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The determiner role of dynamic balance, flexibility and aerobic endurance on change of direction ability in young male soccer players

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Abstract. The purpose of this study was to investigate the role of dynamic balance (DB), flexibility and aerobic endurance in relation to change of direction (COD), and to compare playing positions in terms of COD, dynamic balance, flexibility, and aerobic endurance in young male soccer players. *Material and Method.* Forty-seven amateur soccer players aged 15-17yrs (U17) (16.21±0.68yrs, 10 center backs, 9 side backs, 10 midfielders, 11 wingers, 7 strikers) were included in the study. COD performance was assessed using the 505 and T-tests. The sit and reach test was used for the assessment of flexibility, the star excursion balance test for dynamic balance and Cooper's test for aerobic endurance. *Results.* The 505 test was correlated with Anterior (right) balance ($p=0.036$, $r=0.306$) and VO_{2max} ($p=0.011$, $r=-0.367$), and the T-test was correlated with postero-lateral (left) balance ($p=0.009$, $r=-0.377$) and VO_{2max} ($p<0.0001$, $r=-0.564$). Postero-medial (right) balance was different in favor of midfielders compared with side backs ($p=0.037$, 95% -23.12/-0.537). The VO_{2max} ($p=0.01$) and anterior (right) balance ($p=0.03$) were found as significant determiners for the 505 test ($R^2=0.223$). The VO_{2max} ($p<0.0001$) and postero-lateral (left) balance ($p=0.01$) were found as significant determiners for the T-test ($R^2=0.414$). *Conclusions.* This study showed that the aerobic endurance was a determiner for the 505 and T-tests in young male soccer players. The relationship between COD performance and dynamic balance was dependent on the COD test. COD, aerobic endurance or flexibility did not differ but dynamic balance could vary depending on the game positions.
Key words: *soccer, athletic performance, athletes, 505-change of direction test, T-test.*

Introduction

Soccer is defined as a high-degree coordinated sport discipline that uses both aerobic and anaerobic efforts. The character of the game requires skills performed under pressure in a restricted time and rapidly changing environment. Potential predictors of talent in youth soccer include a broad perspective on individual and sociologic predictors. In this content, many physiologic and physical measures such as agility, speed, strength, balance, coordination, flexibility, power, and muscular and cardiorespiratory endurance are used to determine the predictors of performance (1).

Agility is defined as rapid change of direction (COD) or velocity in response to a stimuli and the ability to start and stop quickly (2). Agility is separated into cognitive and perceptual factors (decision-making process) and performance factors (COD). COD is described as movements that are not required as an immediate reaction to a stimulus, they are considered as pre-planned in nature (2). There is increasing evidence about the importance of COD in the improvement of performance and decreasing musculoskeletal injury risk in soccer and other competitive sports in youth and elite team-sport players (3-5). However, most of youth soccer teams are not sufficiently focused on enhancing COD ability due to the lower training volume or lack of knowledge about how to develop COD.

COD is influenced by sprinting, speed, strength, power, and level of experience in soccer (5-7). An effective training program was suggested for improving COD in young athletes, and since then, the investigation of related factors to COD performance has become important. However, the literature focuses on its relationship between speed, muscular power (8) and some anthropometric variables in young athletes (9).

Soccer also requires some technical skills based on dynamic balance and flexibility such as accelerating, passing dribbling, kicking, jumping, and curling the ball. Seculic et al. (8) reported that COD performance was related to balance measures for men. Rouissi et al. (10) observed that some selected reaching directions of dynamic balance were related to COD performance in young elite soccer players. On the other hand, it has been found that the COD performance worsened in young soccer players with limited hamstring flexibility (11). There is very limited information in the literature about the relationship between COD, dynamic balance, and flexibility in soccer.

It is well known that fast twitch muscle fibers are dominant in COD movements. However, soccer is characterized by variant periods of high and low speed, which are able to stimulate both aerobic and anaerobic systems (12, 13). Aerobic fitness enhances recovery from high intensity intermittent exercise by increased aerobic response, improved lactate removal, and enhanced phosphocreatine regeneration (14). From this point of view, the relationship between aerobic endurance and sprint ability (12) or aerobic power (15) were investigated separately. However, as described above, COD is not just a sprint or power based ability. To the best of our knowledge, there is no evidence about the relationship between COD performance and aerobic endurance in soccer.

Based on these considerations, the first aim of our study was to investigate the role of dynamic balance, flexibility, and aerobic endurance in relation to COD and the determinative role of these parameters on COD performance in young soccer players. Such physical capacities of young soccer players may be dependent on the playing position in the field. Therefore, the secondary aim of the study was to compare playing positions in terms of COD performance, dynamic balance, flexibility, and aerobic endurance.

Material and Method

Sixty-one volunteer amateur soccer players aged of 15-17 (U17) years who had a soccer license for at least 6 months from 5 different regional youth amateur soccer teams were screened for the study. All participants had been involved in regular soccer training for at least five years. Participants who had any diagnosis of cardiopulmonary and vascular disease, a history of musculoskeletal injuries in the lower limbs in the last 6 months, and goal keepers were excluded from the study. This study was approved by the local ethics committee (2018/15-21) and was conducted in accordance with the Helsinki Declaration between March 1st, 2018, and May 1st, 2018. Written informed consent was obtained from the parents of the participants because all participants were aged under 18 years.

The content of the regular training programs was noted prior to the study for each team through the information from the coaches. They were all similar including; 10-15 min dynamic and static stretching exercises, 20 min running, sprinting, weight training, drill training, team-based functional training, small-sided games, and competitive matches for technical training. All teams performed three training sessions per week.

Demographic and sport-related data were noted. COD, sit and reach performance, dynamic balance, and aerobic endurance were measured. All assessments were made in the same time interval in the two days off with one-day break by the same researchers. The participants performed the sit and reach test and Cooper's 12-minute run test on the first day, and the Star Excursion Balance Test (SEBT), T-test, and 505 COD-test were performed on the second day. The participants were allowed to rest for one hour between tests for complete muscle recovery.

Sit and Reach Test. A sit and reach box (Baseline Evaluation Instruments, NY, USA) was used for the test. The participants performed a three minute warm up and static stretch for the low-back and lower body prior to the testing. The box was then placed on the floor and participants sat while keeping both legs extended without shoes. The participants maintained a 90-degree neutral position with their feet at the zero point of the box (equal to the 23 cm) and reached forward as far as possible for 3 seconds. The tester reminded the players to avoid forceful movement or bouncing and noted the distance reached on the box. The test was repeated three times and the best value was recorded in centimeters (cm) (16). The interclass correlation coefficient (ICC) for the repeated tests was 0.96 (95% CI; 0.70-0.85) and the coefficient of variation (CV) was 3.67 %.

Cooper's 12-Minute Run Test (Aerobic Endurance). The participants were instructed to run and complete as many laps as possible during the 12-minute test period on a 400-meter running track. The tester counted the laps completed during the test and alerted the players of the time elapsed at the 3rd, 6th, and 9th minutes, and verbally encouraged the participants when needed. At the end of the 12-minute period, the distance covered

during the test was determined. Cooper's formula (VO_{2max} = 22.351 d (km) - 11.288 (mL/kg/min)) was calculated for the determination of estimated $VO_{2max.}$ (17).

Star Excursion Balance Test (SEBT). The participants stand on one leg in the center of a grid with strips of tape placed at 45-degree angles, with the most distal aspect of the big toe on the starting line. The SEBT consists of 8 directions. The adapted version of the test was used in this study (18). Participants reached as far as possible with the reaching limb to the anterior (ANT), posteromedial (PM), and poster lateral (PL) directions while standing on a single leg and lightly touching the tape with the distal part of the bare foot, then returned to the starting position to resume a stable bilateral stance. The participants were allowed to rest for 5 minutes between the tests. The maximal reach distances were measured for each direction after three performances with both legs (18). The ICC for the repeated tests was 0.92 (95% CI; 0.83-0.94) and CV was 5.62%. The distances were then normalized to subjects' leg length, which was measured from the anterior superior iliac spine to the distal tip of the medial malleolus. The between-leg differences in relative reach distances were also derived from the formula ((stance leg with greater reach distance-stance leg with lesser reach distance)/stance leg with greater reach distance x 100 for each direction) (19).

Change of Direction Speed. The COD speeds were evaluated using the T-test and 505 COD-test.

T-test. This test assesses forward, left and right lateral, and backward running (20). Four cones were arranged in a T shape; the starting cone (point A), a cone placed 10 m (~10 yard) (point B) from the starting cone, and 2 further cones placed 5 m (~5 yard) (point C for left, point D for right) on either side of the second cone. The participants began with both feet behind the starting point (point A) and were instructed not to cross their feet while side shuffling. At their own discretion, each subject sprinted forward 10 m to point B and touched the base of a cone with the right hand. They then shuffled 5 m to the left to point C and touched the base of a cone with the left hand. The participants then shuffled to the right 10 meters to point D and touched the base of a cone with the right hand. They then shuffled 5 m to the left back to point B and touched the base of a cone with the left hand. Participants then ran backwards, passing the finishing line at point A. Three test trials were performed, and the best time was recorded. The ICC for the repeated tests was 0.88 (95% CI; 0.75-0.88) and CV was 6.02%.

505 Change of Direction Test (COD-t). This test assesses the 180-degree turning ability (21). The test cones were set up at 0 m, 10 m, and 15 m (turning point) in a line marked on the ground. The two timing gates were positioned at the 10-m cone. The participants take a starting position and sprint from the 0-m cone. The timing begins when they pass the 10 meter cone. When the participants reach the 15-m cone they turn 180 degrees with their preferred leg, then they sprint back towards the 10-m cone, at which point the tester stops the timer. The participants performed two trials with 2 minutes' rest between the trials, and the best time was recorded. The ICC for the repeated tests was 0.87 (95% CI; 0.72-0.94) and CV was 6.17%.

Data Analysis. The statistical analyses were performed using the Statistical Package for the Social Sciences (IBM, SPSS) Ver. 21.0 software package. Data are presented as mean ± standard deviation. Normal distribution of the participants was analyzed using the Shapiro-Wilk test. Pearson correlation analysis was used for parametric data (sit and reach distance, dynamic balance parameters, 505 COD-t, T-test, VO_{2max}), and Spearman correlation analysis was used for nonparametric data (between-leg difference in reach for all directions in SEBT). A correlation coefficient (r) between 0.26 and 0.49 reflects poor agreement, those between 0.50 and 0.69 reflect moderate agreement, and ≥0.70 reflects high agreement. Stepwise multiple linear regression analysis was performed to determine the multivariate influence of the predictors of 505 COD-t and T-test performance. One-way analysis of variance (ANOVA) was used in the comparison of the 5 playing positions. Dunnett's T3 post hoc multiple comparison test was performed to detect the differences between the groups. A two-tailed p value <0.05 was accepted as significant for all tests.

Results

Sixty-one young amateur soccer players were screened in terms of eligibility for the study. Ten goalkeepers and 4 players in different positions with a history of lower extremity injury in the last six months were excluded. Forty-seven players were included in the statistical analysis. The playing positions of the players were as follows; 10 center backs, 9 side backs, 10 midfielders, 11 wingers, and 7 strikers. Thirty-one players were right- and 16 were left-foot dominant. Table 1 and Table 2 represent the demographic features and results of flexibility, balance, COD, and aerobic endurance of the subjects according to the positions.

Table 1. The demographic features and the results of agility, flexibility, and aerobic endurance of the subjects according to the playing positions

	Total (n=47)	Center Back (n=10)	Side Back 2 (n=9)	Midfielder 3 (n=10)	Wing 4 (n=11)	Striker 5 (n=7)	*p*
Age	16.21±0.68	16.±0.81	16.44±0.72	16.3±0.67	16.09±0.53	16.28±0.75	0.653
Dominant Foot							
Right	31 (66)	10	4	7	5	5	0.060
Left	16 (34)	0	5	3	6	2	
BMI (kg/cm2)	21.22±2	21.95±1.48	21.57±2.58	20.7±2.6	20.9±1.23	21±2.02	0.636
Career duration (month)	57.57±24.21	59.4±23.4	58.66±26.45	61.2±34.15	53.45±19.61	54.85±16.76	0.956
Sit and Reach (cm)	29.98±8.79	34.15±4.69	33.11±6.07	26.20±8.47	26.68±13.46	30.64±3.54	0.141
505 COD-t (sec)	2.4±0.25	2.43±0.15	2.33±0.31	2.48±0.38	2.43±0.16	2.45±0.21	0.779
T-test (sec)	11.64±0.94	11.56±0.91	11.6±0.55	12±1.47	11.38±0.8	11.67±0.66	0.683
VO_2max (ml/kg/min)	40.9±7.39	42.51±4.14	42.41±7.6	35.75±9.25	41.87±7.52	42.52±6.03	0.181

Data presented as mean±SD or n (%); BMI: Body Mass Index; COD-t: Change of Direction Test

Table 2. The dynamic balance results of the subjects according to the playing positions

	Total (n=47)	Center Back (n=10)	Side Back 2 (n=9)	Midfielder 3 (n=10)	Winger 4 (n=11)	Striker 5 (n=7)	*P*
ANT (R) (%)	100.76±10.44	103.01±10.41	99.01±8.35	103.02±10.32	101.06±10.78	96.09±13.38	0.645
PL (R) (%)	88.75±13.7	91.66±16.4	84.74±12.04	87.46±8.75	94.31±16.04	82.84±12.69	0.362
PM (R) (%)	95.73±11.09	99.23±7.99	88.6±7.48	100.43±8.01	98.49±11.17	88.83±16.31	0.034*
ANT (L) (%)	101.11±11.37	103.83±10.91	99.56±10.53	105.28±11.04	100.6±13.95	94.07±7.44	0.317
PL (L) (%)	91.77±14.04	91.54±18.43	87.17±7.04	95.89±15.97	96.15±12.88	85.24±11.49	0.364
PM (L) (%)	95.63±12.29	97.68±8.13	92.56±10.55	94.89±13.91	101.17±13.37	88.98±13.9	0.277
ANT Between-Leg Difference in Reach (%)	5.68±4.34	5.27±4.21	6.43±3.18	3.57±3.03	7.14±5.65	6.01±4.99	0.274
PL Between-Leg Difference in Reach (%)	8.19±6.2	7.06±4.81	7.43±6.28	9.89±7.74	8.95±7.12	7.17±4.82	0.919
PM Between-Leg Difference in Reach (%)	7.32±6.47	5.86±2.69	6.34±4.27	9.09±9.78	5.71±5.67	10.7±7.75	0.525

Data presented as mean±SD; SD: Standard Deviation, BMI: Body Mass Index, R: Right, L: Left, Ant: Anterior, PL: Postero-lateral, PM: Postero-medial * Indicates a significant difference in favour of midfield compared with side back.

There were no significant differences between the positions in terms of age (p=0.653), dominant foot (p=0.060), body mass index (BMI) (p=0.636), career duration (p=0.956), sit and reach test (p=0.141), 505 COD-t (p=0.779), T-test (p=0.683), VO_{2max} (p=0.181), ANT (R) (p=0.645), ANT (L) (p=0.317), PL (R) (p=0.362), PL (L) (p=0.364), PM (L) (p=0.277) balance, ANT between-leg difference (p=0.274), PL between-leg difference (p=0.919), and PM between-leg difference (p=0.525) in reach of the subjects. There was a significant difference in PM (R) in favor of midfielders compared with the side backs (p=0.037, 95% -23.12/-0.537).

The correlations between COD and flexibility, balance, and aerobic endurance are shown in Table 3. There were positive poor correlations between 505 COD-t and ANT (R) (p=0.036, r=0.306) and VO_{2max} (p=0.011, r= -0.367). The T-test showed a poor negative correlation with PL (L) balance (p=0.009, r= -0.377) and VO_{2max} (p<0.0001, r= -0.564).

A stepwise multiple linear regression model was created by including only independent variables in the analysis that were correlated with the 505 COD-t (F=6.315, p=0.04) or the T-test (F=15.568, p<0.0001). There were no relationships between independent variables (colinearity statistics variance inflation factor; 505 COD-t=1.001, T-test=1.016). The independent variables explained between 18% (505 COD-t) and 38% (T-test) of the variance of the COD tests. The VO_{2max} (p=0.01) and ANT (R) balance (p=0.03) were found as significant determiners for the 505 COD-t. The VO_{2max} (p<0.0001) and PL (L) (p=0.01) were found as significant determiners for the T-test (Table 4).

Table 3. The correlation between agility and balance, flexibility, and aerobic endurance

	505 COD-t (sec) r	T-test (sec) r
Sit and Reach Distance (cm)	-0.109	-0.249
Anterior (right) (%)	0.306*	-0.078
Posteromedial (right) (%)	0.032	-0.165
Poster lateral (right) (%)	-0.035	-0.238
Anterior (left) (%)	0.240	-0.205
Posteromedial (left) (%)	0.078	-0.191
Poster lateral (left) (%)	0.007	-0.377**
ANT Between-Leg Difference in Reach (%)	0.029	0.198
PM Between-Leg Difference in Reach (%)	-0.083	0.193
PL Between-Leg Difference in Reach (%)	-0.005	-0.058
Vo2max (ml/kg/min)	-0.367*	-0.564**

Ant: Anterior, PL: Poster lateral, PM: Postero medial
*p<0.05. **p<0.001

Table 4. Multiple regression results for 505 COD-t and T-test

	505 COD-t (sec)			T-test (sec)		
	ß Coefficient	95 % Confidence Interval	R^2 (Adjusted R^2)	ß Coefficient	95 % Confidence Interval	R^2 (Adjusted R^2)
ANT (right) (%)	0.298*	0.001 / 0.014	0.223 (0.188)	*Not included in the model*		0.414 (0.388)
PL (left) (%)	*Not included in the model*			-0.009**	-0.037 / -0.005	
VO_{2max} (ml/kg/min)	-0.359*	-0.022 / -0.003		-0.526*	-0.097 / -0.037	

Ant: Anterior, PL: Posterolateral.
*p<0.05. **p<0.001

Discussions

The results of this cross-sectional study showed that aerobic endurance was a determiner of the 505 COD-t and T-test in young male soccer players. The relationship between COD ability and dynamic balance was dependent on the COD test. Additionally, COD ability, aerobic endurance or sit and reach performance was not differ according to playing position but posteromedial dynamic balance for right foot was better for midfielders compared with the side backs.

The T-test and 505 COD-t have been proved as reliable, sensitive (22), valid, and specific (10) tests for assessing COD-based agility in competitive sports including soccer. Most studies reported their results based on these tests or other COD tests under the term of 'agility' (8, 11, 22, 23). However, we prefer to discuss the results of these studies using 'COD performance' as suggested in the literature (2, 5). The characteristics of the two test are different in terms of the direction, COD angles, covered distance, and time taken. Our findings indicated diverse results about the relationship between dynamic balance and COD performance in two tests. We found that the T-test was negatively related with PL left balance and the 505 COD-t was positively related with anterior right and left balance. Lockie et al. (24) observed a significant relationship between medial right balance and T-test performance and emphasized the contribution of hamstring muscle strength in abilities of changing direction and speed.

Although we did not include medial reaching distance in the study, we found a relationship between the T-test and PL left balance, in line with the results of Roussi et al. (10) in the 90-degree COD test. It has been reported that the PL stability during SEBT is accomplished by the increased role of hip flexors of the supported leg and hip internal rotators in stabilizing the pelvis in the 90-degree lateral movement (25). The positive correlation between the 505 COD-t and anterior balance for the right foot was somewhat surprising

in this study. Roussi et al. (10) reported that the contribution of dynamic balance on changing direction performance was angle dependent and upon the leg used to turn. Their results indicated that the contribution of dynamic balance was lower at higher angles of COD compared with lower angles. In the present study, the players turned 180 degrees with their preferred foot during the 505 COD-t. We observed that the preferred foot was not always the same as the dominant foot. We think that the diversity in the relationships between COD tests and dynamic balance arises from the angle of COD and leg used to turn. Moreover, the 505 COD-t produces longer contact times compared with the T-test (26). It can be argued that the contact time may be longer in subjects with better balance. Considering that anterior balance was found as a determinant factor for the 505 COD-t in multiple regression analysis, we believe that this result is required to be re-examined with high-speed kinematic video analysis by testing both feet in future studies.

Although the anaerobic performance was found related with aerobic endurance (12), the relationship between COD and aerobic endurance was not directly investigated in young soccer players. The multiple linear regression analysis revealed the determiner role of estimated VO_{2max} for both COD tests in our study. Anaerobic or alactic energy source-dependent ballistic movements such as sprinting and COD are restored using aerobic energy through the resynthesis of phosphocreatine kinase and better lactate removal (14). It may be considered that this mechanism might be stronger in young competitive sports players with lower anaerobic metabolism (27,). This result indicates the possibility of improving COD through aerobic endurance training.

The T-test results of our study population were about 3 seconds slower (23) but the 505 COD-t results found similar (24) compared with previous studies conducted in young soccer players. In this study, while estimated VO2max values was interpreted as lower (28), the sit and reach performance (29) and SEBT results (10) were found similar to previous findings of male soccer players. The differences regarding these parameters according to playing positions in soccer have been investigated in several studies. Most studies categorized the players as defenders, midfielders, and forwards (24, 29). In this study, we categorized the players to 5 positions as center and side backs, midfielders, wingers, and strikers according to the Fédération Internationale de Football Association (FIFA) ultimate team positions. It has been observed that the literature provides conflicting results in comparing playing positions for different performance tests (23, 24, 29). Lockie et al. (24) investigated the COD and 505 COD-t according to playing positions and found that right-leg 505 COD-t was faster in midfielders compared with defenders and forwards. In contrast, Sporis et al. (23) found that the T-test showed significant differences between the defenders and midfielders, and defenders and attackers in favor of the defenders. They also suggested using specific tests according to the playing positions. For example, considering that defenders run backwards and midfielders made the most 180-degree turns during the game because of their specific role, it may be appropriate to use a 180-degree COD test. However, this type of evaluation can only provide a comparison of performance for players playing in the same position. We believe that these different results are due to the use of different types of tests for players of the same age or professional soccer players. In our study, all positions showed the same performance in both COD tests. This result may support Fiorilli et al. (6) who did not recommend using COD as an indicator to assign playing positions in youth soccer.

In our study, there were no difference between the positions in terms of sit and reach performance and VO_{2max}. Previous findings suggested more consistent results regarding VO_{2max} for different positions, even using different tests (29), suggesting that VO_{2max} does not differ between the playing positions. Only one study investigated sit and reach performance according to playing positions in a group of amateur soccer players and reported parallel results to ours (29). To our knowledge, there is no evidence about the dynamic balance abilities of young soccer players according to playing positions. In this study, posteromedial dynamic balance for the right foot was found better for midfielders compared with the side backs. Chatara et al. (30) showed that the maximal isometric strength of the lower limb had a significant implication on dynamic balance upon the reaching angle and the stance leg in young elite soccer players. Therefore, a possible explanation for our finding may be related with lower extremity muscle strength. From a general perspective regarding the comparison of playing positions, our results suggest that COD performance, flexibility, most of the parameters of dynamic balance, and aerobic endurance capacities were similar among players in different positions. All young amateur soccer teams perform the same kind of training, which was not differ according to the positions, except for goalkeepers. The similarity of performances according to the different positions may arise from the content of the training because we did not include goalkeepers in the study.

The limitations of the study should be acknowledged. First, the results may be transferred to improve COD-based agility performance; however, improving COD ability may not reflect the performance of reactive agility or agility with ball. The 505 COD-t was performed only for the preferred leg. Assessing the performance of both legs may gave different results. Although it has been reported that the sit and reach test is a valid method for measuring hamstring flexibility, the test is also sensitive for low back flexibility. Lastly, Cooper's 12-minute run test is a valid and widely used test in practice; however, it may underestimate VO_{2max} in individuals with lower VO_{2max} values (28).

Conclusions

The present study found that the aerobic endurance was a determiner of 505 COD-t and T-test in young male soccer players. This is the first study showed the determiner role of aerobic endurance on COD performance. A practical implication of the present finding is that COD performance for different directions may be improved through aerobic endurance training. The 505 COD-t performance was negatively influenced by ANT right balance and a better PL left balance contributed to the T-test performance. Therefore, the determiner role of reaching a direction in SEBT for COD performance seemed to depend on changing direction. This suggests that future investigation is needed to define the role of dynamic balance and muscle recruitment on COD performance through video-based kinematic analysis. In addition, only PM dynamic balance for the right foot was better for midfielders compared with side backs among the young male soccer players. Coaches should be aware that even through performing the same training with a relative lower volume, the dynamic balance abilities of young soccer players may be affected by the playing position. Furthermore, this may indicate including specific dynamic balance training depending on players' need.

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References

1. Unnithan V, White J, Georgiou A, et al. (2012). Talent identification in youth soccer. *J Sports Sci*; 30(15): 1719-26.
2. Sheppard JM, Young WB (2006). Agility literature review: Classifications, training and testing. *J Sports Sci;* 24(9): 919-932.
3. Lisman P, Gribbin T, Murphy K, et al. (2017). A Systematic Review of the Association between Physical Fitness and Musculoskeletal Injury Risk: Part 3-Flexibility, Power, Speed, Balance, and Agility. *J Strength Cond Res*; 33(6): 1723–1735.
4. Chaouachi A, Chtara M, Hammami R, et al. (2014). Multidirectional sprints and small-sided games training effect on agility and change of direction abilities in youth soccer. *J Strength Cond Res*; 28(11): 3121-27.
5. Paul DJ, Gabbett TJ, Nassis GP. (2016). Agility in team sports: Testing, training and factors affecting performance. *Sports Med*; 46(3): 421-442.
6. Fiorilli G, Mitrotasios M, Iuliano E, et al. (2017). Agility and change of direction in soccer: differences according to the player ages. *J Sports Med Phys Fitness*; 57(12): 1597-1604.
7. Pojskic H, Åslin E, Krolo A, et al. (2018). Importance of reactive agility and change of direction speed in differentiating performance levels in junior soccer players: reliability and validity of newly developed soccer-specific tests. *Front Physiol*; 9: 506
8. Sekulic D, Spasic M, Mirkov D, et al. (2013). Gender-specific influences of balance, speed, and power on agility performance. *J Strength Cond Res*; 27(3): 802-811.
9. Brughelli M, Cronin J, Levin G et al. (2008). Understanding change of direction ability in sport. *Sports Med*; 38(12): 1045-1063.
10. Rouissi M, Haddad M, Bragazzi NL, et al. (2018). Implication of dynamic balance in change of direction performance in young elite soccer players is angle dependent? *J Sports Med Phys Fitness*; 58(4): 442-449.
11. García-Pinillos F, Ruiz-Ariza A, Moreno del Castillo R et al. (2015). Impact of limited hamstring flexibility on vertical jump, kicking speed, sprint, and agility in young football players. *J Sports Sci*; 33(12): 1293-1297.
12. Aziz AR, Mukherjee S, Chia M et al. (2007). Relationship between measured maximal oxygen uptake and aerobic endurance performance with running repeated sprint ability in young elite soccer players. *J Sports Med Phys Fitness*; 47(4): 401.
13. Tomlin DL, Wenger HA. (2001). The relationship between aerobic fitness and recovery from high intensity intermittent exercise. *Sports Med*; 31(1): 1-11.
14. Stølen T, Chamari K, Castagna C, et al. (2005). Physiology of soccer. *Sports Med*; 35(6): 501-536.

15. Karakoç B, Akalan C, Alemdaroğlu U, et al. (2012). The relationship between the yo-yo tests, anaerobic performance and aerobic performance in young soccer players. *J Hum Kinet*; 35(1): 81-88.
16. Medicine ACoS. (2013). *ACSM's guidelines for exercise testing and prescription*: Lippincott Williams & Wilkins.
17. Cooper KH. (1968). A means of assessing maximal oxygen intake: correlation between field and treadmill testing. *JAMA*; 203(3): 201-204.
18. Plisky PJ, Rauh MJ, Kaminski TW, et al. (2006). Star Excursion Balance Test as a predictor of lower extremity injury in high school basketball players. *J Orthop Sports Phys Ther*; 36(12): 911-919.
19. Lockie RG, Schultz AB, Callaghan SJ, et al. (2016). The relationship between dynamic stability and multidirectional speed. *J Strength Cond Res*; 30(11): 3033-43.
20. Semenick D. (1990). The T-test. *Natl Strength Cond Assoc J*; 12: 36–37.
21. Draper J. (1985). The 505 test: A test for agility in horizontal plane. *Aust J Sci Med Sport*; 17(1): 15-18.
22. Negra Y, Chaabene H, Hammami M, et al. (2017). Agility in Young Athletes: Is It a Different Ability From Speed and Power? *J Strength Cond Res*; 31(3): 727-735.
23. Sporis G, Jukic I, Milanovic L, et al. (2010). Reliability and factorial validity of agility tests for soccer players. *J Strength Cond Res*; 24(3): 679-686.
24. Lockie RG, Moreno MR, Orjalo AJ, et al. (2019). Repeated-Sprint Ability in Division I Collegiate Male Soccer Players: Positional Differences and Relationships with Performance Tests. *J Strength Cond Res*; 33(5): 1362–1370
25. Neptune RR, Wright IC, Van Den Bogert AJ. (1999). Muscle coordination and function during cutting movements. *Med Sci Sports Exerc*; 31: 294-302.
26. Spiteri T, Newton RU, Binetti M, et al. (2015). Mechanical determinants of faster change of direction and agility performance in female basketball athletes. *J Strength Cond Res*; 29(8): 2205-2214.
27. O'gorman D, Hunter A, McDonnacha C, et al. (2000). Validity of field tests for evaluating endurance capacity in competitive and international-level sports participants. *J Strength Cond Res*; 14(1): 62-67.
28. A Apostol, A Ionescu, M Vasilescu (2013). Aerobic versus Anaerobic-comparative studies concerning the dynamics of the aerobic and anaerobic effort parameters in top athletes. *Medicina Sportiva*. The Journal of the Rpmanian Sports Medicine Society; 9(2): 2130-2140.
29. A Apostol, A Ionescu, M Vasilescu, M Berteanu (2013). A new approach to estimate the anaerobic capacity of the top athletes. *Medicina Sportiva*. The Journal of the Rpmanian Sports Medicine Society; 9(3): 2147-2159.
30. Hebestreit H, Mimura K, Bar-Or O. (1993). Recovery of muscle power after high-intensity short-term exercise: comparing boys and men. *J Appl Physiol*; 74(6): 2875-2880.
31. Aslan C. (2015). Comparing Selected Physical, Physiological and Technical Characteristics of a Group of Turkish Amateur Soccer Players According to Playing Positions. *Journal of Athletic Performance and Nutrition*; 2(2).
32. Chtara M, Rouissi M, Bragazzi NL, et al. (2016). Dynamic balance ability in young elite soccer players: implication of isometric strength. *J Sports Med Phys Fitness*; 58(4): 414-420.

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