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Change of Direction Ability

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Relationship among the Change of Direction Ability, Sprinting, Jumping Performance, Aerobic Power and Anaerobic Speed Reserve: A Cross-Sectional Study in Elite 3x3 Basketball Players

by
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The main purpose of this study was to determine the relationships among sprinting performance, change of direction ability (COD), change of direction deficit (CODD), and aerobic power expressed by maximal oxygen velocity (V_{max}IFT), anaerobic speed reserve (ASR) as well as jumping performance (countermovement jump with (CMJa) and without an arm swing (CMJ)) in elite 3x3 basketball players. A total of 15 Polish Olympic 3x3 team players (age: 26.86 ± 8.28 years; body height: 191 ± 5.33 cm; body mass: 90.68 ± 10.03 kg, basketball experience: 15.53 ± 5.8 years) participated in the study. Athletes were tested for the following measures: the linear speed at the first section (5 m), the second section (9 m), the third section (10 m) and total distance (24 m), two sets; the 30-15 Intermittent Fitness Test (first session); COD speed by the Change of Direction and Acceleration Test (CODAT) (the same sections and total distance as in the linear speed test), five repetitions, two sets; and jumping performance by the CMJ with and without an arm swing (second session). CODD was calculated by subtracting the COD speed time from linear speed time at adequate sections and total distance. Maximal sprinting speed (MSS), maximal aerobic velocity (V_{max}IFT), and anaerobic speed reserve (ASR) were also considered. Anaerobic Speed Reserve (ASR) was calculated as the difference between MSS and V_{max}IFT. A Pearson's correlation test was used to determine the relationship between power-speed-related variables and CODD, final velocity attained at the 30-15 Intermittent Fitness Test (V_{max}IFT), ASR, and COD performance. Moderate to strong correlations were registered between COD and linear speed at 5, 10, and 24 m, while moderate to strong negative correlations were detected between COD, CODD, and CMJ, CMJa. Moreover, moderate to strong correlations were observed between COD, CODD, and V_{max}IFT, MSS at 9, 10, and 24 m sprints. No relationship was detected between COD, CODD, LS, and ASR in any measured sector. Finally, statistically significant differences were registered in COD and CODD between trial 1 and trial 2.

Key words: *3x3 basketball, locomotor performance, physical fitness.*

Introduction

Basketball is an intermittent sports activity characterized by periods of moderate- and high-intensity movements, including sprinting, backward and sideways running, shooting, rebounding, dribbling, as well as turning and cutting. These activities are usually followed by very short low-intensity periods (Garcia et al., 2021; Mikolajec et al., 2012; Ostojić et al., 2006; Stojanović et al., 2018). Depending on the competition level and playing position, a basketball player may change direction and speed of movement from 550 up to 1000 times during a game (Drinkwater et al., 2008). McInnes et al.

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(1995) and Abdelkrim et al. (2007) state that an elite player performs over 997 ± 183 activities during the game, changing pace and direction of movement every 2 s. The same authors indicate that elite players perform up to 100 sprints at a distance ranging from 3 to 5 m, while lateral movements, usually shuffling, account for 30% of the game time.

More specifically, during a basketball match, around 991 m are covered while performing high-intensity movements, which include 50–60 activities related to changes of direction and sprinting speed (Balčiūnas et al., 2006; McInnes et al., 1995). Additionally, change of direction movements (COD) contain 20.7% of sprinting activity (Conte et al., 2014), which means that every 1–3 s on average, players are required to execute sudden accelerations and decelerations combined with changes of pace and direction (Mathew and Delextrat, 2009; Scanlan et al., 2011; Stojanović et al., 2018). Taylor et al. (2017) discovered that COD activities were very common during a basketball game, and detected that more than 450 lateral maneuvers were made per game. Stojanović et al. (2019) concluded that COD speed (CODs) is one of the most important aspects of physical preparation impacting game outcomes in basketball. Scanlan et al. (2014) observed that linear sprinting at 5, 10, and 20 m was correlated with COD. Delextrat et al. (2015) found that 74.8% of the variance was explained by the linear sprinting speed at 20 m. On the contrary, studies conducted by Loturco et al. (2018) and Pereira et al. (2018) showed that athletes who attained better results in linear sprinting tests were less effective in COD tests. An athlete's ability to change direction quickly is a crucial aspect of team sport-related fitness, but there has been a lot of controversy on how to evaluate and improve this skill (Lockie et al., 2013). Considering the locomotor performance of basketball players, COD ability is perhaps the most significant fitness component in this team sport (Delextrat et al., 2015; Scanlan et al., 2014; Spiteri et al., 2014, 2015).

In recent years, the popularity of 3x3 basketball has essentially increased, and in 2017, this basketball competition was included in the Olympic Program. The first competition at an elite level took place during the Olympic Games in Tokyo 2020. Assuming that it is a relatively new sport, limited information related to the physiological and locomotor game demands is available with a scarcity of studies that have investigated these issues (Conte et al., 2019).

3x3 is an extremely intense sport characterized by high workloads over a relatively short duration, thus one of the most important tasks of the training process is to prepare players to meet these demands. One game lasts 15 to 20 min, and every player has his/her individual average time which he/she spends either playing or sitting on the bench. By analyzing the number of intervals spent in the game or on the bench, the most common duration of activities and rest during a game were determined. The most common intervals are 30–75 s spent in the game and 0–30 s spent on the bench. The average distance covered is 771 m, while the biggest distance is slightly less than 1 km (Lukic and Kamasi, 2019)Game effortrt intensity measured by means of the average heart rate level is 152 bts/min; however, the average heart rate peak is 186 bts/min. The average lactate concentration is about 6 mmol/l. The average player load for 5x5 is 435.3 ± 120.4 units and for 3x3, it is 128.2 ± 39.6 units, but the relative player load is different: 6.7 ± 1.5 for 3x3 and 3.1 ± 0.9 for 5x5. It should be taken into consideration that the number of measured changes of direction in 3x3 basketball is also much higher as it consists of more lateral and backward movements. Two or three games are played in one day at a tournament, which often results in insufficient recovery (Lukic and Kamasi, 2019). Montgomery and Maloney (2018) analyzed data derived from 3x3 elite games and determined that female elite athletes performed 20 vertical jumps, 34 decelerations, 32 accelerations, and 11 changes of direction during a single game. According to male 3x3 basketball players, the statistics were as follows: 24 vertical jumps, 44 decelerations, 34 accelerations, and 15 COD. Whereas 3x3 basketball presents some similarities to traditional 5x5, it is defined by different rules: 3x3 basketball is played on a half-court (15 m width x 11 m length) with one hoop, and the game duration is 10 min (single possession time 12 s). In addition, the team is composed of three starting players and one bench player; players can be substituted without limitations. Taking into consideration all differences listed above, it is not possible to apply traditional basketball data to 3x3 basketball (Conte et al., 2019).

The change of direction deficit (CODD) is a relatively new variable constructed by Nipmhius et al. (2013), that represents the value obtained by subtracting the time of linear sprinting from the time of an adequate COD test. The importance of CODD in the assessment of athletes' ability to change direction was confirmed by Dos'Santos et al. (2019) and Nimphius et al. (2013, 2016). Despite some investigations conducted in this area, the relationship between CODD and the locomotor profile of basketball players has not been fully explained.

The 30-15 intermittent and progressive field-based test is a reliable tool that allow obtaining in much significant information about the general fitness status of the player, especially the athlete's aerobic performance (Buchheit, 2008, 2010). The crucial outcome of the 30-15 IFT is the final velocity used to design high-intensity interval trainng, and can be related to several physical abilities (Buchheit, 2008). It reflects maximal cardiorespiratory function, anaerobic capacity, neuromuscular qualities (Scott et al., 2017), and recovery abilities (Haydar et al., 2011). Some of the authors that presented findings of investigations conducted in this area reported positive correlations between COD ability, repeated sprint performance, lower limb power, and V_{max}IFT results (Buchheit, 2008; Buchheit and Rabbani, 2014; Haydar, 2011; Scott et al., 2017).

Anaerobic Speed Reserve (ASR) is calculated as a difference between maximal sprinting speed (MSS) and maximal velocity obtained during the intermittent fitness test (V_{max}IFT). According to the relationship between V_{max}IFT and ASR, some authors (Sanford et al., 2021) classified the athlete's locomotor profile as follows: speed profile (low V_{max}IFT/large ASR), hybrid profile (both factors at moderate levels) and endurance profile (high V_{max}IFT/low ASR). However, there is a lack of evidence regarding the relationships between kinematic performance (linear speed, change of direction ability (COD), change of direction deficit (CODD), anaerobic speed reserve (ASR), maximal aerobic speed (V_{max}IFT)), and other physical performance variables in elite 3x3 basketball players.

Therefore, this study aimed to determine the relationships among selected factors determining physical performance (linear speed, COD ability, COD deficit) and a combination of a player's maximal oxygen uptake and running economy measured by the final velocity (V_{max}IFT) attained in the 30-15 Intermittent Fitness Test and anaerobic speed reserve (ASR), as well as lower extremities power output measured by the countermovement jump with (CMJa) and without an arm swing (CMJ) in 3x3 elite basketball players. The second goal was to evaluate the differences between particular distances at the first and second sets of CODAT to identify the impact of fatigue and repeatability of COD performance.

Methods

Study Design

A cross-sectional design was performed in this study to estimate the relationships and differences among chosen variables related to COD and CODD.

Participants

A total of 15 elite 3x3 basketball players participated in the study (age: 26.86 ± 8.28 years; body height: 191 ± 5.33 cm; body mass: 90.68 ± 10.03 kg, basketball experience: 15.53 ± 5.8 years). All participants were members of the Polish Olympic team (Tokyo 2020). Participants had no recorded injuries in the previous two months and attended 90% of workouts prior to the beginning of testing procedures. All athletes were familiarized with the goals of the study and forms of assessment. The study was conducted in accordance with the ethical principles of the Helsinki Declaration for human research and was approved by the Ethics Commission of the local academy.

Testing Procedures

The testing procedures were completed after 48 hours of recovery following the last workout. The tests were performed on two different days with 24 h of recovery in between. Linear speed and the 30-15 Intermittent Fitness Test were carried out on the first day, while a change of direction ability and jumping performance were measured on the second day. Each participant completed the testing procedure on an indoor basketball court.

Linear speed

Following a standardized 20-minute warm-up, all participants were given two attempts at 24 m with a rest interval of 3 min between subsequent attempts to avoid fatigue. Sprinting time was measured at the following sections: 0–5 m, 5–14 m, 14–24 m, and 0–24 m. Timing gates were installed at a height of 1.2 m above the floor. Players were positioned 0.5 m away from the first timing gate and were encouraged to sprint as fast as possible. Before the start, players took one step forward with their preferred foot, with no signal given. Sprinting time was detected by electronic timing gates (Fusion Sport, Brisbane, QLD, Australia). Athletes were instructed to perform the trial with maximal effort. For further analysis, the best sprinting time was used (Sheppard et al., 2006).

Aerobic performance: 30-15 Intermittent Fitness Test

The test involves 30 s of running alternated with 15 s of walking. The test is performed at a distance of 28 m. Participants start behind one of the end lines, spaced from each other by at least one meter. They begin to run on the first "beep", pacing their effort to be in the area around the midline at the second "beep", then arrive at the opposite end at the third "beep". This continues until there is a double beep, indicating the end of the 30 s period, at which point they stop running. This will not necessarily be at either end line. They then walk forwards to the next line, waiting for the start of the next level in 15 s. As listed in Buchheit (2008), the initial velocity is 8.0 km/h, with increments of 0.5 km/h every 45 s stage thereafter. The test ends when the athlete does not make it into the tolerance zone three times.

Change of direction ability

The standardized 20 min warm-up was applied before the assessment. Change of direction ability was assessed by the test designed for field-based sports-CODAT (the Change of Direction and Acceleration Test). The CODAT involves a 5-m linear sprint followed by three 3-m sprints performed at angles of 45 and 90 degrees, and a straight 10-m sprint to the finish line (Lockie et al., 2013). Sprinting time was measured by electronic timing gates (Fusion Sport, Brisbane, QLD, Australia) at the following sections: 0–5 m, 5–14 m, 14–24 m, and 0–24 m. Athletes performed 2 sets of 5 repetitions with a 30 s rest interval between repetitions and a 6 min rest interval between sets. The best result of each set was considered for further analysis.

Jumping ability

The optical measurement device (Optojump Next, Microgate, Bolzano, Italy) was used to assess athletes' jumping ability utilizing the Countermovement Jump (CMJ) test. During the CMJ, arms were positioned on hips to avoid their influence on jump height, while during the CMJa, hands were free to move. Athletes then descended to a semi-squat position (90° between upper and lower extremities) and performed a maximal vertical jump. Each jump was performed three times and the best result was taken for further analysis. The rest interval between CMJ and CMJa testing was 2 min. The jump height [cm] was measured as commonly used in the assessment of jumping ability in basketball players (Wen et al., 2018).

Change of direction deficit

Change of direction deficit was calculated as the difference between the linear sprinting test [LST] time and the change of direction test [CDT] time as follows: CODD for 5 m = 5 m LST – 5 m CDT time; CODD for 9 m = 9 m LST – 9 m CDT time; CODD for 10 m = 10 m LST – 10 m CDT time; CODD for 24 m = 24 m LST – 24 m CDT time.

IFT velocity (VIFT) and Anaerobic Speed Reserve (ASR)

According to the 30-15 IFT test, the final velocity (V_{max}IFT) is obtained from the last completed stage and anaerobic speed reserve is calculated by subtracting maximal IFT velocity (V_{max}IFT) from maximal sprinting speed (MSS) as follows: ASR [km/h] = MSS – V_{max}IFT

Statistical analyses

Before using a parametric test, the assumption of normality was verified using the Shapiro-Wilk test. The distributions of all variables were normal. The numbers of quality data for analyzing variables were obtained using the analysis of the contingency table.

Two-way ANOVA was used with the level of significance set at $p < 0.05$ to determine differences between CODD T1 and T2, as well as between COD T1 and T2 variables. When appropriate, a Tukey's post hoc test was used to compare selected data, and the effect of each test was calculated to determine the significance of the results. Effect sizes were reported where appropriate. According to Hopkins guidelines, the effect size (eta-squared; $\eta 2$) was established as follows: 0.01 small, 0.06 medium, and 0.14 large. Statistical significance was set at $p < 0.05$.

The relationships among the analyzed variables were determined using Pearson's correlation analysis. Correlations were evaluated as follows: trivial (0.0–0.09), small (0.10–0.29), moderate (0.30–0.49), large (0.50–0.69), very large (0.70–0.89), nearly perfect (0.90–0.99), and perfect (1.0). All statistical analyses were performed using Statistica 12.0 (TIBCO Software Inc., Palo Alto, California, CA, USA) and Microsoft Office (Redmont, Washington, DC, USA).

Results

Table 1 shows the results of post hoc tests for two-way ANOVA between COD T1 and T2, while Table 2, between CODD T1 and T2. Two-way ANOVA revealed statistically significant differences between speed time at different distances both in the pair of COD T1 and T2 and CODD T1 and T2. There were no significant differences between COD T1 and T2 as well as between CODD T1 and T2 variables at the same distances.

Pearson's correlation analysis showed a statistically significant and strong correlation between COD T1 and 10 m for V_{max}IFT, as well as between LS vs. 9 m, 10 m, 24 m, and COD T1 and 2 vs. 10 m for MSS. There were no statistically significant and strong correlations among 5 m, 9 m, 10 m, and 24 m distances and LS COD T1, T2, CODD T1, T2 for ASR.

Furthermore, the same Pearson's correlation analysis revealed statistically significant correlations between 5, 10, and 24 m distances of COD T1 and linear speed (LS) 5 m to 24 m, the countermovement jump (CMJ) before and after effort, like between 5 m, 10 and 24 m distances of COD T2 and linear speed (LS) 5 m to 24 m, as well as between 9 m vs. the CMJ and CMJa.

Table 1. *Statistically significant differences between COD T1 and COD T2 after post hoc tests.*

Variables	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
COD 5 m T1 {1}		0.001 η2 = 0.25	0.001 η2 = 0.23	0.001 η2 = 0.21	0.999	0.001 η2 = 0.20	0.001 η2 = 0.22	0.001 η2 = 0.23
COD 9 m T1 {2}	0.001 η2 = 0.25		0.001 η2 = 0.20	0.001 η2 = 0.22	0.001 η2 = 0.22	0.862	0.001 η2 = 0.19	0.001 η2 = 0.18
COD 10 m T1 {3}	0.001 η2 = 0.23	0.001 η2 = 0.20		0.001 η2 = 0.25	0.001 η2 = 0.20	0.001 η2 = 0.21	0.999	0.001 η2 = 0.19
COD 24 m T1 {4}	0.001 η2 = 0.21	0.001 η2 = 0.22	0.001 η2 = 0.25		0.001 η2 = 0.18	0.001 η2 = 0.23	0.001 η2 = 0.24	0.266
COD 5 m T2 {5}	0.999	0.001 η2 = 0.22	0.001 η2 = 0.20	0.001 η2 = 0.18		0.001 η2 = 0.25	0.001 η2 = 0.17	0.001 η2 = 0.21
COD 9 m T2 {6}	0.001 η2 = 0.20	0.862	0.001 η2 = 0.21	0.001 η2 = 0.23	0.001 η2 = 0.25		0.001 η2 = 0.16	0.001 η2 = 0.22
COD 10 m T2 {7}	0.001 η2 = 0.22	0.001 η2 = 0.19	0.999	0.001 η2 = 0.24	0.001 η2 = 0.17	0.001 η2 = 0.16		0.001 η2 = 0.18
COD 24 m T2 {8}	0.001 η2 = 0.23	0.001 η2 = 0.18	0.001 η2 = 0.19	0.266	0.001 η2 = 0.21	0.001 η2 = 0.22	0.001 η2 = 0.18	

Table 2. *Statistically significant differences between CODD T1 and CODD T2 after post hoc tests.*

Variables	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}
CODD 5 m T1 {1}		0.999	0.001 η2 = 0.26	0.001 η2 = 0.27	0.001 η2 = 0.24	0.001 η2 = 0.25	0.001 η2 = 0.22	0.001 η2 = 0.24
CODD 5 m T2 {2}	0.999		0.001 η2 = 0.28	0.001 η2 = 0.26	0.001 η2 = 0.25	0.001 η2 = 0.17	0.001 η2 = 0.25	0.001 η2 = 0.22
CODD 9 m T1 {3}	0.001 η2 = 0.26	0.001 η2 = 0.28		0.768	0.001 η2 = 0.25	0.001 η2 = 0.17	0.001 η2 = 0.21	0.001 η2 = 0.21
CODD 9 m T2 {4}	0.001 η2 = 0.27	0.001 η2 = 0.26	0.768		0.001 η2 = 0.20	0.001 η2 = 0.19	0.001 η2 = 0.15	0.001 η2 = 0.22
CODD 10 m T1 {5}	0.001 η2 = 0.24	0.001 η2 = 0.25	0.001 η2 = 0.25	0.001 η2 = 0.20		0.999	0.001 η2 = 0.23	0.001 η2 = 0.21
CODD 10 m T2 {6}	0.001 η2 = 0.25	0.001 η2 = 0.23	0.001 η2 = 0.17	0.001 η2 = 0.19	0.999		0.001 η2 = 0.25	0.001 η2 = 0.19
CODD 24 m T1 {7}	0.001 η2 = 0.22	0.001 η2 = 0.25	0.001 η2 = 0.21	0.001 η2 = 0.15	0.001 η2 = 0.23	0.001 η2 = 0.25		0.231
CODD 24 m T2 {8}	0.001 η2 = 0.24	0.001 η2 = 0.22	0.001 η2 = 0.21	0.001 η2 = 0.22	0.001 η2 = 0.21	0.001 η2 = 0.19	0.231	

Some correlations among 5 m, 9 m, 10 m, and 24 m distances for CODD T1 and CODD T1 and linear speed 5 m to 24 m, the countermovement jump (CMJ, CMJa) were statistically significant, but not strong. Pearson's correlation analysis revealed statistically significant correlations among 5 m and LS 5 m, LS 10 m; 10 m and LS 10 m, CMJ; 24 m and CMJ of CODD T1, alike between 5 m and LS 5 m, LS 10 m; 9 m, 10 m, 24 m and the CMJ of CODD T2.

Discussion

The main goal of the study was to determine the relationship among selected factors determining physical performance (linear speed, COD ability, COD deficit) with a combination of player's maximal oxygen uptake and running economy measured by the final velocity attained in the 30-15 Intermittent Fitness Test (V_{max}IFT) and anaerobic speed reserve (ASR), as well as lower extremities power output evaluated by the countermovement jump (CMJ, CMJa) in 3x3 elite basketball players. The investigation was also aimed to determine the differences related to considered distances between the first and second sets of the CODAT.

Moderate to strong significant correlations were noticed between the change of direction (COD) and linear speed (LS) at 5 m, 10 m, and 24 m. This result was expected, and it is in line with previous research (Scanlan et al., 2021), and related to all distances, except the 9 m sector.

COD is strongly affected by linear performance, and it can lead to misinterpretation of the data (Nipphius et al., 2016). However, the CODAT was designed to evaluate the change of direction in field-related sports including four diagonal direction changes mixed with short 3-m sprints, in a zig-zag pattern. This CODAT mimics on-court player's activity in team sports. It makes that assessment practical and reliable (Lockie et al., 2013). Contrary to our research, Sassi et al. (2009) detected no correlation between COD ability assessed by the Modified Agility T-Test and 10 m linear sprint. Moreover, some scientists observed no relationship between MAT and 5 m linear speed distance (Papla et al., 2020; Scanlan et al., 2021).

Mostly small and moderate correlations were found between linear speed (LS) and change of direction deficit (CODD). A limited number of studies have analyzed the relationship between linear sprint (LS) and change of direction deficit (CODD) among team sports (Loturco et al., 2018, 2020; Papla et al., 2020; Rouissi et al., 2016). Our results are in line with the findings of Papla et al. (2020), where the authors showed that 20-m linear sprint time was not significantly correlated with COD deficit in two different tests. On the contrary, Loturco et al. (2018) registered a statistically significant correlation between COD deficit and 10 m flying start linear sprint. According to a real 3x3 basketball game scenario, most of COD's maneuvers occur with angles between 0 and 90°. Therefore, the CODAT was used in our current research. Additionally, we considered linear speed from the standing start. Because of those described differences, it is impossible to compare the findings of the current investigation with the results obtained by Loturco et al. (2018). However, the use of COD angles above 90° also needs be considered when evaluating 3x3 basketball players' performance, and can't be ignored due to a smaller frequency of occurrence.

Subsequently, moderate, significant negative correlations were detected among COD, CODD, and CMJ, CMJa. These findings are not surprising since most aspects of COD performance are strongly dependent on lower body power. In order to effectively execute this kind of movement, the body position needs to descent during the deceleration phase, while speed decreases rapidly by eccentric contractions, and then in order to accelerate in a new direction as quickly as possible, it is necessary to generate high forces to the ground by concentric muscle contractions (Shepard and Young, 2006; Spiteri et al., 2015).

Moreover, moderate to strong significant correlations were observed among COD, CODD, and V_{max}IFT, at 9 m, 10 m, and 24 m. On the one hand, effective COD can have a positive impact on player's performance in the last stages of the IFT. On the other hand, high aerobic capacity can support results achieved on the CODAT (Buchheit, 2010; Silva et al., 2022)

Considering that ASR is calculated as a difference between MSS and V_{max}IFT, a large correlation between ASR and COD performance was expected, taking into consideration the possible domination of the fast-twitch fiber type profile among basketball 3x3 players. However, no relationship was detected among ASR and COD, CODD, and LS at any measured distance.

The authors of previous reports noticed strong correlations between ASR and MSS (Buchheit, 2010). Therefore, the results of the current research seem to be surprising, and contrary to Silva et al. (2022) who detected a small to moderate correlation between ASR and COD ability in youth soccer players. Additionally, this association is smaller than the one observed in V_{max}IFT. A possible explanation can be that ASR is a relatively independent measure that should be analyzed as part of the player's locomotor profile.

Finally, statistically strong differences were found in COD and CODD between trial 1 and trial 2. It can be explained by the effect of fatigue during the second set of the CODAT impacting change of direction performance.

This study has several limitations. For example, it should have been conducted with a larger number of participants including female athletes and considering their on-court positions. The analysis of jump height only rather than obtained velocity, the rate of force development, the reactive strength index, and single leg assessment could be considered. Moreover, the linear sprint was measured from a standing start (no flying start measures were performed) and only 45° and 90° angles of COD and CODD were assessed. Besides, further investigations should focus on the effects of specific training programs oriented at developing locomotor abilities in 3x3 basketball players.

Conclusions and practical applications

In summary, the results of the current study confirm the existence of relationships among change of direction ability (COD), change of direction deficit (CODD) and linear speed (LS), the explosive power of the lower body, and maximal sprinting speed (MSS) in 3x3 elite basketball players. Moreover, a statistically significant moderate relationship was found between COD ability and maximal aerobic velocity (V_{max}IFT). Surprisingly, no association was registered between COD ability and anaerobic speed reserve (ASR). These findings confirm the complexity of COD performance and allow to define some conclusions regarding its development in the training process. More agility-based, basketball-oriented, task-specific drills should be utilized instead of linear sprinting exercises. Linear sprinting tests and change of direction acceleration tests (CODAT) with the evaluation of a particular distance (5, 9, 10, 24 m) in both tests seem to be reliable tools recommended for 3x3 basketball. Additionally, the countermovement jump test without and with free arms as well as the 30-15 Intermittent Fitness Test should be applied as a diagnostic tool allowing to determine the locomotor profile of 3x3 basketball players.

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