

Change of direction in soccer: the relationship with different physical abilities

Mudança de direção no futebol: a relação com diferentes habilidades físicas

Cambio de dirección en el fútbol: la relación con diferentes habilidades físicas

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Keywords:

Performance;
Strength;
Training;
Team sports.

ABSTRACT

The study aimed to explore the relationship between maximum dynamic strength, linear velocity, and muscle power with the change of direction deficit (DCOD) in young soccer athletes. Twenty male U-17 soccer athletes (16.05 ± 0.60 years) participated. They underwent various physical tests, including bench press, deadlift, squat repetitions, squat jump, countermovement jump, and linear speed assessments (10 and 20 m), as well as the zigzag test for change of direction. Multiple linear regression revealed weak correlations between physical abilities and DCOD ($R^2=0.35$, $p > 0.05$), indicating limited association. Overall, physical abilities exhibited low correlation with DCOD, suggesting its limited utility as a performance measure in young soccer athletes change of direction tests.

Palavras-chave:

Desempenho;
Força;
Treinamento;
Esporte coletivo.

RESUMO

O estudo teve como objetivo explorar a relação entre força dinâmica máxima, velocidade linear e potência muscular com o déficit de mudança de direção (DCOD) em jovens atletas de futebol. Vinte atletas masculinos da categoria Sub-17 ($16,05 \pm 0,60$ anos) participaram. Eles foram submetidos a testes físicos de supino, levantamento terra, agachamento, potência de membros inferiores, velocidade linear (10 e 20 m) e com troca de direção. A regressão linear múltipla revelou correlações fracas entre habilidades físicas e DCOD ($R^2=0,35$; $p > 0,05$), indicando uma associação limitada. Em geral, as habilidades físicas apresentaram baixa correlação com o DCOD, sugerindo sua utilidade limitada como medida de desempenho nos testes de mudança de direção em jovens atletas de futebol.

Palabras clave:

Rendimiento;
Fuerza;
Entrenamiento;
Deportes de equipo.

RESUMEN

El estudio tuvo como objetivo explorar la relación entre la fuerza dinámica máxima, la velocidad lineal y la potencia muscular con el déficit de cambio de dirección (DCOD) en jóvenes atletas de fútbol. Participaron veinte atletas de fútbol masculino U-17 (16.05 ± 0.60 años). Se sometieron a diversas pruebas físicas, incluyendo press de banca, peso muerto, repeticiones de sentadilla, salto de sentadilla, salto de contramovimiento y evaluaciones de velocidad lineal (10 y 20 m), así como el test en zigzag para cambio de dirección. La regresión lineal múltiple reveló correlaciones débiles entre las habilidades físicas y el DCOD ($R^2=0.35$, $p > 0.05$), indicando una asociación limitada. En general, las habilidades físicas mostraron una correlación baja con el DCOD, sugiriendo su utilidad limitada como medida de rendimiento en pruebas de cambio de dirección en jóvenes atletas de fútbol.

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Received 25 March 2024; accepted 16 October 2024.

DOI: <https://doi.org/10.1590/rbce.46.20240025>



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INTRODUCTION

Soccer players perform a high number of sprints with a change of direction and speed during the execution of their actions, followed by periods in which the speed tends to decrease, generating an intermittent characteristic (Loturco et al., 2019). Several pieces of evidence have suggested that the formal soccer game changed due to its modernization, such as increases in the number of sprints, changes of direction, and distance covered during these efforts (Bush et al., 2015; Di Salvo et al., 2009). In this sense, several researchers in the exercise sciences have sought to develop and understand training methods that enable the increase of repeating sprints and the development of their acceleration (Beato et al., 2022; Loturco et al., 2018).

In team sports, it is evident that the initial phase of sprint is critical, as it has the highest acceleration rate (Akenhead et al., 2013). In soccer, high-intensity efforts start from displacements at moderate or low intensities, and their peak speed can often be between 6 and 20 m (Loturco et al., 2019; Di Salvo et al., 2009; Rumpf et al., 2016). Furthermore, sprints are usually performed at moments of great importance in the game, such as defensive actions, aiming to interrupt opponent attacks (Rumpf et al., 2016; Sasaki et al., 2015) or during the execution of fast offensive actions, generating opportunities and thus can have a direct impact on the result of the match (Faude et al., 2012). However, other actions are recognized as frequent and important, such as jumps and changes of direction (Loturco et al., 2018).

More specifically, the ability to change of direction (COD) has been widely studied, seeming to play an essential role in soccer athletes' success (Goral, 2015; Mujika et al., 2009). The COD can be defined as the ability to make directional changes suddenly (Chaouachi et al., 2012) and has been described as a complex skill, being affected by several factors, such as linear speed, running technique, lower limb power, and strength (Thomas et al., 2018). Due to this complex characteristic and the frequency with which CODs occur within the game, it is essential to identify its impacts on physical performance since COD can result in additional time during displacement (Loturco et al., 2019). This time difference between COD and linear sprints is called a deficit of COD (DCOD) and is proposed as the best strategy for evaluating COD in football (Loturco et al., 2018). Studies investigating young soccer athletes have reported that higher linear speeds may not be associated with a DCOD, suggesting that other physical capacities may directly impact this variable, such as muscle strength (Loturco et al., 2018).

In this line, as far as our knowledge is concerned, current studies are dedicated to identifying the variable with a greater relationship with the DCOD values (Loturco et al., 2018; Thomas et al., 2018). So, it is pertinent that there are a possible identification and quantification of the relationship of different physical

capacities in the COD in different team sports, which, in the practical field, could optimize the training process since these are improved in isolation or small sets (Faude et al., 2017). Considering this scenario, the present study aimed to investigate the relationship of maximum dynamic strength, linear speed, and muscle power with DCOD young soccer athletes.

MATERIALS AND METHODS

STUDY DESIGN

This is a cross-sectional observational study of a predictive nature. Due to the selected subjects' previous routines, they were already familiar with the tests used in the present study. The order to perform the procedures was: i) heel height and lower limb power tests; ii) maximum sprint speed test; iii) ability to change direction, and; iv) maximum dynamic strength test. Before evaluations, athletes performed standardized warm-up, which included running at self-selected moderate intensity for 5 min, and submaximal attempts at the exercises to be performed. During the procedure, which took place between 1 pm and 5 pm and was carried out in a regular training field, the temperature was 25°C, and the relative humidity was 52%. Previously, all athletes and their guardians signed an informed consent. This study has prior approval from the local research ethics committee (number #3.536.069).

SUBJECTS

The sample consisted of 20 young males (age: 16.05 ± 0.60 years; height: 176.65 ± 6.17 cm; body mass: 71.25 ± 6.75 and; fat percentage: 7.66 ± 2.23), which make up the squad of a football team in the U-17 category. For inclusion in the study, the athlete should have been included in the group for at least 3 uninterrupted months and have attendance higher than 85% in the month's training sessions before the assessment. All those who had functional limitations resulting from a previous injury that made it impossible to perform the exercises or not complete the evaluations' battery were excluded. Recruitment occurs through convenience, through verbal invitation, due to the institutional link already established.

LOWER LIMB POWER

To evaluate the power of the lower limbs was used squat jump (SJ) and countermovement jump (CMJ), and in both jumps, there was the use of a contact mat (Jump System®, Nova Odessa, Brazil). The SJ started from 90° knee flexion for three seconds and subsequent vertical jump, while the CMJ started from squatting followed by a vertical jump. The subjects performed the jumps barefoot and with the hands-on the waist (test-retest reproducibility of $r = 0.93$) (Markovic et al., 2004). For the jumps, two attempts were granted, considering the highest valid trial. After this procedure, the best

CMJ performance was used in conjunction with the predictive equation: $\text{Power (W)} = 54,2 * \text{jump height (cm)} + 34,4 * \text{body mass (kg)} - 1520,4$, proposed by [Gomez-Bruton et al. \(2019\)](#).

MAXIMUM SPRINT SPEED

The maximum sprint speed was measured during 10-m (S10) and 20-m (S20) linear sprint tests. For this, photocells (Multisprint, Hidrofit®) were used, positioned in the field at 0 and 10 m and at 0 and 20 m (test-retest reproducibility of $r = 0.89$) ([Moir et al., 2004](#)). Two attempts were made for each test with a 1 min interval between them, and the best performance was recorded.

ABILITY TO CHANGE OF DIRECTION

The COD was tested in the open field, using a zigzag test ([Loturco et al., 2018](#)), which consists of displacements of 20 m and a change of direction at 100° angles every 5 m, as shown in Figure 1. To measure the total travel time, photocells (Multisprint, Hidrofit®) were used, positioned in the field at 0 and 20 m. The best mark between the two attempts, with a 1 min interval between them, was adopted for further analysis. To quantify the DCOD, a calculation adapted by [Pereira et al. \(2018\)](#), namely: speed of 20 m - speed of the zigzag test.

For identifying this variable, repetition maximum (RM) testing was employed using the 10RM protocol, which followed the recommended for [Materko et al. \(2007\)](#). The exercises adopted were bench press, deadlift, and squat. Before the attempts, 10 submaximal attempts were made for each exercise to be performed, using 30% of the individual's body mass as a reference. In order to standardize the tests, five strategies were adopted: i) specific warming; ii) standardization of the explanation given to the subjects before the test was performed; iii) the subjects received the same instructions regarding the pattern of execution of the movements; iv) feedback and extrinsic encouragement were adopted during the tests and; v) the masses of washers and bars were measured with a platform scale (Filizolla®), with a precision of 0.1 kg. All subjects had, at most, five attempts with intervals between 3 and 5 min between each one ([Materko et al., 2007](#); [Fermino et al., 2005](#)).

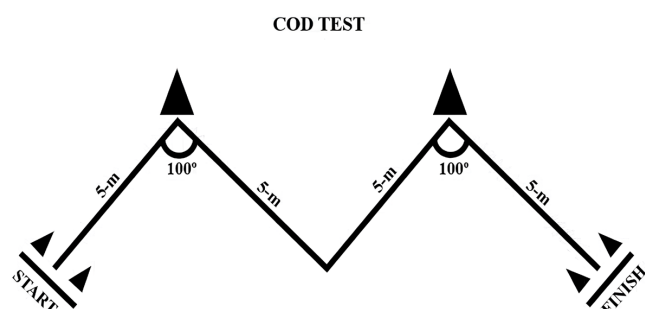


Figure 1. Change of direction Test. *Maximum dynamic strength.*

STATISTICAL ANALYSIS

The normality of the data was verified using the Shapiro-Wilk test. Due to the normal distribution, descriptive data are presented by means and standard deviation (SD). Considering that the COD test and the S20 present the same distance covered, although the S20 is performed in a linear way, Student's T-test was used to identify possible differences between the tests. The Pearson test was used to measure the correlation between the physical performance variables and the DCOD. Also, multiple linear regression was used to verify associations between DCOD and other physical abilities. The significance level adopted was 5%. All statistical treatments were performed using the SPSS 20.0 software.

RESULTS

Table 1 presents the descriptive data obtained through the evaluation of physical performance in young soccer athletes. Significant differences were found in the time of COD test about S20 ($p < 0,05$).

Figure 2 presents data about the correlation between DCOD and physical performance variables. It is noteworthy that there were no significant relationships with the measured parameters.

Table 2 presents the data obtained in the multiple linear regression, which sought to verify associations between the DCOD and the different physical capacities measured. In general, the variables when observed in isolation do not present significant values, despite the model used in the analysis predicting 35% of the DCOD.

DISCUSSION

The present study aimed to investigate the relationship between DCOD and different physical fitness

Table 1. Descriptive data of physical tests performed in soccer players ($n=20$).

Variables	Mean ($\pm$ SD)	95% CL
Change of Direction (sec)	$5.75 \pm 0.33^*$	5.59 – 5.91
Deficit change of Direction (sec)	-2.81 ± 0.31	-2.96 – -2.66
Squat jump (cm)	37.76 ± 4.25	35.77 – 39.74
Countermovement jump (cm)	38.89 ± 4.35	36.92 – 40.92
Power of lower limbs (W)	3038.43 ± 372.50	2864.10 – 3212.77
Sprint 10-m (sec)	1.69 ± 0.10	1.64 – 1.74
Sprint 20-m (sec)	2.93 ± 0.10	2.88 – 2.98
Bench press (kg)	71.29 ± 8.45	67.33 – 75.24
Deadlift (kg)	119.41 ± 16.02	111.91 – 126.91
Squat (kg)	114.94 ± 20.92	105.14 – 124.73

SD: standard deviation; CL: confidence of limits; $*p < 0,05$ in relation to sprint 20-m.

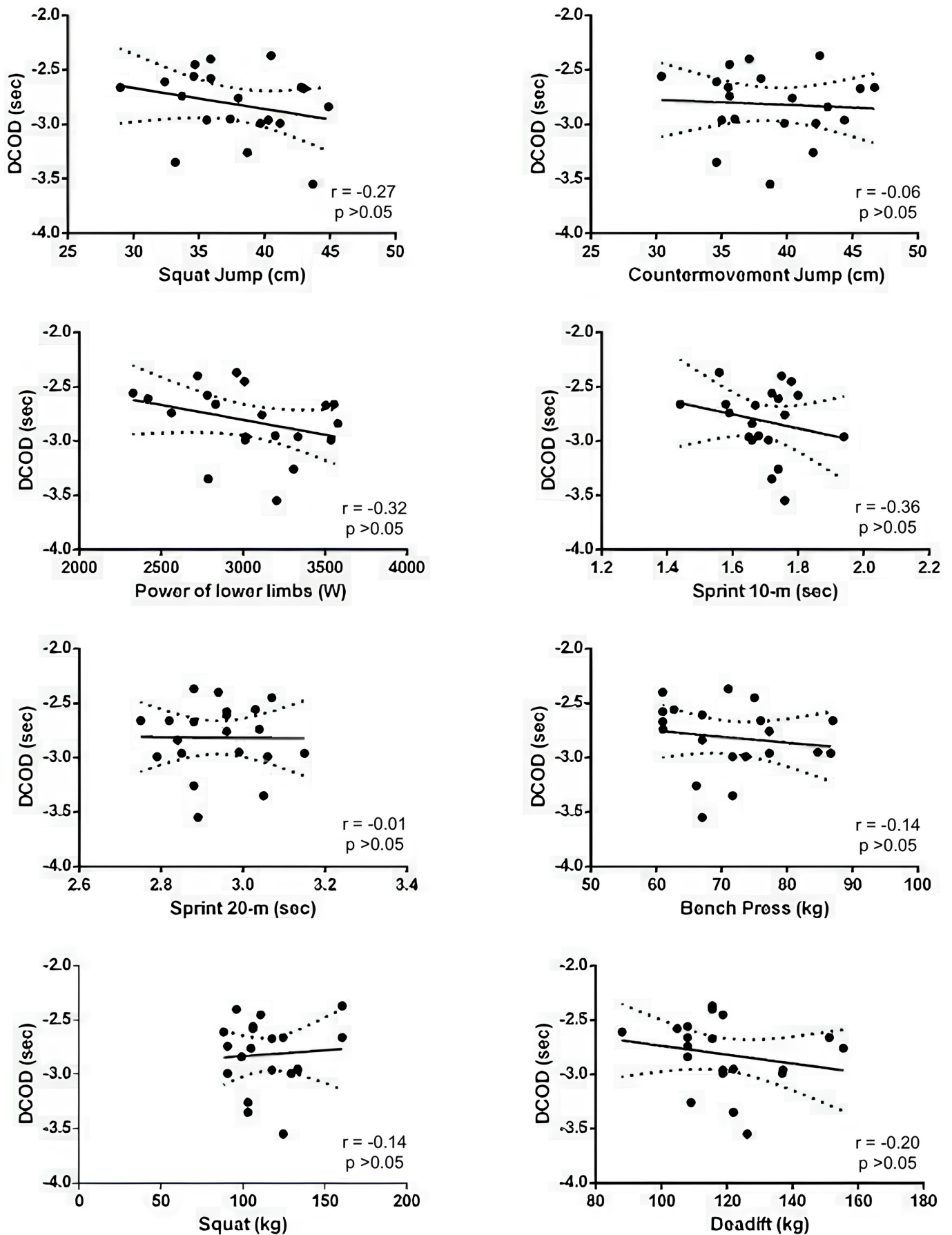


Figure 2. Correlation coefficients (r) between DCOD and physical test performed ($n=20$).

Table 2. Multiple linear regression to estimate the associations between DCOD and different physical abilities (n=20).

Variables	B	CI 95%	R ² Change	P-value
Constant	-3.678	-12.919 – 5.564		>0.05
Squat jump	-0.30	-0.113 – 0.054	0.06	>0.05
Countermovement jump	0.059	-0.039 – 0.158	0.004	>0.05
Sprint 10-m	-0.414	-2.604 – 1.775	0.046	>0.05
Sprint 20-m	0.752	-1.683 – 3.187	0.000	>0.05
Power of lower limbs	-0.001	-0.002 – 0.001	0.106	>0.05
Bench press	-0.005	-0.036 – 0.025	0.021	>0.05
Deadlift	-0.003	-0.018 – 0.012	0.043	>0.05
Squat	-0.004	-0.007 – 0.016	0.005	>0.05
R ² = 0.353				
SEE= 0.33				
F= 0.751				
P= >0.05				

R²: Determination coefficient; F: F statistic; p: model significance; SEE: standard error of the estimate; B: Beta coefficient; CI 95%: Confidence interval of 95%.

variables, such as maximum strength, linear speed, and power in young soccer athletes. As the main finding, the fact that the different physical capacities considered in this manuscript have a low non-significant correlation with DCOD is highlighted.

In soccer, CMJ is widely presented as a frequent exercise in training and testing, presenting similarity with specific gestures, and a good correlation with other physical capacities (Barker et al., 2018). Studies have sought to understand the relationship between CMJ and COD performance (Emmonds et al., 2019; Suarez-Arrones et al., 2020), but the results are still controversial. Suarez-Arrones et al. (2020) conducted a study whose sample involved athletes from 4 different team sports (n = 50), sought to identify associations between linear sprints, CMJ, and COD (90°). The authors show that S10 showed a moderate correlation ($r = -0.41$; $n = 50$) with DCOD, but the same was not observed in CMJ, which had a low correlation ($r = 0.33$). Although the data on the relationship between CMJ and DCOD are similar to those presented in the present study, S10 and DCOD are contrary. However, Loturco et al. (2018) corroborate our findings by reporting a low correlation between DCOD (measured through the zigzag test) and S10, when evaluating elite athletes. This counterpoint between the studies may be, in part, attributed to the number and angle of the COD used in the aforementioned manuscripts. In our study, as in that of Loturco et al. (2018), three DOCs were performed with an angle of 100° in displacements of 20 m, while in the study by Suarez-Arrones et al. (2020), a test was used with a single directional change of 90° and a total displacement of 10 m. Still, it is worth mentioning that a crucial point to be mentioned is the athletes' biomechanical pattern, which is a point of convergence between the studies addressed in this paragraph.

The study conducted by Freitas et al. (2019), evaluating elite rugby and soccer athletes, evaluated the

effect of different levels of CMJ peak power on performance in COD testing and DCOD, and the peak power had a small effect on these variables. These findings are in line with those obtained in the present study since our data suggest a small correlation. Still, previous research with elite team sports athletes divided the sample based on sprint speed (i.e., faster versus slower players) (Materko et al., 2007) and the maximum acceleration rate (i.e., high versus low acceleration capacity) (Loturco et al., 2019) and found that players with higher acceleration potential exhibit higher DCOD values. Our findings add to a robust recent body of evidence that suggests that more powerful and stronger athletes tend to be less efficient in changing direction (Loturco et al., 2019; Loturco et al., 2018; Pereira et al., 2018; Freitas et al., 2019).

Studies have suggested that the maximum dynamic strength improvement in a chronic way can generate favorable adaptations to develop speed, whether linear or with COD (Hammami et al., 2018), which raises questions about how these variables in fact are related (Loturco et al., 2017). A study conducted by Freitas et al. (2019), involving elite male athletes (46 soccer players and 32 rugby athletes) divided into groups of higher or lower loads considering the result obtained in a 1RM test using a half squat, sought to measure the influence of maximum strength under the COD, which in the results, was reported to have a small effect size. The previously mentioned research is in line with the present study's findings since the statistical analysis showed a trivial correlation between these variables. The similarity between the works can be that the test employed is multifaceted, making it more complex to relate the COD with physical fitness variables in isolation. A crucial point to be mentioned is that the strength tests carried out in the present study and previous works (Loturco et al., 2019; Pereira et al., 2018) are oriented vertically, and for the performance of the COD tests, in addition to

vertical strength, there is also a need to apply horizontally oriented strength (Freitas et al., 2019).

The data displayed suggests that COD performance is multifaceted and directly depends on different physical capabilities (Hewit et al., 2012; Goral, 2015). Still, we must also be clear that, as with any complex motor skill, there is a need to consider movement pattern, which was not performed in the present study and should be taken as a limitation of the study. However, since our study sample comprises athletes in the training process and their training routine, there are educational exercises to improve the movement pattern. We believe that this methodological bias is reduced.

CONCLUSION

In summary, in our study, physical abilities have a low correlation with the DCOD used here as a parameter to measure the performance in COD tests in young soccer athletes. However, these findings must be carefully observed. When taken to the practical field, it should be clear that our results in no way report that the skills employed here are not important for DCOD. On the contrary, we would like to emphasize the multifaceted characteristic of DCOD and that, due to this, the relationship between different variables is important for its improvement.

FUNDING

None.

CONFLICTS OF INTEREST

None.

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