Journal of Strength and Conditioning Research™

Change of Direction Performance in Elite Players From Different Team Sports

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Abstract

Loturco, I, Pereira, LA, Reis, VP, Abad, CCC, Freitas, TT, Azevedo, PHSM and Nimphius, S. Change of direction performance in elite players from different team sports. *J Strength Cond Res* 36(3): 862–866, 2022—The primary aim of this study was to examine the differences in change of direction (COD) deficit between elite futsal, soccer, handball, and rugby players. A secondary aim was to compare the performance in both COD and linear speed tests among these athletes. One-hundred sixty-one elite male players from 4 team sports performed a 20-m linear sprint speed and a Zigzag COD speed test. The COD deficit was calculated as the difference between linear and Zigzag test velocities. Differences in COD speed, COD deficit, and sprint velocity were assessed via 1-way analysis of variance. The significance level was set at $p < 0.05$. Soccer players displayed significantly lower performance than the remaining team sports, and rugby players performed better than all the other groups in the Zigzag COD test. Moreover, the COD deficit was significantly higher in soccer players in comparison with the other disciplines ($p < 0.05$). No differences were observed in the COD deficit among rugby, futsal, and handball players ($p > 0.05$). In summary, soccer players were slower than futsal, handball, and rugby players to change direction and presented the greatest COD deficit magnitude. By contrast, the fastest athletes in the COD speed test (rugby players) were not more effective than futsal and handball players at changing direction (as they exhibited similar levels of COD deficit). Coaches should be aware of this evidence, which reinforces previous findings, indicating that very specialized training strategies might be required to improve COD performance in professional athletes.

Key Words: court sports, football, velocity, directional change, agility

Introduction

Change of direction (COD) ability has been considered a critical factor for successful performances in many team sports (6,25,26). In soccer, for example, rotations and COD sprints are among the 3 most frequent actions that immediately precede goal-scoring opportunities in a professional league (9). Furthermore, elite rugby and Olympic handball players have been consistently shown to outperform their younger and less specialized peers in a series of COD assessments (i.e., zigzag, pro-agility, and T-test), which indicates that this physical quality may be able to discriminate between athletes competing at distinct levels and age categories (16,27). As a consequence of these findings and inferences, there has been emerging literature on this topic, specifically designed to better define and characterize the main determinants of COD performance (5–7).

Indeed, the capability to make calculated decisions and efficient COD maneuvers seems to be a strong characteristic of the best team-sport athletes (26). Briefly, a COD drill may be described as a preprogrammed movement, where "no immediate reaction to a stimulus is required" (2). Nonetheless, in the context of the game, directional changes typically occur in a reactive manner (e.g., opponents' actions or ball movements), which partially limits the examination of preplanned tasks (1,36). Even so, for some authors, deeper understanding of performance during planned activities is an essential step toward the implementation of more effective agility training practices (23,26). The same holds true for the development of specific measurement techniques, especially those able to "isolate" (and consequently better assess) this multifaceted skill (2,33). For this purpose, Nimphius et al. (24) suggested the calculation of the "COD deficit," a variable which reports the additional time necessary to execute a COD task when compared with the time required to cover an equivalent distance in a straight sprint. Using this approach, practitioners can more precisely analyze the efficiency of a given athlete for turning or cutting, by quantifying his or her capacity to use their maximum linear velocity during COD efforts (8,24). Interestingly, recent studies on players from multiple sports and competitive levels revealed that faster and more powerful athletes are potentially less efficient at changing direction (10,18,19). Similar differences have been observed between sexes, with men (who are typically stronger and faster than women) displaying greater COD deficits (11,28). Nevertheless, despite the growing body of work exploring this phenomenon, there is still a lack of research comparing the magnitudes of COD deficit among athletes from various disciplines.

Because it is well known that different game activities have different technical and physical demands and considering the crucial importance of COD ability in team sports (6,25,26), it would be interesting to investigate whether a varied sample of players exhibit higher or lower levels of COD deficit. This information could help

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Journal of Strength and Conditioning Research 36(3)/862–866

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coaches and sport scientists to create more tailored and applied training schemes, based on the particular characteristics of each sport. Thus, the primary objective of this study was to examine the differences in COD deficit between elite futsal, soccer, handball, and rugby players. A secondary aim was to compare the performance in both COD and linear speed tests (i.e., measures used in COD deficit calculation) among all these sports.

Methods

Experimental Approach to the Problem

This cross-sectional comparative study was designed to test the differences in COD performance and COD deficit and the linear sprint velocity between athletes from distinct team-sport disciplines. Athletes involved in this study were assessed during the competitive phase of the season and were well familiarized with testing procedures due to their constant assessments in our facilities. Physical tests were performed on the same day in the following sequence: a 20-m linear sprinting speed and zigzag COD speed test. Subjects were required to be in a fasting state for at least 2 hours, avoiding caffeine and alcohol consumption for 24 hours before the procedures. Before the tests, the athletes performed standardized warm-up protocols including general (i.e., running at a moderate pace for 10 minutes followed by active lower limb stretching for 3 minutes) and specific workouts (i.e., submaximal attempts at each tested exercise). Between each test, a 15-minute rest interval was allowed, to explain the procedures and adjust the equipment.

Subjects

One-hundred sixty-one elite male athletes (mean ± *SD*; 25 soccer players: age: 23.6 ± 3.5 years; body mass: 70.3 ± 8.6 kg; stature: 176.8 ± 7.8 cm; 27 handball players: age: 29.4 ± 3.0 years; body mass: 91.6 ± 10.7 kg; stature: 188.8 ± 5.6 cm; 47 rugby players: age: 26.4 ± 3.2 years; body mass: 89.2 ± 9.4 kg; stature: 177.9 ± 6.7 cm; and 62 futsal players: age: 25.3 ± 3.2 years; body mass: 75.2 ± 6.2 kg; stature: 178.3 ± 5.2 cm) from 4 different sports participated in this study. Soccer players participated in the first division of the Paulista State Championship. Handball players participated in the first division of the Brazilian National Championships, comprising 15 athletes of the Brazilian National Team. Rugby players were members of the Brazilian National Team. Finally, futsal players participated in the Brazilian National League. Therefore, we can confirm the high level of performance of the subjects in this study. The training strategies over distinct training phases, commonly programmed for the specific team-sport athletes that participated in this study, are presented in Table 1. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The study was approved by the Anhanguera-Bandeirante University Ethics Committee.

Procedures

Linear Sprint Speed Tests. Four pairs of photocells (Smart Speed, Fusion Sport, Brisbane, AUS) were positioned at the starting line and at the distances of 0-, 5-, 10-, and 20-m. The athletes sprinted twice, starting from a standing position 0.3 m behind the starting line. The sprint tests were performed on an indoor running track made of artificial turf, composed of polyethylene and monofilament fibers (~100-μm thick). All athletes performed the tests using their regular gym shoes. Sprint velocity (VEL) was calculated as the distance traveled over a measured time interval. A 5-minute rest interval was allowed between the 2 attempts, and the fastest time was considered for subsequent analyses.

Zigzag Change of Direction Speed Test. The zigzag COD test was performed on an indoor court and consisted of 4 sections of 5-m (total 20 m of linear distance) marked with cones set at 100° angles (11,19,28), requiring the athletes to decelerate and accelerate as fast as possible around each cone. Two maximal attempts were performed with a 5-minute rest interval between attempts. Starting from a standing position with the front foot placed 0.3 m behind the first pair of timing gates (Smart Speed, Fusion Equipment, Brisbane, Australia) (i.e., starting line), the athletes were instructed to complete the test as quickly as possible until crossing the second pair of timing gates, placed 20 m from the starting line. The fastest time from the 2 attempts was retained for further analysis. To properly evaluate the efficiency of each athlete to use his linear speed during a COD task (as 180° turns are less utilized by team sport players during sport-specific actions) (4), an adapted COD deficit calculation was used, as previously described (24,28). Hence, the COD deficit was calculated as follows: (20-m velocity − zigzag test velocity).

Statistical Analysis

Data are presented as mean ± *SD*. Data normality was tested using the Shapiro-Wilk test. Comparisons of the COD velocity, COD deficit, and sprint velocity between the 4 team-sport disciplines tested were performed using a 1-way analysis of variance. The Bonferroni post hoc test was used to detect where the differences occurred. The significance level was set at $p \leq 0.05$. Effect sizes (ESs) were calculated to estimate the magnitude of significant differences and interpreted using the thresholds proposed by Rhea (30) for highly trained subjects, as follows: <0.25, 0.25–0.50, 0.50–1, and >1 for trivial, small, moderate, and large, respectively. All performance tests used herein demonstrated small errors of measurement, as evidenced by their high levels of accuracy and reproducibility (intra- and intersubject coefficients of variation <10% and intraclass correlation coefficients >0.90 for all assessments).

Results

Table 2 shows the comparison of the sprint velocity over the different distances among the players from the 4 team sports. No significant differences ($p > 0.05$) were observed between any groups in the sprint velocity over any assessed distance. Figure 1 depicts the comparisons of the zigzag test among the 4 disciplines. Soccer players displayed significantly lower performance {ES (95% confidence limits [CL]) ranging from 0.96 (0.50–1.41) to 1.23 (0.92–1.55)}, and rugby players performed significantly better (ES [95% CL] ranging from 0.55 [0.11–1.00] to 1.23 [0.92–1.55]) than all the other groups in the COD speed measurement ($p < 0.05$). Figure 2 shows the comparisons of the COD deficit between the 4 team sports. Soccer players exhibited significantly higher COD deficit than all the other groups (ES [95% CL] = 1.11 [0.71–1.51], 1.07 [0.58–1.56], and 0.93 [0.53–1.34], in comparison with futsal, handball, and rugby players, respectively; $p < 0.05$). No differences were observed in the COD deficit among rugby, futsal, and handball players ($p > 0.05$).

Discussion

This is the first study to examine and compare the differences in COD speed and COD deficit between elite players from 4

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Table 1

Models of training organization for the team-sport athletes during distinct training phases.*

	Preseason			Competitive season		
Futsal						
Training strategy	Resistance training		Plyometrics	Resistance training		Plyometrics
Exercise type	Traditional		VJ-HJ	Ballistic		VJ-HJ
Intensity	50–80% 1RM		Maximum	30–60% 1RM		Maximum
Frequency		2–3 sessions/week			1–2 sessions/week	
Handball						
Training strategy	Resistance training		Plyometrics	Resistance training		Plyometrics
Exercise type	Traditional		VJ-HJ	Traditional-ballistic		VJ-HJ
Intensity	60–95% 1RM		Maximum	40–80% 1RM		Maximum
Frequency		2–4 sessions/week			1–3 sessions/week	
	Preseason			**Competitive season**		
Soccer						
Training strategy	Resistance training	Horizontally-based RST	Plyometrics	Resistance training	Horizontally-based RST	Plyometrics
Exercise type	Traditional	Short sprints	VJ-HJ	Ballistic	Short sprints	VJ-HJ
Intensity	50–80% 1RM	10–20% BM	Maximum	30–60% 1RM	10–20% BM	Maximum
Frequency		2–3 sessions/week			1–2 sessions/week	
Rugby						
Training strategy	Resistance training	Vertically and horizontally based RST	Plyometrics	Resistance training	Vertically and horizontally based RST	Plyometrics
Exercise type	Traditional	Short sprints	VJ-HJ	Traditional-ballistic	Short sprints	VJ-HJ
Intensity	70–95% 1RM	10–30% BM	Maximum	40–80% 1RM	10–30% BM	Maximum
Frequency		3–5 sessions/week			2-4 sessions/week	

*RM = repetition maximum; VJ = vertical jumps; HJ = horizontal jumps; BM = body mass; RST = resisted sprint training (horizontally-based RST = performed with weighted sleds; vertically-based RST = performed with weighted vests).

different team sports. Notably, we observed that although slower than futsal, handball, and rugby players to change direction, the soccer players displayed the greatest magnitude of COD deficit (Figures 1 and 2). Furthermore, as secondary outcomes, no significant differences with respect to 5-, 10-, and 20-m linear speed were detected among the groups of athletes; nevertheless, the rugby players obtained the best results in the COD speed test.

When comparing players from the same sport (e.g., soccer, rugby, and handball), the faster athletes in maximum straight sprints seem to be less efficient at changing direction (i.e., higher COD deficit) (10,18,19,27). A plausible explanation for this paradox may lie in the fact that higher speeds possibly generate greater sprint momentum and, consequently, greater inertia. As a result, faster athletes might find it more difficult to deal with the higher braking and propulsive forces while cutting or turning (6,32), which negatively impacts their capability to repeatedly decelerate and reaccelerate during successive COD maneuvers (10,11,18,19,27). Nonetheless, although in this study all groups presented similar performances in linear speed tests, the soccer players curiously exhibited higher COD deficits. From a general perspective, our findings complement and counterbalance the aforementioned observations, revealing that this "mechanical phenomenon" is not able to discriminate between higher or lower levels of COD efficiency among athletes from different sports. Moreover, they suggest that soccer players are less efficient than their team-sport counterparts at changing direction (i.e., relative to their maximum linear speed), which could be related to the discipline per se or, worryingly, to the typical soccer training practices. This issue is of great practical relevance and should be addressed in further investigations involving different classes and competitive levels of team-sport athletes.

The rugby players outperformed all the other groups in the COD speed measurement (Figure 1). These data agree with those reported by Loturco et al. (20), who (despite the lack of statistical analysis) showed a positive difference of ~4.5% in zigzag test performance (mean velocity values) in favor of elite rugby players (when compared with elite male soccer, futsal, and handball players). In part, this superior ability to execute directional changes may be attributable to their systematic routines because these athletes traditionally perform a consistent and increased volume of strength, speed, and power training during their junior and professional careers (3,14,17,31). Indeed, numerous studies have already highlighted the fundamental importance of these physical capacities in rugby, which is coherent with the intense and forceful demands of this sport (e.g., tackling, scrummaging, mauling, jumping, accelerating, and sprinting) (13,15,22,34). The constant and specific preparations for these dynamic game activities certainly produce strong and powerful athletes. Therefore, as COD ability is greatly influenced by a myriad of neuromechanical aspects (e.g., concentric and eccentric strength, reactive strength, speed and power qualities, left-right balance, and leg muscle properties) (2,12,33), rugby players tend to be more apt than other team-sport players to quickly change direction. These assumptions can be strengthened by comparing the typical training programs of each team sport, which demonstrate the higher frequency and volume of neuromuscular training performed by rugby players across the different phases of the athletes' preparation (Table 1). That said, it can be argued that the total and relative training content is a key factor that must be considered when designing training schemes with the intent of enhancing COD performance.

Table 2

Comparison of the sprint velocity (VEL) in the different distances tested among the distinct team-sport disciplines.

	Futsal	Handball	Soccer	Rugby
VEL 5-m ($m\cdot s^{-1}$)	4.79 ± 0.22	4.85 ± 0.23	4.91 ± 0.29	5.01 ± 0.31
VEL 10-m ($m\cdot s^{-1}$)	5.67 ± 0.23	5.70 ± 0.20	5.76 ± 0.22	5.78 ± 0.28
VEL 20-m ($m\cdot s^{-1}$)	6.62 ± 0.25	6.61 ± 0.23	6.77 ± 0.24	6.77 ± 0.31

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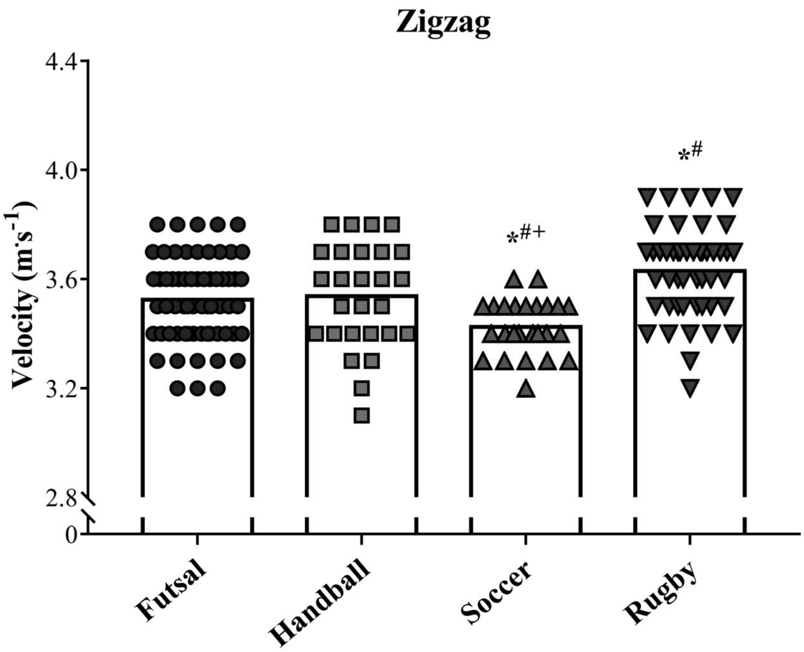

Figure 1. Comparison of the zigzag change of direction test among the distinct team-sport disciplines. Symbols represent significant difference ($p < 0.05$) from: *futsal; #handball; +rugby.

Finally, it is worth noting that (1) all sports analyzed in this research present a considerable COD deficit magnitude (i.e., ~53% of difference between straight speed and COD speed), and (2) the fastest athletes in the COD speed test (rugby players) were not more effective than futsal and handball players at changing direction (as they displayed similar levels of COD deficit; Figure 2). Notwithstanding the expected differences in maximum linear speed and COD speed (because athletes have to consecutively decelerate and reaccelerate during COD assessments), the absence of significant differences in COD deficit among rugby, futsal, and handball players indicates that higher volumes of "regular" strength, speed, and power training may be able to increase COD speed but not COD efficiency. Coaches should be aware of this practical evidence, which reinforces previous findings indicating that very specialized training strategies (e.g., specific COD drills, eccentric strength training, etc.) might be required to improve COD performance in professional athletes. This study is limited by its cross-sectional nature and the selected characteristics

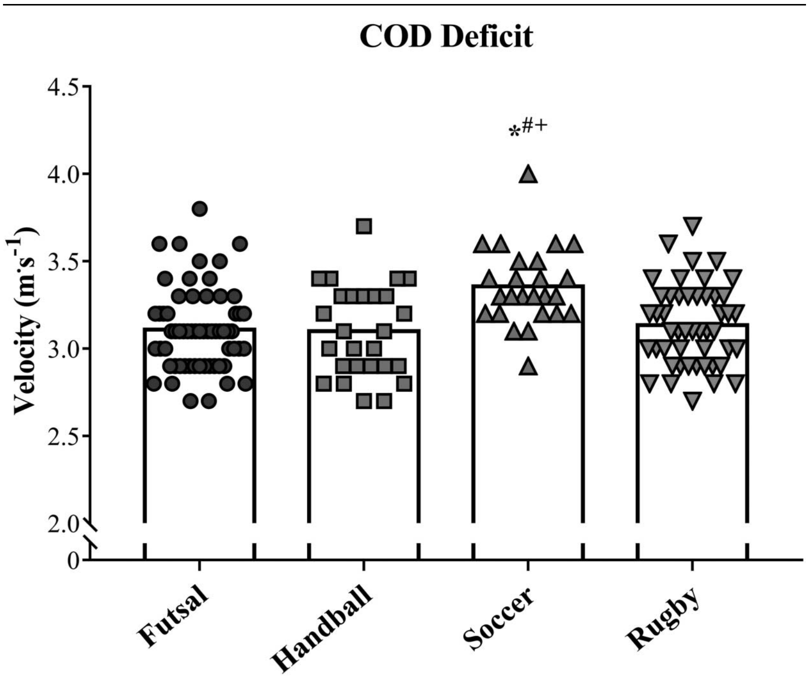

Figure 2. Comparison of the change of direction (COD) deficit among the distinct team-sport disciplines. Symbols represent significant difference ($p < 0.05$) from: *futsal; #handball; +rugby.

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of the subjects (i.e., adult male team-sport players). As such, it is important to investigate this phenomenon in female players as well as in youth athletes during their maturation process.

Practical Applications

Elite athletes from different team sports present substantial magnitudes of COD deficit relative to their maximum linear velocity. Among them, soccer players seem to be the most inefficient group to change direction (i.e., higher COD deficits). Importantly, they are also slower than futsal, handball, and rugby players in the zigzag COD speed test. This suggests that the "mix" of training strategies or even the frequency of training sessions applied over the soccer season may not be the most effective to adequately enhance COD ability in elite soccer players. By contrast, rugby players are faster than all the other groups when changing direction, which is probably related to their more extensive and intense strength, speed, and power training routine. Nevertheless, when compared with futsal and handball players, rugby players exhibit similar levels of COD deficit. Together, these data indicate that the current training practices in professional team sports, especially in soccer, must be revisited and perhaps adjusted to include more encompassing training approaches. Because directional changes play a key role in these sports, coaches and sport scientists should focus more explicitly on developing and implementing innovative speed training schemes, better adapted and, principally, integrated to the context of the game. In this regard, the constant execution of deceleration, acceleration, and reacceleration drills, as well as the use of eccentric strength training and weighted vests, may be highly recommendable (21,29,35). Undoubtedly, these practices should be properly combined with other conventional training methods (e.g., resistance training, resisted sprints, and plyometrics) and frequently distributed over the entire training and competitive season.

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