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Relationship between linear running and change of direction performances of male soccer players*

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Abstract

It is known that there is a strong correlation between agility performance and match performance in terms of soccer players. Moreover, it is expressed that the agility and the linear sprint have different performance skills. Therefore, the purpose of this study was to analyze the relationship between linear sprint and change of direction performance scores and to determine the most appropriate agility test for soccer players. 16 male soccer players (age: 21.93±3.62 years, height: 175.06±3.06 cm, body mass: 69.51±7.40 kg, body mass index: 22.67±2.16 kg/m2, body fat ratio: 7.52±2.64%) participated in linear sprint and agility tests. All participants completed a test battery involving linear sprinting (10, 20, 30 m), agility tests (T test, 505, Pro-agility, illinois). The 10, 20, and 30 m sprint performance were positively correlated with performance on the illinois agility test ($p<0.05$). Furthermore, the 20 m sprint performance were positively significant correlated (r=.571, p=.042) with performance on pro-agility test. Lastly, the 10, 20, and 30m sprint performance were positively correlated (r=.329, p=.272; r=.370, p=.214; r=.338, p=.259 respectively) with performance on T test but this correlation levels were not significance. Given these meaningless relationships, it may state that the one of the most appropriate agility tests is T test for soccer players. This study provides support for the use of T test as an agility performance test in soccer players.

Key words: Agility, Field tests, Football, Sprint

INTRODUCTION

In many sports, athletes are required to accelerate, decelerate, and change direction throughout the game (19).Agility in team sports can be described as essential movements that necessitate the player to perform immediate changes in body direction and move the body movements quickly (7). Traditional definitions of agility have simply identified speed in directional changes as the defining component (16).The ability to move from one point to another as rapidly as possible is a desirable property and prerequisite to success in many activities and sports. In many sports, plenty bouts of rapid increases and decreases in velocity are required because of the determined area of play and to pursue or evade other players (11).

Bloomfield et al. (2) reported that frequency of turning and swerving within a match performed by English soccer players was 727. There is a consensus amongst the soccer fraternity that the game is becoming more dynamic. It is known that there is a strong relationship between agility performance and match performance in terms of average soccer players. Thus, change of direction (COD) ability has been used to predict qualification and player preference in professional American Football League players, and scouts tend to have better COD ability (28). In addition, agility speed is mostlyaffected by movement capability, sprinting speed, and muscular power(14).When the literature is examined, there are studies showing that researchers have been conducting studies on the relationship between linear and COD speed (19, 21). However, recently, acceleration, speed, and agility have been found to be independent, different qualities that generate a restricted transfer to each other (13).Moderate correlation has been reported that between Ttest performance and 37 m sprint times in a group of college-aged women by Paoule et al. (20).In contrast, Little and Williams (15) found a weak correlation between acceleration (10m) and maximum speed in a zig-zag agility test in a group of professional male soccer players.

The movements that are used within COD speed tests are wide and varied. As a result, numerous tests have been developed to assess COD speed in athletes (16).It is stated that the scores measured in the tests applied to assess agility properties should be independent of the maximum sprint rate (23).Because the association between agility and speed increases with longer distances and when examining agility with flying sprint times (27).At this point, it is also stated that the relationship between linear speed and direction change run is different motor characters (23, 1).Hazır et al. (10) concluded that relationship between linear velocity performance scores and agility performance scores is the most appropriate agility test for the test with the lowest level of significance. Thus, when the agility performance is examined in any sport branch, it is considered that the linear running and the agility test with the lowest significance value should be used. Moreover, the linear movements in many sports take place over very short distances (5). Despite high-speed directional movements covering 11% of the total distance, these movements have a feature that acts on the break points of the game. For this reason, rapidly changing movements are an important part of the game in terms of winning and critical interventions (15).

One of the key points of this study was the determination of the most appropriate COD tests applied in terms of sports branches, especially where small areas such as soccer cause significant results. To our knowledge, there has been no research in the literature that previously compared these four COD tests with each other and with linear running performance.Agility and speed tests need to be conducted to ascertain whether these performance characteristics are related. The purpose of this study was therefore to analyze the relationship between linear performance and agility performance scores and to determine the most appropriate agility test for soccer players.

MATERIAL AND METHODS

Participants

A total of 16 young men (age: 21.93±3.62 years, height: 175.06±3.06 cm, body mass: 69.51±7.40 kg, BMI: 22.67±2.16 kg/cm2, body fat ratio: 7.52±2.64%) soccer player participated in the study. All volunteers completed informed consent forms before participation in the study. This study was approved by University of Inonu Ethics Committee for Research on Human Participants. All of the participants were previously informed about the testing procedures and any known risks and provided their own written informed consent. All of the procedures were in accordance with the Helsinki Declaration of 2008 and the ethical standards of the International Journal of Sports Medicine(9).

Testing Procedures

The tests were performed on grass during the normal working day hours of 2:30 p.m. to 4:30 p.m.Firstly, height and weight were measured. We used an electronic body mass scale (SC-330ST Tanita, Illinois, USA) and a portable stadiometer (SECA, Leicester, UK) to measure body mass in the nearest 0.1 kg and stature in the nearest 1 mm with participants being barefoot and in minimal clothing, respectively. These measurements were used to calculate body mass index (BMI) as the quotient of body mass (kg) to stature squared (m^2). Percentage of body fat ratio (BFR%)was also calculated by an electronic body mass scale(SC-330ST Tanita, Illinois, USA). Before motor tests, participants were allowed 10–15 minutes to perform individual warm-up, including 3–5 minutes of light jogging and stretching exercises. Participants were allowed practice trials on all tests before the actual test trials (20). To avoid any fatigue, the tests were divided into three different days and applied at intervals of 48 hours (first test day was applied illinois and Ttest, second test day applied 505 and Pro-agility test). And, a third test day was applied linear running performance test (10-20-30 m). Participants were asked to perform each test three attempts, and only the best score of the three trials was selected for data analysis.

Linear Speed

The running speed of participants was evaluated with a 10-m (acceleration), 20-m (maximum speed) and 30-m (total time) sprint effort using dual beam electronic timing gates (Smart Speed; Fusion Sport, Australia). Gates were positioned 10^{th}, 20^{th}, and 30^{th} m from a pre-determined starting point. Volunteers were instructed to run as quickly as possible along the 30 m distance from a standing start. Participants began each sprint 30 cm behind the start line, in order to trigger the first. Speed was measured to the nearest 0.01 s, with the fastest score from three trials used as the speed score (8).

Change of Direction Speed Tests

Illinois Agility Test (IAT)

Participants started in a prone position at the starting cone. The length of the illinois agility test (IAT) is 10 m and the width (distance between the start and finish points) is 5 m. Four cones were used to mark the start, 2 turning points, and the finish. Another 4 cones were placed down the center an equal distance apart. Each cone in the center is spaced equal distance (3.3 m) apart (16). Participants were only instructed to complete the test as quickly as possible. Each volunteer performed 3 attempts, and only the best one was considered for statictical analysis.

T Test

The T test agility test was administered as originally set out by Semenick(22).Four cones were arranged in a T shape, with a cone placed (B) 9.14 m from the starting cone (A) and two further cones (C and D) placed 4.57 m on either side of the second cone. At theirown discretion, each volunteer sprinted forward 9.14 m (10 yd) to point B and rang a bell at the base of a cone with the right hand. They then shuffled to the left 4.57 m (5 yd) and touched a bell at the base of a cone (C) with the left hand. Participants then shuffled to the right 9.14 m and touched a bell at the base of a cone (D) with the right hand. They then shuffled to the left 4.57 m back to point B and touched a bell with the left hand. Finally, participants ran backward as quickly as possible and return to line A.Time was measured through the use of timing gates (Smartspeed, Fusion Sport, Australia) and considered for analysis. Each volunteer performed 3 attempts, and times were measured to the nearest 0.01 s with the fastest value obtained from three trials used as the T test agility score(20).

505 Test

Markers were set up at 5 and 15 m from a line marked on the ground. The participants run from the 15-m marker toward the line (run in distance to build up speed) and through the 5 m markers, turned on the line, and run back through the 5 m markers. The time was recorded from when the participants first run through the 5-m marker and stopped when they return through these markers. The participants run 10 m in a straight line and touch with the foot (right or left) in a line placed at 5 m from this point, where they change direction and continue to run until crossing the starting point again test (6).Time was measured through the use of timing gates (Smartspeed, Fusion Sport, Australia) and considered for analysis. Each volunteer performed 3 attempts, and only the best one was considered for statictical analysis.

Pro-Agility Test

The pro-agility test was modified by using a flying start to incorporate the use of the timing gates, which were placed at the centre cone at a height of approximately 1.0 m. Participants were only instructed to complete the test as quickly as possible from the starting line to the cone at the other end (9.1m), touched the ground with one hand, changed direction, sprinted back to the start line, again touched the ground with one hand, made a final COD to sprint through the finish line at the centre cone (4.6 m)(27)

Statistical Analysis

SPSS Version 23.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Descriptive statistics were calculated for all experimental data. In addition, all data were examined by the test of normal distribution (Shapiro Wilks) before any further analysis. The Pearson correlation coefficient (r) was used to determine the relationship between linear running and COD speed performances while coefficients of determination (r^2) were used for explicating the meaningfulness of the relationships. The level of significance was set at $p<0.05$ and all data were reported as mean ± SD. Reliability of all tests was high (intraclass correlation coefficient) above 0.89.

RESULTS

Mean body composition scores ± SD for participantswere given in Table 1.In regard to thebody composition parameters, descriptive statistics showed thatparticipants had very low fat percentage (7.52±2.64%), moreover soccer players had an ideal BMI rate (22.67±2.16kg/m^2). The results demonstrated that soccer players of the study had the desired values in terms of body composition.

Table 1. Body characteristics of participants

Age (year)	21.93	3.62
Stature (cm)	175.06	3.06
BW (kg)	69.51	7.40
BMI (kg/m2)	22.67	2.16
BFR (%)	7.52	2.64

(BW: Body weight; BMI: Body mass index; BFR: Body fat ratio)

Pearson'sproduct-movementcorrelation values between the CODtests were presented in Table 2. Correlations coefficients betweent the pro-agilityandillinois(r=598; p<0.05), pro-agilityand505 (r= 786; p<0.01), illinoisand 505 (r=.515; p<0.05) were found in soccer players. Conversely, no significant correlations were determined between T test and other agility tests (p>0.05). Moreover, an inverse correlation (r = -0.53) existed between T testand 505 agility test (p=.846).

Table 2. Correlations between "Pro-agility, İllinois, T test and 505 agility test"

	Proagility	Illinois	T test	505
Proagility	1			
Illinois	r = .598 p = .014*	1		
T test	r = .341 p = .196	r = .365 p =.164	1	
505	r = .786 p = .000**	r = .515 p = .041*	r = -.053 p = .846	1

(Correlation is significance at p<0.05*; Correlation is significance at p<0.01**)

The correlation between linear running and COD performances for soccer players was presented in Table 3. The strongest relationship was between illinois test and 10, 20 and 30 m performances at all time points (r=.635, p=.020; r=.802, p=.001; r=.849, p=.000 respectively). Statistically significant correlation coefficients were also observed between the 20 m and pro-agility test performance (r=.571; p<0.05). There was no significant correlation between 505 and linear running performances (p>0.05). Despite the statistically insignificant relationship between 10 m and 505, it was remarkable (r=.577; p=.077). No significant relationships (p>0.05) were detected among measures of T Line and straight sprint (10-20-30 m) during measures of linear speed and COD speed. The coefficients of determination indicated that T test performance and linear sprint are independent qualities in soccer players (10-13% explained variance). But it may be difficult to arrive at this judgment for other agility tests especially when examining the relationship level between illinois and linear running performances (40-72% explained variance).

Table 3. Relationship between linear running and COD performances

Linear	T test			Pro-agility			505			Illinois		
Running	r	r2	p	r	r2	p	r	r2	p	r	r2	p
10 m	.329	.108	.272	.508	.258	.076	.507	.257	.077	.635	.407	.020*
20 m	.370	.137	.214	.571	.326	.042*	.454	.206	.119	.802	.643	.001**
30 m	.338	.114	.259	.551	.304	.051	.425	.181	.147	.849	.721	.000**

(Correlation is significant: p<0.05*; Correlation is significant: p<0.01**)

DISCUSSION

Agility performance is amajor component of physiological evaluation in soccerplayers (25). This feature not only ensures that soccer do rapidlymaneuvers but also has a precaution to prevent them from being injured(13).The agility skill is also a preliminary assessment test for the determination of the quality of many athletes.

Sevensen and Drust(25) stated that COD tests may be the most excellently indicator of performance for soccer and assure the clearest differentiation between in terms of the level of the players.

Pro-agility, 505 test, T test and illinoistest are among the most frequently used tests to assess COD ability. Each of these is designed to evaluate the ability of COD. But, these tests may have unique skill requirements which disallow them from being used interchangeably.This has lead speculation that some agility tests correlate strongly with velocity such as illinoisagility test, while others correlate well with acceleration such as 505 test(6). In thisregard, Vescovi et al. (27) assumed that the COD tests had higher correlations of determination with the longer running distances (27.4 m and 36.6 m; r=.460 to .831) than the shorter running distances (9.1 m and 18.3 m; r =.297 to .671).In terms of illinois test, this was in agreement withour findings that we found a significant correlation between linear running and illinois test performance ($p<0.05$). Jarvis et al. (12) investigated the relationship between different run tests and illinois agility run test of Welsh Rugby Union Division 5 East league players and found a significant relationship between 40 m sprint and illinois performance (r = 0.68).Draper and Lancaster (6) reported a significantly low correlation in comparing the relationship between performance of the illinois agility test and a 20 m sprint. Markovic et al. (17) also investigated straight sprint training 3 sessions per week for 10 weeks (9–12 total sprints in each training session). Their study included physical education students, and all was assessed with the 20-yard shuttle COD test before and after training intervention. The sprint training significantly imporoved 20-yard shuttle times by 4.3% after the 10-week period (17).In another study,Gabbett et al. (8) examined the relationship between linear running and COD tests (L run, 505 test and Modified 505 test) and found a significant relationship betweenlinear sprint running and performance on all CODspeed tests ($p<0.05$).Our results were comparable with Gabbett et al. (8) who found a similar result to ours, especially regarding the 5 m and 505 tests ($p<0.05$).Likewise, Vescovi and Mcguigan (27) examined the relationship between linear running and agility tests (pro-agility and illinois) and they found that both agility tests had weak to moderate associations with static and flying linear sprint times.

These findings conflict with previous studies (29, 26) that have found a weak relationship between linear sprinting and COD speed. Although there are many studies in the literature that find a significant relationship between straight and COD running, also some studies have found opposite results in the literature.Young et al. (29) investigated the effects of sprint training on the COD performance,and the effects of COD training on the sprint performance. In the study, one of the groupswas included straight-ahead sprint training (n=13), and another group performed COD training (n=13) for a 6-week period (2 trainingsessionsperweek). The COD training affected COD times but did not significantly make better sprint times ($p>0.05$).On the other hand, sprinttrained group significantly improved sprint performances but did not significantly affect COD times.The result was that sprint training and COD training were specific and produced limitedtransfer to each other. Similar studiesbyButtifant et al. (4) and Young et al. (30) in soccer players support the view of Young et al. (29) that sprinting and agility are different physical characters and that linear sprint training does not improve performance in sprints with changes in direction.In the current study, when we examine in terms of T test, those assumptions were partially confirmed.However, Pauole et al. (20) obtained significant correlations between performance in an agility T test and in a 40-yard sprint time in both men and women and alsostated that the Ttest is a measure of agility was not supported. Nevertheless, evidence that the T test is well accepted as a standard test of agility was provided by many scientists (18,21,24). It is also advisable that the T test would be appropriate for practitioners who performed in big courts or fields such as soccer (21).Furthermore, the agility tests with longer straight running distance have a higher relationship with the linear running performance, for this reason it may be stated that the T test which has a lowest linear running distance is the most suitable test for soccer players in four agility tests available.The findings of Brughelli et al. (3) supported that straight sprints and COD were mostly separate motor qualities, besides, Sheppard and Young (23) have supposed that there is not any effect of the straight speed on the COD speed which includes a complex task specific for the sport related. Making mixedskills during agility causes to a lower relationship with the speed in a straight line.Given the conflicting results of researches, it would seem difficult to get at a conclusive result on how straight sprint affects COD ability,and which agility test is most convenientin soccer players.However, we concluded that straight sprints and COD were different motor abilities. Hence, the use of the T test that has a lowest correlation with linear runningcan be considered more appropriate and recommendedfor coaches and trainers. The most interesting observation in our study was the correlation values between changes of direction tests. While the three tests (illinois, 505 and pro-agility) were significantly correlated each other, no significant relationships were detected between T test and other three tests. The research also included semi-professional soccer players. It is thought that in subsequent research it is necessary to develop similar theories with the higher number of sample groups included elite professional soccer players. This can be expressed as the limit of the research.

CONCLUSION

In conclusion, this study investigated that relationship between linear running and COD performance, to determine the relationship between both of themin soccer players and to find which agility test is the most appropriate for soccer branch. The findings of this research indicated that T-test, is a reliable test for assessing agility.Soccer coaches and sports scientists who work to improve speed in elite athletes should be conscious that acceleration, maximum speed, and agility are different qualities.Because there is no single ‘‘most accurate’’ agility test for use in the assessment of soccer players, when testing agility performance, specific tests should be used that evaluate the agility components of importance to the sport in question

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