Vol 8, No 2 (2025): Stadium – Hungarian Journal of Sport Sciences
https://doi.org/ 10.36439/shjs/2025/2/16535

EXAMINING THE CORRELATION BETWEEN SPEED AND CHANGE OF DIRECTION RUNNING SPEED (CODS) IN FOOTBALL

Tamás Horváth [1] , Anetta Müller [2] , Bálint Karap [1] , Melinda Biró [1]

[1] University of Debrecen, Institute of Sport Sciences, Debrecen, Hungary

[2]University of Debrecen, Institute of Sport Economics and Sport Management, Debrecen, Hungary

Abstract

The correlation between speed and change-of-direction speed (CODS) remains unclear, as indicated by the results of previous research. One reason may be that researchers have used different tests to investigate the speed of running with a change of direction (CODS), where the number of direction changes, the angle, the total length of the running test, and the time required to complete the test vary. The researchers agree that agility differs from straight-line running speed, but suggest that further studies are needed to determine the relationship. Our study examined young athletes aged 10-13 years, measuring speed over distances of 5, 10, 20, and 30 meters, as well as agility (CODS), using a T-test with and without a ball. Results demonstrated a significant change in measured abilities. There was a highly significant improvement in speed at 5, 10, 20, and 30 meters, and the same was true for agility scores, both with and without the ball.

Regarding the relationship between speed and agility, the results showed a consistent trend that faster players tend to perform better on the agility test. Still, we could only statistically confirm this at 20 and 30 meters. Only for the agility test to the right was there a significant correlation between 20 and 30 meters alone. Our results indicate that both agility and CODS require different developmental stages.

***Keywords**: football, speed, agility, T-test*

INTRODUCTION

Football is a dynamic and ever-changing sport that demands ever-greater physical exertion and increasingly precise technical and tactical knowledge from players. To play effectively, athletes must consistently demonstrate outstanding abilities (CSÁKI et al., 2013). Players mostly perform short movements in soccer, alternating every 4 seconds (STØLEN et al., 2005). During a match, the distance covered by high-intensity runs ranges from 400 to 700 meters, while fast sprints cover approximately 500 meters (DI SALVO et al., 2007; BRADLEY et al., 2010). However, distances covered at high speed are significant for the match's outcome (WRAGG et al., 2000). According to Di Salvo et al. (2007, 2010), a player sprints every 4 minutes during a match, while the number of sprints ranges from 3 to 40, depending on the position and level. Fast, dynamic sprints are usually 10-20 meters long, but sprints under ten meters are more common than those between 10 and 20 meters. In terms of duration, sprints are short, lasting 2-4 seconds. It is therefore no coincidence that the most used measure of speed in this sport is the 5-10-20-30-meter sprint. In addition to the quantity and intensity of running, changes of direction and turns are also important. The dynamics and changing conditions of the game require players to react quickly to events around them, allowing them to change direction

https://doi.org/ 10.36439/shjs/2025/2/16535

suddenly and make turns. A player makes an average of 727±203 direction changes and turns during a match (BLOOMFIELD et al., 2007).

The ability to react quickly to stimuli during a match (ball, opponent, teammate's movement, change of game situation, etc.) is called agility. This ability is linked to several factors. The speed of decision-making and the ability to adapt to a direction change are among the most crucial factors (MATLÁK et al., 2014) (see Figure 1). For agility, it is necessary to distinguish between perception and decision-making factors, as well as the speed of running with direction changes. For the latter, we refer to maximum running speed involving a change of direction in response to a non-external stimulus, hence the term "change of direction speed" (hereafter CODS).

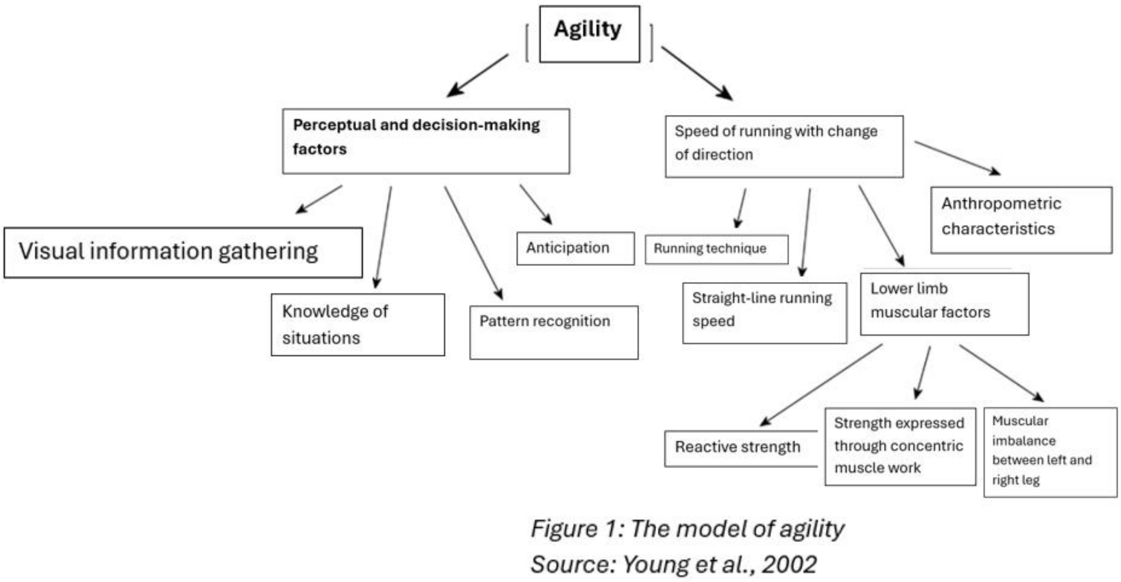

Figure 1: The model of agility
Source: YOUNG et al., 2002

Since agility is a combination of the player's "balancing, spatial orientation, reactivity, rhythmic and kinesthetic differentiation, speed, explosive and reactive power" (KATICS 2015, p. 259), the question arises how these interact. When developing a player's speed, there should be demonstrable improvements in agility. Research, however, gives different results when examining this. Matlák et al. (2014) suggest that the differing results on the relationship between the two abilities may be due to the fact that agility is investigated using various methods. Among the most commonly used tests are the Illinois agility test, the T-test, and the Zigzag test (KOLTAI, 2021). In addition to these tests, modifications of these and other tests are also commonly used by researchers. For this reason, the number of direction changes, the angle, the length of the run test, and the time interval required to complete the test are different. In the case of minor changes of direction and a similar length or duration of the run test to the agility test, a correlation between speed and CODS is more frequent. The researchers agree that this ability is different from straight-line running speed and suggest specific testing and development are needed, with further investigation.

While speed is measured by running different distances in a straight line, agility is also measured, but here the player must change direction. As mentioned earlier, a common question is the relationship between speed and agility when assessing these abilities. Several studies (YOUNG et al., 1996; BUTTIFANT et al., 2002; GABBETT et al., 2008) have shown that there is no or little correlation between the two abilities, suggesting that they should be considered two separate abilities. This is important because if agility test scores and speed test scores do not show a correlation, or in some respects show a less close correlation. Agility is separate from speed and not the same ability.

THE PURPOSE OF THE STUDY

This study investigates the relationship between speed and CODS in 10- to 13-year-old athletes. The aim is to explore the development of players' speed and agility, as well as the correlations between the measurement results. The results will be used to make recommendations for improving the effectiveness of training methods.

RESEARCH QUESTIONS AND HYPOTHESES

Our research questions were. To what extent do players' scores improve between the two measurements? What is the relationship between speed and CODS? As hypotheses, we formulated the following. It is hypothesized that the effect of training methods and maturation will improve the players' results after two measurement dates, i.e., after one year. Based on previous research, we hypothesize that there will be no correlation between speed and CODS. The explanation for this is as follows. Since some research indicates a correlation, while others do not show a significant relationship between the two abilities, either hypothesis is possible based on the literature. However, given that the results depend on the test used, and that in the case of minor changes of direction and short test lengths or durations, a correlation between speed and running with direction changes is more likely to occur.

In the present study, since the T-test exhibits significant directional changes, CODS and speed are unlikely to show a significant correlation. Based on this, the literature emphasizes that speed and CODS also require different development. Thus, it is hypothesized that speed and CODS results will improve due to the training program used, but no correlation is observed.

METHODS

One of the most crucial skills for football is speed and its various expressions (reaction, change of direction, acceleration, maximum running speed). Tests designed to measure speed look at different distances run in a straight line. We used the most commonly used method for measuring speed in football (ZALAI 2016; CSÁKI 2020). For the speed track, we monitored four skills: the 5-meter sprint, the 10-meter sprint, the 20-meter sprint, and the 30-meter sprint. Agility was evaluated with two tests, the T-test with a ball (test 5) and without a ball (test 6). The survey was conducted twice, one year apart. The survey was conducted on an artificial turf

https://doi.org/ 10.36439/shjs/2025/2/16535

pitch. Each measurement was performed twice by the players as recommended in the literature. The tests were averaged over the time taken to complete the measurements.

MEASURING THE ABILITY TO ACCELERATE

In this test, the speed in seconds of the athlete's strong, dynamic acceleration from rest was measured. The OXA starter and infrared timing device were used for the measurement. The player was positioned 80 centimeters from the first measurement point, according to the measurement protocol. The track section was constructed to accommodate the following three measurements, so photocell timers were placed opposite each other, five pairs of 5, 10, 20, and 30 m in a straight line (Figure 2). To measure the acceleration ability, a 5 m track section was measured. Hence, the result was the distance travelled between the first and second sensors. Players were allowed two trials, and we took the average of the results of the two measurements for statistical analysis.

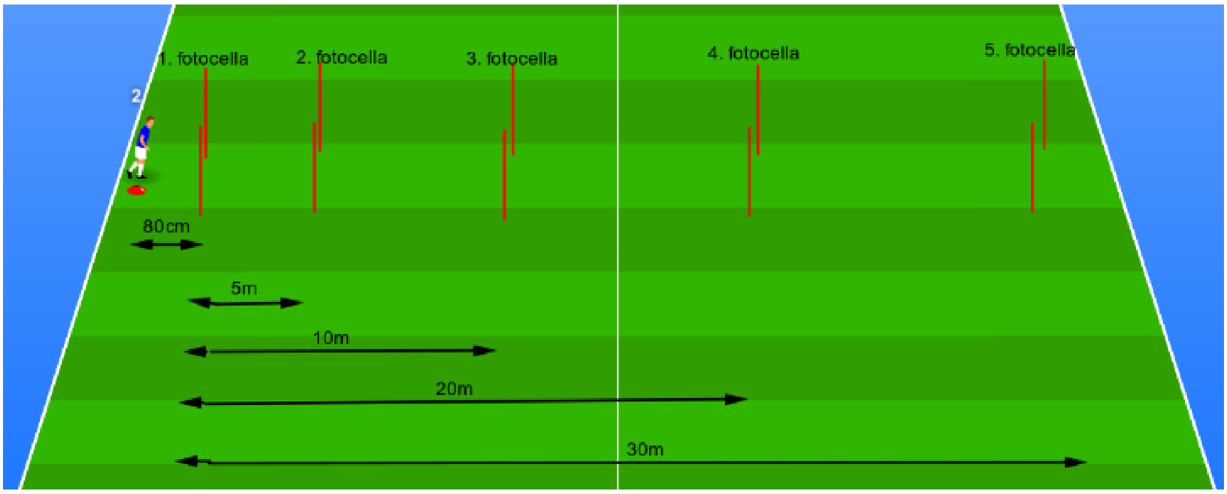

Figure 2: Track layout and dimensions for measuring speed
source: own edit

MEASURING THE ABILITY TO ACCELERATE (10 M DISTANCE)

The OXA Starter+ infra-red timing device was also used to measure the acceleration rate. In this test, the player starts from a standing start with an individual start. The time it took to cover the distance between photocells 1 and 3 was recorded (Figure 2).

MEASURING RUNNING SPEED, RUNNING ACCELERATION (20 METERS)

We applied a photocell timer to measure the athlete's maximum running speed. The player starts from a standing position with an individual start and runs to the finish at maximum speed. Thus, the time it took to cover the distance between photocells 1 and 4 was recorded (Figure 2).

MAXIMUM SPEED, MAXIMUM RUNNING SPEED MEASUREMENT (30 METERS)

The player runs 30 meters from the start. Thus, the time it takes to cover the distance between photocells 1 and 5 is recorded (Figure 2).

CODS WITHOUT BALL

The field design for the exercises was planned, and the necessary equipment was prepared as suggested in the literature. The test was conducted in two ways: without and with a ball. The measurement area was a 20x20 m track section, which (Figure 3) was marked out using three cones based on Semenick's (1990) test track. The starting point was determined 80 centimeters in front of the measurement point. The measurement point was a photocell gate, through which the player passed and then ran to the first buoy, 5 m away, in a straight line. Here, the athlete bypassed the buoy, changed direction, and ran to buoy two, 5 meters away. After a complete turnaround, buoy two had another 10-meter run in a straight line to buoy 3. Once around buoy three again, the player turned to buoy one, where he ran to the finish line after a change of direction. Results were recorded in seconds using the OXA Starter+ infrared timing device.

CODS WITH BALL

The ball agility test differed because the athlete performed the same task as in the previous test, but with a ball. Due to the ball execution, the player's agility is also related to their level of sport-specific technical ability. Thus, in this study, the execution time is influenced by the player's current technical level.

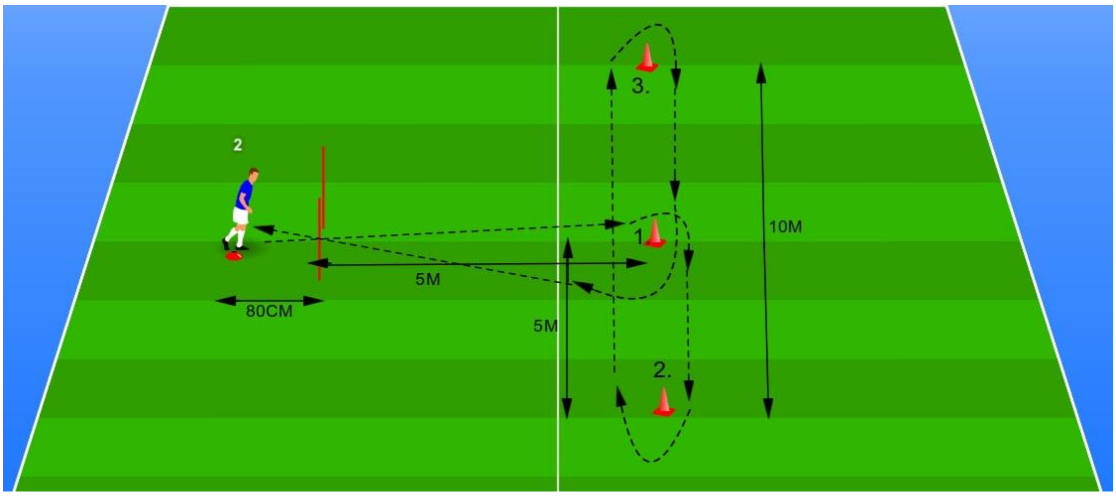

Figure 3: Track layout and dimensions for measuring agility, and measurement protocol
source: own edit

Vol 8, No 2 (2025): Stadium – Hungarian Journal of Sport Sciences
https://doi.org/ 10.36439/shjs/2025/2/16535

SAMPLE

Fifteen participants took part in the test and signed up with the boys' junior teams. Most of them started playing football at the ages of 3-4, so they played it for an average of 5 years. The mean age of the participants is 11.67 years (SD = 0.90), indicating a homogeneous sample, as the range between the minimum and maximum age is narrow (10-13 years). This provides a reasonable basis for comparing agility tests while minimizing age differences.

STATISTICAL ANALYSIS

We conducted fundamental statistical and correlation analysis. Means and standard deviations were calculated for the measured variables. First, a normality test was performed. Since the normality test showed that the sample was normally distributed, we used a 2-sample t-test. We used a significant level of $p \leq 0.05$ for the correlation calculation. A significant correlation ($p \leq 0.05$) is marked in the tables with an asterisk. We used SPSS-27 statistical software to evaluate the results.

RESULTS

One of the research questions was the extent to which skills develop between the two measurements. The results indicate a significant improvement in the measured skills. Significant results were found for each of the skills. The rate of improvement is highly significant for speeds of 5, 10, 20, and 30 meters per second. The same applies to the CODS agility results, both with and without the ball (Table 1).

Table 1: Variation in Speed and CODS Results Between the Two Time Points Measured

	Measurement:	SD (sec)	Asymp. Sig. (2-tailed)
5 meters	1.	1,21	
	2.	1,18	0,000***
10 meters	1.	2,12	
	2.	2,09	0,000***
20 meters	1.	3,75	
	2.	3,69	0,000***
30 meters	1.	5,35	
	2.	5,28	0,000***
CODS right	1.	9,86	
	2.	9,24	0,000***
CODS left	1.	10,06	
	2.	9,45	0,000***
CODS (right)	1.	12,62	
	2.	12,00	0,000***
CODS (left)	1.	12,49	
	2.	11,88	0,001***

Wilkoxon test *p≤0.05; ** p≤0.01; ***p≤0.001 Source: own edit

The second research question was whether there is a correlation between speed and CODS. Our results showed a trend across the board that faster individuals tend to perform better in agility tests; however, we could only statistically prove this at distances of 20 and 30 meters. Only for the CODS test in the right direction was a significant correlation observed at 20 and 30 meters. As the T-test is longer, it only showed a significant relationship with the 20-30 m run, but only when performed in the right direction, not with the ball (Table 2). This indicates that we used a test to measure agility (CODS), where the result is only shown over a longer time span. There could be several reasons for the lack of a significant result; one is that the T-test is inadequate, and the other is that the response is more important at 5 m and 10 m.

Table 2: Results for Speed and CODS

	CODS right	CODS left
5 m	,349	,192
10 m	,406	,356
20 m	**,036***	,194
30m	**,026***	,198

Spearman rank correlation p≤0.05; ** p≤0.01; ***p≤0.001 source: own edit

The data were also evaluated using Spearman's correlation coefficient and the significance level in this case. Correlation coefficient (ρ): The correlation coefficient is 0.511 for 20 m and 0.537 for 30 m, indicating a moderate positive relationship between the second measurement of CODS and 20 m. The positive value suggests that as one measurement increases, the other tends to increase (or vice versa). Significance (Sig. 2-tailed): the significance level is p=0.036 (20 meters) and p=0.026 (30 meters), which is considered significant at the 5% level (as p<0.05p < 0.05p<0.05). There is a statistically significant relationship between the two variables based on the sample. So, there is a high probability of a higher correlation between CODS and running 20m and 30m (see Table 3).

The sample size here is also 13 (N = 13), which is a small sample; however, the significant result gives us confidence that this correlation may be important. The two measurements show a moderate, positive, and statistically significant relationship between the right CODS and the 20- and 30-m runs. We found a significant relationship between CODS performance and 20- and 30-meter run performance, which may be interesting for performance measures.

https://doi.org/ 10.36439/shjs/2025/2/16535

Table 3: Results of the Correlation Test Between CODS (right) and speed (20m, 30m)

			2. measurement agility right	2. measurement 20 m
Spearman's rho	2. measurement agility right	Correlation Coefficient	1,000	,511*
		Sig. (2-tailed)	.	**,036**
		N	17	17
	2. measurement 20 meters	Correlation Coefficient	,511*	1,000
		Sig. (2-tailed)	,036	.
		N	17	17

*. Correlation is significant at the 0.05 level (2-tailed).

			2. measurement agility right	2. measurement 30 m
Spearman's rho	2. measurement agility right	Correlation Coefficient	1,000	,537*
		Sig. (2-tailed)	.	**,026**
		N	17	17
	2. measurement 30 meters	Correlation Coefficient	,537*	1,000
		Sig. (2-tailed)	,026	.
		N	17	17

*. Correlation is significant at the 0.05 level (2-tailed).
Spearman rank correlation *$p \leq 0.05$; ** $p \leq 0.01$; ***$p \leq 0.001$ source: own source

CONCLUSION

The results indicated a significant change in the measured ability. There was a highly significant improvement in speed at 5, 10, 20, and 30 meters, but the same was true for the CODS results, both with and without the ball. The correlation between speed and change of direction running speed (CODS) is unclear from the results. One reason may be that different authors have used different tests (number of changes of direction, angle, total length of the running test, time required to complete the test) to investigate the speed of running with change of direction (CODS). However, our study aimed to find any correlation between CODS and speed. Our investigation was a pilot study.

Regarding the correlation between the two abilities, the results indicated that the player performed better on the CODS test when running at a faster pace. However, we could only statistically prove this at 20 and 30 meters. Only for the CODS test performed at 20 and 30 meters was a significant correlation observed. Since the T-test is longer, it only showed a significant relationship with the 20-30 m run when performed to the right, without the ball. Therefore, our results suggest that agility and CODS require different areas for improvement.

It would be worthwhile examining the relationship between ball technical skills and agility. It would also be beneficial to measure reactionary (reactive) agility and compare it with skill to measure players' decision-making ability and cognitive factors.

FUNDING

Supported by the EKÖP-25-2 University Research Scholarship Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

REFERENCES

Bloomfield, J., Polman, R., O'Donoghue, P. & McNaughton, L. (2007). Effective Speed and Agility Conditioning Methodology for Random Intermittent Dynamic Type Sports. *Journal of Strength & Conditioning Research*, 21(4):1093

Bloomfield, J., Polman, R. & O'Donoghue, P. (2007). Physical demands of different positions in the FA Premier League soccer. *J Sports Sci Med*, 6: 63–70.

Bradley, P.S., Di Mascio, M., Peart, D., Olsen, P. & Sheldon, B. (2010). High-intensity activity profiles of elite soccer players at different performance levels. *J Strength Cond Res*, 24: 2343–2351.

Bradley, P.S., Di Mascio, M., Peart, D., Olsen, P. & Sheldon, B. (2010). High-intensity activity profiles of elite soccer players at different performance levels. *J Strength Cond Res*, 24: 2343–2351.

Burwitz, L. (1997). Developing and acquiring football skills. In T. Reilly, J. Bangsbo, & M. Hughes(Eds.), Science and football III (pp. 201–206). London: E & FN Spon. Available from: https://www.researchgate.net/publication/326194482_Affects_of_Defense_Unit_on_Score_Goals_in_Soccer#fullTextFileContent

Buttifant, D., Graham, K. & Cross, K. (2002). Agility and speed in soccer players are two different performance parameters. In: Spinks, W. (ed.): Science and football IV. Routledge, London. 329-332

Csáki, I., Bognár, J., Révész, L. & Géczi, G. (2013). Theories and practices for the selection and evaluation of talented football players, Hungarian Sports Science Review, 14: 53. 12-18.

Csáki, I. (2020). Measurement and Monitoring in Football. Centre for Training Theory and Methodology (MTSE/SI); [ed.] Mihály Takács. Puskás Academy, Hungarian University of Physical Education, Felcsút, Hungary, Budapest, Hungary, 431 p

Di Salvo, V., Baron, R., Tschan, H., Calderon, Montero, F.J., Bachl, N. & Pigozzi, F. (2007). Performance Characteristics According to Playing Position in Elite Soccer. *Int J Sports Med*, 28: 222–227.

Di Salvo, V., Baron, R., GonzÁLez-Haro, C., Gormasz, C., Pigozzi, F. & Bachl, N. (2010). Sprinting analysis of elite soccer players during European Champions League and UEFA Cup matches. *J Sports Sci*, 28: 1489–1494.

Gabbett, T.J., Kelley, J.N. & Sheppard, J.M. (2008). Speed, change of direction speed, and reactive agility of rugby league players. *J Strength Cond Res*, 22: 174–181.

Katics, L. (2015). Development of conditioning and coordination skills (physical education, recreational, and competitive sports). Pécs, Publikon Publishers. https://tamop-sport-2015.ttk.pte.hu/files/tananyagfejlesztes/kondicionalis-es-koordinacios-kepessegek-fejlesztese.pdf

Koltai, M. (2021). Agility is an autonomous, complex ability. Habilitation thesis https://real.mtak.hu/142720/1/Koltai_habilitacios_dolgozat.pdf

Matlák, J., Tihanyi, J. & Rácz, L. (2014). A review of research on agility. *Magyar Sporttudományi Szemle* 15. évfolyam 62.szám 2014/3. 23-30

Reilly, T., Bangsbo, J. & Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. J Sports Sci, 18: 669-683 Semenick, D. (1990): Tests and measurements: the T-test. *National Strength and Conditioning Association. Journal,* 1122: 1. 36–37.

Semenick, D. (1990). Tests And Measurements: The T-test. *National Strength and Conditioning Association Journal*, 12(1):36-37

Sheppard, J.M. & Young, B. (2006). Agility literature review: Classifications, training, and testing. *J Sports Sci,* 24: 919-932

Stølen, T., Chamari, K., Castagna, C. & Wisløff, U. (2005). Physiology of Soccer: An Update. *Sports Med,* 35: 501–536.

Wragg, C.B., Maxwell, N. & Doust, J.H. (2000). Evaluation of the reliability and validity of a soccer-specific field test of repeated sprint ability. *Eur J Appl Physiol*, 83: 77–83.

Young, W., Hawken, M. & McDonald, L. (1996). Relationship between speed, agility, and strength qualities in Australian Rules football. *Strength Cond Coach*, 4: 3–6.

Zalai, D. (2016). "Reflections on the running performance of modern football matches" *Physical Education, Sport, Science,* 1:1, 21–26