlation between the 10m sprint and zig-zag agility test. Similar to that, Köklü, Alemdaroğlu, Özkan, Koz, & Ersöz (2015) also conducted experiments on male soccer players and found a moderate correlation between the 10m sprint and COD test with angles of 100 degrees, which is also the test that we used in this study. The reason for our results may lie in the fact that each agility test contains a running distance of 10m. The sprint time (10m) of elite female players in this study was faster than that previously reported of elite Australian players (1.91±0.04) and close, but a bit slower than that of elite English players (1.87±0.06). Analyzing the correlation between COD and the linear 30m sprint, the pattern of backward movement performed between 15 and 20m allows us to determine the specific skills needed during a soccer match (Popowczak et al., 2019).

Regarding this, we have not found a relationship between the 20m sprint and any of the COD tests, even if the relationship between the mentioned speed tests was close (r=0.37). The differences between studies, most likely, could reflect the use of different agility tests. Likewise, the total time to complete the COD test does not necessarily represent the player's COD ability (Nimphius et al., 2016). Therefore, a player who has a greater linear speed could still perform well on a COD test, due to their sprinting ability which could disguise any deficiencies in COD ability (Emmonds et al., 2019). Better momentum is usually associated with stronger braking and propulsive forces during sequential decelerations and accelerations, and longer contact time with the ground in COD drills (Chaalali et al., 2016). Thus, the entry and exit velocities could possibly be affected during successive COD maneuvers while reducing the efficiency of faster athletes to change of direction (Vescovi & Mcguigan, 2008). In this regard, one of the possible reasons might be technical issues, such as biomechanical adjustments. It is known that players need to change their manner of running from forward (deceleration) to backward (re-acceleration) during COD tests, which requires high-level motor abilities that are of crucial importance among all the skills needed for COD (Popowczak et al., 2019).

There are study limitations that should be mentioned. Despite the fact that COD performance can distinguish between playing levels in male soccer players (Suchomel, Nimphius, & Stone, 2016), there is limited research available on the COD ability of female soccer players. As there is limited data available, the contrast between the studies is further limited by the different testing methods used to assess COD ability (505, T-test, pro agility). It would be of interest to investigate other COD tests, as well as the COD deficit, unilateral, and dynamic strength. Dissimilarities in the length of the lower limbs and body asymmetry have not been taken into consideration in this study; however, these might be important to the manner of speed. Furthermore, the relationships between physical qualities and change of direction performance through different turn angles should be considered. According to Nimphius et al. (2018), COD ability could be influenced by the angle of direction change, and this is probably associated with the physical qualities required for optimal performance. Also, future research should include reactive agility, as an important skill besides agility which is the key skill required for soccer success (Andrašić et al., 2021). Comprehending the physical qualities that could mostly influence COD ability improvements over shorter and longer distances could highlight training efficiency (Lockie, Post, & Dawes, 2019). It is of big importance to consider specific movement patterns before making a training program for team sport athletes (Stanković et al., 2021), in particular those that include eccentric exercises, acceleration and deceleration efforts, which can include specific for COD drills.

CONCLUSION

Elite female soccer players with higher maximum acceleration rates and speed tend to perform better in change of direction tests. On the other hand, jump performance does not significantly correlate with COD ability. In practical terms, this means that they need more time to change direction. Future studies should investigate whether more combined training strategies, such as circuit-training sessions involving eccentric exercises, plyometrics, and successive acceleration-deceleration drills, are able to improve COD in elite female soccer players.

PRACTICAL IMPLICATION

There are several practical applications that can be drawn from this study which could be of great benefit for strength and conditioning coaches. The primary finding of this study is that speed and COD are related abilities. Thus, using the load that maximizes linear sprint abilities can improve the COD performance of elite female soccer players. Therefore, both a conditioning coach and a sport scientist can tailor the physical conditioning more effectively to improve players' performance. Additionally, this supply provides normative data and performance quality for elite female soccer players, so that a conditioning coach can use these particulars to adjudicate standards of physical condition in the preseason and during the season.

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POVEZANOST PERFORMANSI SKOKA, BRZINE I COD BRZINE ELITNIH FUDBALERKI

Svrha ove studije bila je da se predstavi fizički učinak elitnih fudbalerki i da se analizira povezanost između performansi skoka, brzine i COD brzine. U ovom istraživanju učestvovalo je 16 elitnih fudbalerki (uzrast: 20,05±2,85; visina: 166,47±4,83cm; telesna težina: 60,52±8,30 kg, BMI 21,88±2,86) iz ženskog kluba koji igra najviši rang takmičenja. Sposobnosti skoka, brzine i COD svake igračice određivane su korišćenjem: (1) skoka iz čučnja (SJ), (2) vertikalnog skoka (CMJ), vertikalnog skoka sa zamahom rukama (CMJA), (2) brzine trčanja na 30- m sa prolaznim vremenom na 10m i 20m, (3) pro agiliti test (pro), (4) cik-cak test (cik-cak), (5) 9-6-3-6-3 sprint (9-6 -3-6-9). Rezultati Pirsonove korelacije ukazali su na umereno značajnu povezanost između brzine trčanja na 10m i pro agiliti testa (r=0,59; p<0,01), kao i cik-cak testa (r=0,55; p<0,01), kao i između 30m i svi COD testovi (pro agilnost r=0,66; p<0,01, cik-cak r=0,59; p<0,01 i 9-6-3-6-9 r=0,58; p<0,05). Uočena je mala korelacija (r=0,49; p<0,03) između testa trčanja na 10 metara i testa agilnosti 9-6-3-6-9, kao i između CMJA (r=0,45; p<0,05) i 9- 6-3-6-9 test agilnosti. Nalazi ove studije ukazali su na značajnu korelaciju između brzine i svih COD testova, dodatno između CMJA i 9-6-3-6-9 COD testa. Stoga, elitne fudbalerke sa većim maksimalnim ubrzanjem, kao i brzinom, imaju tendenciju da bolje rade testove promene smera. S druge strane, performanse skoka nemaju značajnu korelaciju sa sposobnošću COD-a.

Ključne reči: *timski sport, agilnost, terensko testiranje, eksplozivna snaga*