ASSESSMENT OF THE RELATIONSHIP BETWEEN PHYSICAL PERFORMANCE AND PERCENTAGE CHANGE OF DIRECTION DEFICIT IN HIGHLY TRAINED FEMALE SOCCER PLAYERS

Abstract

Purpose: Different studies indicate that female players in team sports, such as soccer, tend to have a lower change of direction deficit (CODD) than their male counterparts and that players who performed better in linear and curved sprints tended to have a worse CODD, suggesting that maximum speed does not equate to a faster change of direction (COD). This study assessed how performance variables related to speed and jumping influence the variability of %CODD among adult highly trained female soccer players. ***Methods:*** Fifty-two highly trained female soccer players (age: 23.1 ± 3.25 years; height: 163.6 ± 5.49 cm; weight: 59.7 ± 5.71 kg) participated in this study and performed 180COD, 40-m sprint, countermovement jump (CMJ), and standing broad jump (SBJ) tests. ***Results:*** Significant correlations were found between 180CODL, %CODDR, %CODDL, and between-limbs SBJ asymmetry (r = 0.28 to 0.74). A very large correlation existed between %CODDR and %CODDL (r = 0.91). Regression analyses indicated a strong inverse relationship between the 10-m sprint time and %CODDR and %CODDL. No predictive models were found for 180COD in either limb. Differences in performance variables such as 180CODR, 180CODL, and asymmetry %CODD were significant between the **high and low** %CODD groups, with moderate to large effect sizes. ***Conclusions:*** The present study suggests that specific physical performance variables, particularly acceleration and unilateral horizontal jumping, are vital to improving COD in highly trained female soccer players, highlighting the need for specific training interventions.

Key Words:
football; women; dynamic performances; velocity

Introduction

It is estimated that soccer attracts 265 million people worldwide [1]. Recent statistics from the Fédération Internationale of Football Association indicate that there are more than 13.3 million officially registered women players [2]. Emphasis on the advancement of women's soccer is imperative to improve performance, reduce the likelihood of injury, and understand the unique physical requirements and talents of female athletes [3].

From a time-motion analysis standpoint, female players run distances ranging from 4 to 13 km per match, of which a significant part, between 0.2 and 1.7 km, is done at high speed (>15-km/h) [4]. In addition, elite female players perform more high-intensity running in international than domestic league matches [5]. These statistics highlight the demanding nature of high-level women's soccer, which requires a focus on both physical and technical skills. The physical and technical demands of high-level women's soccer involve various actions, such as jumping and rapid changes of direction (COD), which are critical in influencing match outcomes and are considered key indicators of performance level in the sport [6]. The ability to rapidly change direction is recognised as a key component of physical fitness, emphasised by the frequent and dynamic changes of direction executed by players throughout competitive matches [7]. In the specific context of soccer, it is observed that the majority of COD movements are 180º or less, with a significant majority not exceeding 90º [8]. The ability to sprint, jump, and execute cutting manoeuvres is believed to depend on the ability to exert high levels of force [9]. These data underline the importance of tailoring training programs to the individual athlete's specific fitness levels and competitive parameters, supporting the idea that physical performance assessments are essential to personalise training programs.

Emerging from COD ability are terms such as the change of direction deficit (CODD) and the percentage of change of direction deficit (%CODD), which serve as crucial metrics for evaluating physical performance in soccer. CODD is calculated as the difference between the time taken to complete a specific distance (inclusive of a COD), and the time taken to run the same distance in a straight line [10]. At the same time, %CODD gives a percentage perspective of this difference, highlighting the efficiency of COD relative to pure speed [11]. These metrics provide deeper insight into an athlete's ability to perform rapid COD maneuvers, which are fundamental in soccer. Furthermore, until now, few studies have investigated in depth the analysis of variations in the %CODD [11,12]. Introduced by Freitas et al. [13], this novel computational approach to CODD is designed to provide a rationalised analysis, considering that there are currently two methodologies for CODD, one based on time and the other on velocity, which can be confusing for coaches and trainers. By focusing on the proportional disparity between speed (in a straight-line sprint) and COD capability rather than raw numbers, this technique normalises the metric, improving the overall understanding of COD capabilities when comparing groups [13]. Recent research indicates that female athletes in team sports, such as soccer, tend to have a shorter CODD than their male counterparts, which implies a superior result, ultimately indicating greater COD efficiency. Kobal et al. [14] found that athletes who performed better in linear and curved sprints tended to have higher CODDs, suggesting that faster players have to brake harder because of their increasing velocity. However, a greater CODD does not necessarily mean that players have to brake harder; rather, may also imply that players simply decelerate over a longer distance. Furthermore, female soccer players were observed to have a higher CODD than their counterparts in other team sports, suggesting a comparative disadvantage in COD ability, regardless of their linear speed ability [15].

The practical application of the CODD and %CODD in women's soccer not only improves our understanding of the physical demands of the sport but also guides the development of more effective training strategies for movement patterns that are common in the sport. Highlighting these aspects can contribute significantly to the evolution of training methodologies aimed at improving specific physical attributes necessary for competitive success in women's soccer.

A previous study conducted with adolescent female soccer players showed that the first 10-m sprint seems to have a key role in determining an individual's ability to change direction effectively, which accounts for a substantial part of the variance in 180COD performance [11]. Nevertheless, the study found no significant predictors for %CODD, although there were correlations among 180COD performance, %CODD, acceleration, linear sprint, and horizontal jump performance [11]. In contrast, research on male soccer players from a professional academy did not identify any significant predictors of CODD based on velocity and jumping [16]. These studies highlight a critical gap in the literature, as they do not sufficiently explore the relationship between physical performance variables and %CODD in adult female soccer players. To the best of our knowledge, studies have yet to assess these aspects in adult female soccer players, leaving a gap in understanding the physical characteristics that may underpin CODD in this population. Therefore, the current study aimed to analyse the influence of performance variables related to speed and jumping ability in explaining variability in %CODD among highly trained adult female soccer players. By addressing this gap, this study attempts to provide valuable information that can help improve future training interventions, with the goal of increasing performance and reducing the incidence of injury among elite female soccer players. Finally, we hypothesized that specific performance variables, such as speed, COD and jumping ability, would significantly contribute to the variability in %CODD among highly trained adult female soccer players.

Methods

Subjects

Fifty-two highly trained [17] female soccer players (age: 23.1 ± 3.25 years; height: 163.6 ± 5.49 cm; weight: 59.7 ± 5.71 kg) consented to participate in this study. This sample size of 52 was determined to detect moderate effect sizes (ES: 0.7) in an independent t-test that guaranteed a statistical power of 80% and an alpha level of 0.05, according to G*Power calculations (version 3.1.9.6). Inclusion criteria required participants to have a minimum of six years of soccer training experience and to be actively involved in competitive matches. Exclusion criteria included any recent injury (within the last six months), chronic illness that could affect performance, and an inability to complete the testing protocols. These soccer players had participated in club-level soccer training for a minimum of six years, with a regimen that included three 90-minute technical and tactical field sessions per week. In addition, they undertook a 90-min physical training session each week aimed at improving speed, agility, quickness, coordination, and injury prevention. In addition, players were tested in the fifth month of the competition. They participated in one game per week in Spain's third national league. The study adhered to the ethical guidelines of the Declaration of Helsinki (2013) and received regional ethics committee approval (CP19/039, CEICA, Spain).

Procedures

Physical performance assessments were performed on a single day, starting with horizontal and vertical jumps, followed by linear sprints, and concluding with COD assessments. The tests were conducted on an artificial turf surface, with weather conditions being mild and dry, temperatures around 21°C, and no significant winds. Athletes were discouraged from engaging in high-intensity activities 48 h before the assessments to reduce muscle fatigue. They were also instructed to stay away from caffeine and other stimulants (e.g., energy drinks and dietary supplements) that could affect performance. Given the regular training sessions and evaluations conducted on these teams, each athlete was familiar with the testing protocols. A Raise, Activate, Mobilise and Potentiate (RAMP) system warm-up protocol was performed before testing [18]. A 3-min rest period was established between tests to promote recovery and ensure consistency of performance. Sports shoes were used for the jumping tests and soccer boots for the sprint and COD assessments.

Unilateral standing broad jump

Unilateral standing broad jump (SBJ) was measured using a standard 30-m tape measure and was assessed as described elsewhere [19]. Each participant was given two opportunities, with a 45-s rest interval between them. The greater of the two distances achieved was then selected for further statistical evaluation. The evaluation covered unilateral jumps, starting with the dominant leg before moving to the non-dominant leg, ensuring equal flexion. The variables analysed included right SBJ with one leg (SBJR) and left SBJ with one leg (SBJL). Intraclass correlation coefficient (ICC) values ranged from 0.86 to 0.88 for the unilateral SBJ.

Unilateral countermovement jump

The countermovement jump (CMJ) was evaluated using Optojump (*Optojump system, Microgate, Bolzano, Italy*), which consists of two photocells for accurate data acquisition and is described elsewhere [19]. Each athlete was given two opportunities, with a 45-second interval to rest between attempts. The best recorded jump was chosen for a detailed examination. Variables analysed included the left CMJ with one leg (CMJL) and the right CMJ with one leg (CMJR). ICC values ranged from 0.91 to 0.93 for unilateral CMJ jumps.

40-m linear sprint

Sprint speed was assessed over a linear 40-m sprint, with intermediate times recorded at 10 and 30 m, as described elsewhere [19]. Timing gates placed at different intervals allowed differentiation between acceleration (0 to 10 metres) and maximum speed (30 to 40 metres) capabilities. Each participant performed the sprint twice, interspersed with a 3-min period of passive rest, ensuring that they were fully recovered and could execute the next sprint with maximum effort. The reliability of these measurements was confirmed by an ICC ranging from 0.92 to 0.96.

180^{o} change of direction test

The timing accuracy of this event was ensured using double-beam photoelectric cells provided by Witty (Microgate, Bolzano, Italy) as described elsewhere [19]. Each athlete was given two opportunities to complete the test, with a 3-min passive rest period between attempts and facilitate full recovery. The fastest time recorded was chosen for analysis in the study, achieving an ICC of 0.93, indicating high reliability. The variables analysed included the one 180COD with left (180CODL) and right (180CODR) legs. The percentage CODD was calculated using the formula: ((COD time – 10 m sprint time)/10 m sprint time) x 100 [20].

Statistical Analysis

All statistical analyses were performed using SPSS version 25 and Microsoft Excel. Data are presented as mean ± standard deviation (SD). Reliability was assessed by CV and ICC using a spreadsheet. Normality was assessed using the Shapiro-Wilk test, which confirmed normal distribution for all variables except interlimb asymmetries. Multiple linear regression models (stepwise backward elimination procedure) with COD times and %CODD as dependent variables and anthropometric measures, jumping performance, sprint times, and asymmetries as independent variables. Variables with $P > .05$ were excluded. Pearson's correlation assessed the relationships between COD times and %CODD with the rest of variables according to Hopkins et al. [21]. The median split technique divided players into high or low %CODD groups and compared them using paired *t*-tests. Differences in asymmetries were analysed with Friedman's ANOVA ($P < .05$). Cohen's d effect size values were classified as follows: trivial (<0.2), small (>0.2), moderate (>0.5), and large (>0.8) [21].

Results

Table 1 presents the descriptive data on physical performance and asymmetries.

Table 1 here

The relationship between 180CODL, %CODDR, %CODDL, between-limbs SBJ asymmetry and between-limbs CODD asymmetry demonstrated significant correlations ($P < .05$), with correlation coefficients ranging from small to very large (r = 0.28 to 0.74) with 180CODR (Figure 1A). Significant ($P < .05$) and small to very large (r = -0.30 to 0.41) relationships were found between 180CODL and %CODDL, SBJR, and SBJL (Figure 1B). In addition, a very large correlation was found between %CODDR and %CODDL (r = 0.91; $P < .05$) and 10-m (r = -0.84; $P < .05$) (Figure 1C). A very large negative correlation was observed between %CODDL and 10m (r = -0.83; $P < .05$) (Figure 1D).

Figure 1 here

For %CODDR, the regression analysis in Model 1 showed a negative and significant standardised coefficient for the 10-m sprint time (β = -0.62), indicating a strong inverse relationship between the 10-m sprint time and %CODDR (Table 2). This model accounts for 37% of the variance in %CODDR. For %CODDL, Model 1 also shows a negative and significant standardised coefficient for the 10-m sprint time (β = -0.75), suggesting a strong inverse relationship between the 10-m sprint time and %CODDL. Model 2 for %CODDL introduces SBJL as another predictor with a negative standardised coefficient (β = -0.30). The R^2 value of 0.74 in Model 2 indicates that this model explains 74% of the variance in %CODDL. However, no regression model was predictive for 180COD in either limb.

Table 2 here

Between-group analyses with high and low %CODD revealed significant differences in performance across several tests, including 180CODR, 180CODL, 10-m sprint, %CODDR, %CODDL, and %CODD asymmetry with significant ($P < .05$) and moderate and large ES (ES: -1.07 to 0.55) (Table 3).

Table 3 here

Discussion

This study assessed how performance variables related to speed and jumping influence the variability of %CODD among adult highly trained female soccer players. The main findings of the study were that: 1)significant correlations between several performance metrics, including 180CODL and 180CODR, %CODDR and %CODDL, and SBJ asymmetry (r = 0.28 to 0.74) were found, highlighting the relationship between COD ability, jumping power and acceleration; 2)a very large correlation (r = 0.91) between %CODDR and % CODDL indicated a uniform pattern of directional change deficit; 3)regression analysis showed the predictive power of 10-m sprint time for %CODDR and %CODDL, with strong inverse relationships indicating that faster 10-m sprint times correspond to a greater %CODD; 4)the addition of SBJL as a predictor of %CODDL significantly improved the explanatory power of the model, explaining a substantial part of the variance in %CODDL and underlining the importance of jumping performance in determining COD ability; and, 5)comparative analysis between groups classified by %CODD performance revealed significant disparities in several tests, such as 180COD and %CODD asymmetry. The effect sizes varied from moderate to large, indicating performance differences based on COD efficiency and highlighting the relevance of %CODD as a critical factor in assessing physical capabilities.

This study observed a significant relationship between 180CODR and 180CODL, %CODD of both legs, and SBJ asymmetry (r = 0.28-0.74). A similar relationship was observed between 180CODL and %CODD of the same leg and SBJ of both legs (r = -0.30 to 0.41). In addition, a very large correlation (r = 0.91) was found between %CODDR and %CODDL, reflecting a uniform pattern of directional change deficit. Focusing on the relationship between 180COD and %CODD, our findings are reinforced by those found in a recent study of adolescent soccer players, which found important relationships between 180CODL, 180CODR, %CODDR, and %CODDL (r = 0.63-0.82) [11]. To date, limited research has investigated the relationship between 180COD and %CODD in women's soccer. The use of %CODD was recommended by Freitas et al. [13] and is based on the difference in percentage between sprint and COD itself. The aim was to standardise the measurement of CODD as it is currently proposed to be calculated based on time or speed, something that could lead to confusion for technical teams [11]. For this reason, previous research has used CODD instead of %CODD [16,22]. In such research, "large" correlations have been reported between the COD test and CODD in the left and right (r = 0.69-0.65) limb in adolescent soccer players [16] and male team athletes between 505 times and CODD (dominant leg r = 0.64 and non-dominant r = 0.63) [22]. This suggests that better performances in COD tests correlate with CODD and %CODD. Another outstanding result was the relationship between 180CODR and SBJ asymmetry or 180CODL and SBJ performance with both legs. Regarding jump asymmetry and COD, Maloney et al. [23] demonstrated that unilateral jump asymmetry was associated with lower COD performance (r = 0.6) in healthy adult males. Dos'Santos et al. [24] found a unilateral horizontal jump asymmetry of 6.3% that showed no association with COD performance in a male university sample. To the authors' knowledge, there are few studies on the relationship between jump asymmetries and COD performance in adult female soccer players [21,22]. Notably, the aforementioned studies found jumping tests to be more sensitive in identifying limb asymmetries (8-12%) than COD tests (2-3%) and were negatively related to sprint times [25,26]. These contradictory results indicate the need to increase knowledge through research to establish the relationship between these asymmetries and physical performance. The last of the aspects mentioned refers to the greater horizontal jump distance and performance in the COD. In the action itself performed to change direction, we can find certain similarities with unilateral horizontal, vertical, and lateral jumps [27]. The present study found significant relationships between 180CODL and SBJ of both legs (r = -0.31-0.30). Other research has found similar results between 180COD and horizontal jumping with the right (r = -0.59-0.47) and left legs (r = -0.53-0.49) in a sample of adolescent female soccer players [11]. One explanation for the lower ratio in our study is that movement patterns associated with horizontal jumping are trained from an early age [28,29], whereas skills such as COD are developed more intensively in later stages of the athletic career; thus, this ratio decreases in older athletes [25]. Coaches and practitioners are advised to include plyometric exercises such as: lateral jumps, unilateral forward and backward jumps, in addition to lateral displacements, quick footwork exercises with ladders, and sprints with elastic resistance bands or sleds. This allows athletes to partly mimic the movement patterns of the sport and increase explosive power capabilities.

In our study, the regression analysis shows the predictive power of a 10-m sprint time for %CODD in both legs, indicating that a faster 10-m sprint corresponds to a higher (worse) %CODD. Furthermore, by adding SBJL as a predictor for %CODDL, the model's explanatory power increased significantly, explaining a substantial part of the variance in %CODDL and emphasising the importance of jumping performance in COD capacity. Fernandes et al. [16] suggested that one explanation for athletes with higher acceleration performing worse in CODD could be that higher momentum requires more intense braking, which depends on eccentric strength. In that study, adolescent female players with better CODD showed no correlations between the 10-m sprint and CODL (r = -0.39) and CODR (r = -0.34) [16]. Similar results were observed in male athletes playing team sports in the CODD and acceleration (sprint 10-m) (r = -0.11) [10]. The hypothesis of Fernandes et al. [16] is supported by previous research linking CODD mainly to the braking phase and thus to eccentric-type strength [30]. Consequently, exercises that emphasise eccentric loading, such as isoinertial training, could improve the CODD [30]. As noted above, horizontal jumping is related to COD performance, and the predictive power of SBJL demonstrates this for %COD. Kugler et al. [31] have highlighted the importance of horizontal forces for acceleration, emphasising that not only is maximal force needed in the forward direction, but it must also be applied optimally. A current systematic review and meta-analysis revealed a positive relationship between horizontal jump distance and linear sprint performance, suggesting that athletes who achieve longer jumps tend to have faster sprint speeds [32]. This result is due to the fact that there are certain similarities in the two tasks: 1)the strength in the horizontal direction and power output, 2)the anaerobic energy metabolism and, 3)the characteristics of the movement (unilateral contacts with the ground and the extension of the three joints) [32]. In a similar vein, Robbins et al. [33] conducted an analysis of the relationship between linear velocity (acceleration in the first few metres and velocity over longer distances) and horizontal jump in elite college soccer players, finding correlations between long jump distance and top speed performance ranging from 0.35 to 0.47, while their correlation coefficients with acceleration performance ranged from 0.35 to 0.43. Furthermore, Mackala et al. [34] found large to very large associations between long jump performance and sprint times at 10 m ($r = 0.70$), 30 m ($r = 0.74$), and 100 m ($r = 0.82$). Despite all the above, research on SH is difficult to interpret because of the different protocols used: the standing long jump, the horizontal drop jump, the horizontal triple jump, and its scarcity in women's soccer [26].

When analysing the sample by dividing it into two groups (high-low %CODD), the group exhibiting high %CODD demonstrated superior outcomes in 180CODR and 180CODL (ES= -0.86 and -1.07) and %CODD (ES right= -0.64 and ES left= -0.83). However, the same group also had a significantly higher %CODD asymmetry (ES = 0.55) and a significant worse 10-m sprint time (ES =0.42). Similar results were reported in a recent study of adolescent female soccer players with the same sample division (%CODD high and low groups) [11]. The %CODD high group performed better in horizontal jump asymmetry, 180CODR, and %CODDR-%CODDL (ES = 0.73-2.39) [11]. In addition, the group with the worst %CODD score had a significantly lower acceleration performance (ES = 0.63) and a non-significant but higher %CODD asymmetry (ES = 0.37) [11]. Similar results were observed in the aforementioned study by Fernandes et al. [16]. As indicated, athletes with greater speed in the first few metres could be penalised in the COD by braking more intensely, generating a more significant eccentric load. In addition, more trained athletes may have a greater asymmetry in the CODD because of the greater specialisation or adaptation of one of the limbs by repeating similar movement patterns with that leg. Despite the significant findings in these studies, further research is needed to draw conclusions and fully understand how these variables interact.

Among the limitations of the present study, it should be noted that the research focused on adult female soccer players, and the findings cannot be generalised to other populations (e.g. male football, other ages and team sports). In addition, a larger sample would have facilitated the classification of players by position and allowed more reliable results to be obtained [29,30]. Finally, the scarcity of research related to %CODD in women's soccer was another limiting factor. However, this study provides novel data relevant to improving women's soccer performance.

Conclusions

The present study shows a strong relationship between COD, jumping power, and acceleration, highlighting the correlation between %CODDR and %CODDL. The study also reveals that 10-m sprint times predict %CODDR and %CODDL and that faster times indicate greater CODD, highlighting the role of sprinting performance on COD ability. Group analysis based on %CODD showed that those with better %CODD had better results in 180CODR, 180CODL, and overall %CODD but also showed greater %CODD asymmetry.

Practical Applications

Based on the results of this study, it is recommended that the physical preparation of adult female soccer players should focus on trying to improve acceleration, deceleration and, therefore, COD movements as well. For this purpose, vertical and horizontal jumping exercises executed unilaterally should be included. In addition, with the aim of improving deceleration, higher eccentric loads should be worked on with specific COD exercises or inertial training.

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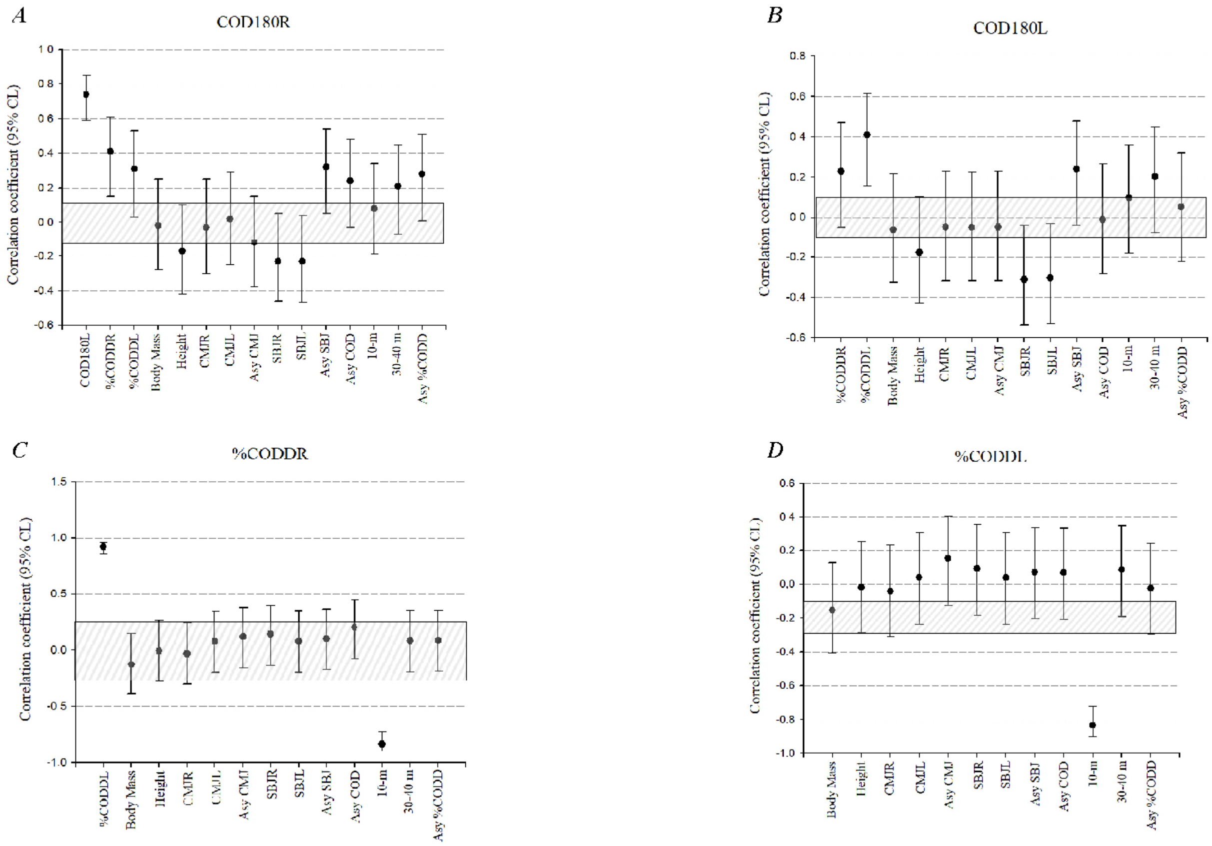

Figure 1. Correlation coefficients (95% confidence interval) describing the relationships between the 180º change of direction right (180CODR) and left (180CODL), the percentage-based change of direction deficit with right leg (%CODDR) and left leg (%CODDL), body mass, height, unilateral countermovement jump with right (CMJR) and left (CMJL), between-limbs CMJ asymmetry (Asy CMJ), standing broad jump with right (SBJR) and left (SBJL) legs, between-limbs horizontal jump asymmetry (Asy HJ); 10 m linear sprint, 30-40 m sprint, and between-limbs %CODD asymmetry (Asy %CODD) for all female soccer players. The grey areas represent the range of trivial correlation coefficient.

Table 1. Descriptive data for all physical performance tests

Variable	Mean ± SD	Asymmetry (%)
CMJR (cm)	13.5 ± 2.07	6.16 ± 5.56
CMJL (cm)	13.7 ± 1.91	
SBJR (cm)	144.2 ± 12.7	2.81 ± 2.01
SBJL (cm)	144.8 ± 12.1	
180CODR (s)	2.67 ± 0.17	3.44 ± 2.75
180CODL (s)	2.65 ± 0.18	
10-m (s)	1.94 ± 0.16	
30-40 m (s)	1.39 ± 0.09	
%CODDR (%)	38.8 ± 16.4	11.6 ± 9.73
%CODDL (%)	38.1 ± 15.6	

CMJR and CMJL: unilateral countermovement jump with right and left legs; SBJR and SBJL: standing broad jump with right and left legs; 10-m: linear sprint of 10 m; 180CODR and 180CODL: 10-m shuttle-sprint with one change of direction to right or left; %CODDR and %CODDL: the percentage-based change of direction deficit to right of left

Table 2. Model linear regression analysis with measures of COD and %CODD.

		Intercept	Standardized coefficient	Partial *r*	*P*	R^2	*r*
%CODDR	Model 1	10-m	-0.62	-0.62	< .001	0.37	0.62
%CODDL	Model 1	10-m	-0.64	-0.64	< .001	0.41	0.40
	Model 2	10-m	-0.75	-0.70	.008	0.74	0.47
		SBJL	-0.30	-0.37			

*No variables in 180CODR and 180CODL models

180CODR and 180CODL: 10-m shuttle-sprint with one change of direction to right or left; %CODDR and %CODDL: the percentage-based change of direction deficit to right of left; SBJL: standing broad jump with left leg.

Table 3. Analysis of all variables between **high and low** %CODD groups

	High %CODD (n=16)	**Low** %CODD (n=17)	ES (95% CI)	*P*
CMJR (cm)	14.1 ± 1.81	13.3 ± 2.19	0.36 (-0.18; 0.92)	**.197**
CMJL (cm)	13.3 ± 1.73	13.6 ± 2.06	0.14 (-0.41; 0.68)	**.631**
Asy CMJ (%)	6.19 ± 5.21	5.98 ± 5.99	0.04 (-0.51; 0.58)	**.895**
SBJR (cm)	144.1 ± 11.7	144.5 ± 13.9	-0.04 (-0.58; 0.51)	**.898**
SBJL (cm)	145.9 ± 10.6	144.1 ± 13.5	0.15 (-0.39; 0.70)	**.590**
Asy SBJ (%)	2.68 ± 1.83	3.01 ± 2.17	-0.15 (-0.71; 0.39)	**.577**
180CODR (s)	2.61 ± 0.12	2.73 ± 0.16	-0.86 (-1.43; -0.28)	**.004***
180CODL (s)	2.59 ± 0.11	2.74 ± 0.15	-1.07 (-1.65; -0.47)	**< .001***
Asy COD (%)	3.83 ± 2.51	3.18 ± 2.99	0.23 (-0.32; 0.7)	**.407**
10-m (s)	1.96 ± 0.21	1.90 ± 0.09	0.42 (-0.13; 0.97)	**< .001***
30-40 m (s)	1.41 ± 0.10	1.37 ± 0.09	0.34 (-0.21; 0.89)	**.231**
%CODDR (%)	34.8 ± 20.1	44.1 ± 6.07	-0.64 (-1.20; -0.08)	**.02***
%CODDL (%)	33.2 ± 18.1	44.2 ± 6.18	-0.83 (-1.40; -0.25)	**.005***
Asy %CODD (%)	14.6 ± 9.35	9.76 ± 8.58	0.55 (-0.01; 1.11)	**.04***

CMJR and CMJL: unilateral countermovement jump with right and left legs; SBJR and SBJL: standing broad jump with right and left legs; 10-m: linear sprint of 10 m; 180CODR and 180CODL: 10-m shuttle-sprint with one change of direction to right or left; %CODDR and %CODDL: the percentage-based change of direction deficit to right of left; CI: confidence intervals; ES: effect size

* indicates a significant difference between **high and low** %CODD groups ($P < .05$).