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ASSESSMENT OF SPRINTING SKILL OF SOCCER PLAYERS BASED ON STRAIGHT AND ZIG-ZAG SPRINT TESTS

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ABSTRACT

The mastery of maximal and high-intensity physical activities is key for successful performance in football. The aim of this study was to compare respective sprinting skills of Polish and South African soccer players by conducting straight and zig-zag sprint tests. The study sample comprised a total of 40 college level soccer players, 20 from Poland and 20 from South Africa. The sprint tests included a 30m-straight sprint test and a 30m-Zig-zag sprint test. ANOVA, followed by Fisher's LSD as a post-hoc test, were used for statistical analysis. The study found that the Polish players were significantly faster by a margin of 0.117 seconds ($p \leq 0.001$) than their South African counterparts, and developed a significantly higher running speed with a corresponding margin of 0.198m/s ($p \leq 0.001$) after 30 metres. In the 30m-Zig-zag sprint test, the Polish players also exhibited a significantly higher level of speed skills than the South African players, with a difference in a running time of 0.939 seconds ($p \leq 0.001$) and in a running speed of 0.307m/s ($p \leq 0.001$) that represented greater differences than those found in the 30m straight sprint test.

***Keywords*:** Sprinting skill; Soccer; 30m-Sprint test; 30m-Zig-zag-sprint test; Performance.

INTRODUCTION

One of the most important factors influencing the outcome of soccer matches, is the motor preparation of players. Straight sprinting, sprinting with changes of direction (COD), and repeated sprint ability (RSA) are some of the most common activities during a soccer game (Andrzejewski *et al.*, 2013). The outcome of a soccer match also depends on other factors, such as individual skills, analytic and decision-making processes, psychological strength and resilience and team strategy of players (Dellal *et al.*, 2011). Over the past decade, many authors have suggested that the intensity of play during soccer matches has increased significantly and dramatically (Bishop & Girard, 2013). Subsequently, there has been a visible shift from aerobic to anaerobic energy production processes during football performance. The intensity of the match depends largely upon the number, frequency and length of performed sprints (Andrzejewski *et al.*, 2013). Faude *et al.* (2012) reported that during German Bundesliga matches 83% of the activities before scoring goals were high-intensity explosive actions, and that most activities took place without any opposing player nor with the ball. The players' high intensity activities also featured frequent sprints in a straight line, performed both by the goal scorer and the player who passed to the goal scorer.

Keiner *et al.* (2014) also showed that apart from linear sprints soccer players perform, there are many sprints with changes of direction (COD). Young and Farrow (2013), in their study of COD sprinting ability, found that it was also associated with acceleration and deceleration skills. Bloomfield *et al.* (2007) noted that during a single match, soccer players perform more than 700 changes of direction and turnovers at various angles. Faude *et al.* (2012) concluded that rapid changes of sprinting direction are not as frequent as linear sprints. However, numerous authors claim that rapid changes of sprinting direction are crucial in team games, with soccer being no exception (Sheppard & Young, 2006; Bloomfield *et al.* 2007; Brughelli *et al.*, 2008). Consequently, the ability to perform frequent changes of direction while sprinting remains a significant criterion for the selection of soccer players of different ages and sporting levels (Reilly, 2005; Stølen *et al.*, 2005).

Kinetic analyses of matches from top soccer leagues show that players cover between 9 and 12 kilometres during a single match (Di Salvo *et al.*, 2007; Rampinini *et al.*, 2007b; Andrzejewski *et al.*, 2012). They also spend between 8 to 12 percent of match time performing either high-intensity or sprinting activities (Burgess *et al.*, 2006; Rampinini *et al.*, 2007a; Vigne *et al.*, 2010). During a soccer match, a player performs anywhere between 17 and 81 sprints, depending on the accepted definition of running speed (Burgess *et al.*, 2006; Di Salvo *et al.*, 2007; Vigne *et al.*, 2010). Vigne *et al.* (2010) also found that more than 90% of all sprints performed during a match are shorter than 20 metres and that the mean sprinting time is between 2 and 4 seconds (Burgess *et al.*, 2006).

Another important aspect of the speed abilities of soccer players is peak running speed (Konefał *et al.*, 2014). It has been reported that even a slight difference of 0.8% between two players' peak running speed can affect the outcome of the contest for control of the ball by two players (Bishop & Girard, 2013). According to Dellal *et al.* (2011), another important component of the speed abilities of players during a match is explosive start and acceleration over a certain distance. A player who is able to overtake an opponent over a distance of a few metres is extremely useful to any soccer team. In professional football, a ball loss or a ball gain can be decided by one hundredth of a second (Yue *et al.*, 2014).

Following the observations made by the cited authors, a complex analysis of straight and zig-zag running speeds appears to be necessary for success in soccer. Straight running speed tests assess acceleration and peak speed. The former is usually evaluated through the use of 5-metre and 10-metre tests (Stølen *et al.*, 2005; Jovanovic *et al.*, 2011), while the latter is usually measured using 30-metre and 40-metre tests (Buchheit *et al.*, 2014; Al Haddad *et al.*, 2015). At present, there is no available literature describing a universal zig-zag test which would assess speed skills involving sudden changes of running direction among soccer players (Sheppard & Young, 2006; Brughelli *et al.*, 2008; Chaouachi *et al.*, 2012). Thus far, tests involving changes of direction from 90 to 180 degrees, shuttle run tests, T-tests and backward running tests with maximal intensity have been used. The results of these tests are also significantly affected by the motor coordination abilities of the athletes (Chaouachi *et al.*, 2012; Sekulic *et al.*, 2013).

PURPOSE OF RESEARCH

Athletes train in varying social, cultural, economic and climatic conditions in different regions of the world and, consequently, their abilities might be different, irrespective of the fact that they all may practise the same sport (Temfemo *et al*., 2007; Knechtle *et al*., 2017). It has been highlighted that speed skills are crucial for achieving success in soccer matches (Faude *et al.* 2012) and thus, the investigation regarding differences in speed skills between Polish and South African soccer players is warranted. To the best of our knowledge no research has been conducted focusing on a comparison of speed skills of soccer players from two different countries, and therefore the present study can contribute to a better understanding of sprint abilities of these players. Secondly, further studies could investigate the reasons for these differences. The results of the study can be used to enhance competencies of coaches through implementing various training methods aimed to improve the speed abilities of soccer players. This study compares the sprinting skills of Polish and South African players, measured in linear and change of direction running tests.

METHODOLOGY

Participants

The research sample comprised Polish (n=20) and South African (n=20) collegiate soccer players. The Polish players, aged 22.7±2.5 years and had a mean training experience of 10.3±2.8 years, a mean body weight of 74.7±6.2 kg and body height of 180.6±4.6 cm. The South African players had a mean body mass of 67.6±7.6 kg, a body height 172.4±8.6 cm and were aged 23.4±2.2 years with a training experience of 11.0±3.2 years. Anthropometric measurements were carried out in a changing room next to the main gym, by well-qualified and experienced professional staff. The study was approved by local ethics boards in Poland and South Africa (UFH-GEN013).

Measurements

The study made use of two assessments: a 30m-straight sprint test and a 30m-zig-zag sprint test with each comprising of six 5-metre line segments to indicate changes of running direction to the right and to the left (containing an angle of 74°). The traditional 30m-sprint test (STRAIGHT) was selected because of its popularity and widespread use in soccer clubs all over the world and at all levels of competition (Kutlu *et al.,* 2012; Lago-Peñas *et al.,* 2014). The 30m-zig-zag test (ZIG-ZAG) requires alternating between accelerations and decelerations, as well as running directions that are components of a soccer match (Lockie *et al.,* 2013; Sekulic *et al.,* 2013).

The players performed each test twice. Between the trials the players had a 5 min-rest break. The better of the two results was analysed statistically. Before the tests, the players performed a 20min-warm-up of incremental intensity, until reaching a heart rate of between 165 and 170 beats per minute. The warm-up intensity was monitored with RCX 5 sport testers (Polar, Poland). The players began their sprinting tests from a standing position with the front leg 20cm behind the starting line. The tests were conducted in an indoor sport facility. A Smart Speed photocell system (Fusion Sport) with an accuracy of 0.001 seconds was used to measure the players' performance levels. In each test, split times and the speed of movement of each player were recorded every 5 m. Each player was required to run the prescribed distance and to attain their peak running speed as quickly as possible. Both sets of players were assessed during their respective competitive seasons, with no matches or training staged 48 hours prior to the assessment day. Both groups of players followed a similar motor training programme, consisting of 3-4 training sessions a week.

Statistical analyses

The arithmetic means and standard deviations were calculated. The normality of distribution was checked with the Shapiro-Wilk test ($p \leq 0.05$). Repeated measures ANOVA, followed by Fisher's LSD as a post-hoc test, was used to analyse the data. The level of statistical significance was set at ($p \leq 0.05$), ($p \leq 0.01$) and ($p \leq 0.001$). All statistical calculations were made using the Statistica 10.0 software package.

RESULTS

30m-Straight sprint test

In the 30m-straight sprint test, the Polish players achieved lower times than their South African counterparts at all six 5-metre consecutive measurement segments (Table 1). As the distance covered increased, the time difference between the two respective groups of players widened steadily until the 15-metre point. At the 30-metre mark, the difference between the mean running times of the two groups was the greatest at 0.117 seconds (Table 1). Statistically significant differences were found between the times of Polish and South African soccer players at each measurement segment of the running distance (from $p \leq 0.05$ to $p \leq 0.001$).

Table 1. **MEAN TIMES FOR 30 M-STRAIGHT LINE SPRINT TEST**

Segments	**Polish players** M±SD	**SA players** M±SD	p-Value
5m [s]	0.971±0.038	1.042±0.056	0.022*
10m [s]	1.696±0.060	1.773±0.065	0.013*
15m [s]	2.326±0.074	2.430±0.083	0.001***
20m [s]	2.965±0.100	3.054±0.102	0.004**
25m [s]	3.557±0.120	3.645±0.113	0.005**
30m [s]	4.127±0.125	4.244±0.148	0.001***

Significant differences: * ($p \leq 0.05$), ** ($p \leq 0.01$), *** ($p \leq 0.001$)
M=Mean SD=Standard Deviation

There was a significant ($p \leq 0.001$) increase in the running speed of the Polish players at the end of each measured segment. After 5 metres from the start the Polish players attained a mean speed of 5.159±0.199 metres per second, and after the full 30 metres, 7.275±0.221 metres per second. A similar increase in running speed was found among the South African players ($p \leq 0.001$). After 5 metres they reached a mean speed of 4.813±0.255 metres per second, which increased to 7.077±0.244 metres per second after 30 metres (Figure 1). A comparison of the speed test results for the two groups showed that after each 5-metre segment of the measured distance the Polish players attained a significantly higher running speed than their South African counterparts (Figure 1). The differences between the speeds at the fifth metre and the thirtieth metre of the distance were 0.346m/s (p≤0.001) and 0.198m/s (p≤0.01), respectively. For both groups the peak running speed was recorded after 30 metres.

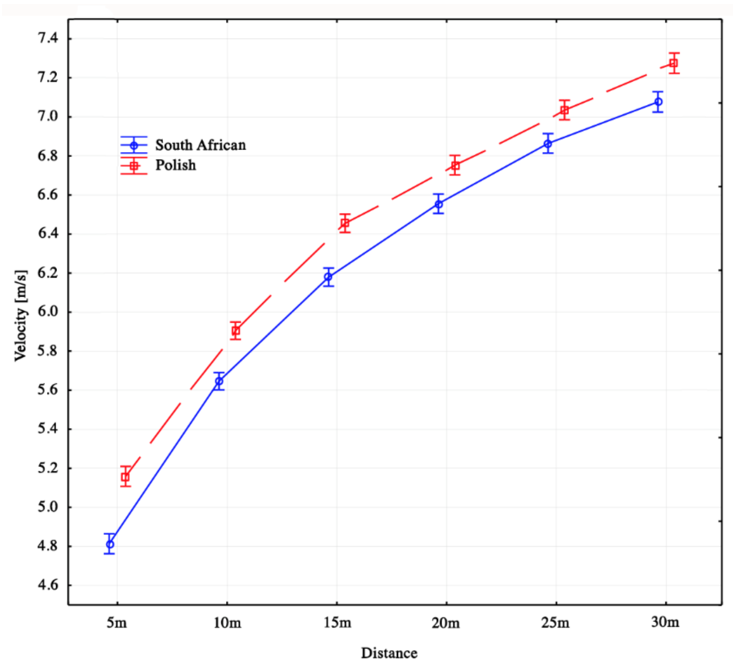

Figure 1. **30 M-STRAIGHT LINE MEAN RUNNING SPEED VALUES**

30m-Zig-zag sprint test

Table 2. **MEAN TIMES FOR 30-METRE ZIG-ZAG SPRINT TEST**

Segments	**Polish players** M±SD	**SA players** M±SD	p-Value
5m [s]	1.297±0.078	1.447±0.144	0.105
10m [s]	2.841±0.165	3.127±0.176	0.003**
15m [s]	4.484±0.167	4.892±0.255	0.001***
20m [s]	6.099±0.240	6.656±0.338	0.001***
25m [s]	7.722±0.284	8.435±0.420	0.001***
30m [s]	9.052±0.332	9.991±0.542	0.001***

Significant differences: * (p≤0.05), ** (p≤0.01), *** (p≤0.001)
M=Mean SD=Standard Deviation

In the 30m-zig-zag sprint test, the mean recorded time for the Polish players at the 5-metre mark was 0.150 seconds less than that of the South African players (Table 2). At the consecutively marked segments of the Zig-zag test, the Polish players were also faster than the South Africans, by a margin of 0.939 seconds at the 30-metre mark. As the distance covered increased, the differences between the mean times of the two groups also increased significantly, namely at $p \leq 0.01$ after 10 metres and at $p \leq 0.001$ after 15, 20, 25 and 30 metres.

The analysis of the running speeds of the Polish players in the 30m-zig-zag test showed a consistent decline until 25 metres (3.242±0.120 metres per second). Although it showed a significant ($p \leq 0.001$) decrease in running speed until 15 metres, over the final 5 metres of the test a significant increase in the running speed ($p \leq 0.05$) was noted at 3.318±0.122 metres per second, which was close to the speed reached after 15 metres. A similar pattern of fluctuations in running speeds was found among the South African players. The lowest mean running speed of 2.970±0.143 metres per second was recorded after 25 metres (Figure 2). Although it increased to 3.011±0.157 metres per second over the final 5-metre segment, the increase was not statistically significant and corresponded with their speed after 20 metres.

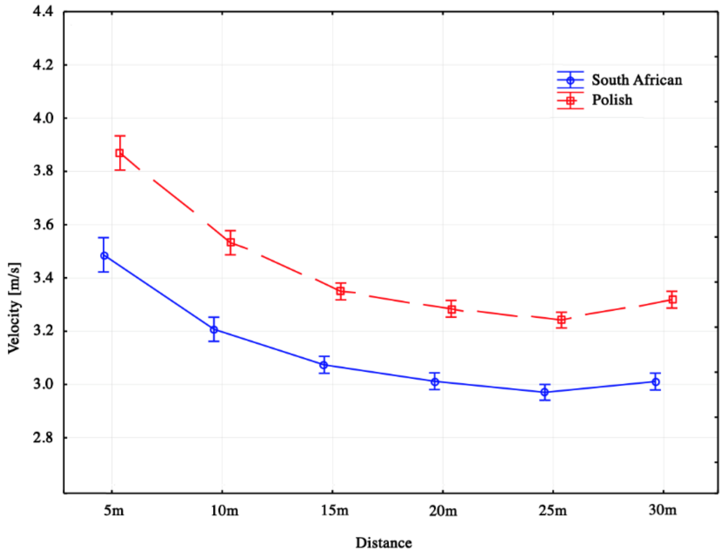

Figure 2. **30 M ZIG-ZAG MEAN RUNNING SPEED VALUES**

A comparison of the running speeds reached by the players after 30 metres of the Zig-zag test showed that despite the similar dynamics in the development of running speed in both groups, the Polish players achieved significantly higher results at each measured segment ($p \leq 0.001$). The peak running speed was recorded by both groups of players after 5 metres, with the results of the Polish players being significantly higher with a mean of 3.869±0.229 metres per second than 3.487±0.338 metres per second for the South African players. At consecutive measurement segments the differences in running speed were similar for both groups: from 0.271 metres per second after 25 metres to 0.325 metres per second after 10 metres.

DISCUSSION

Maximal and high-intensity activities are crucial for successful performance in soccer (Haugen *et al.,* 2014). The players' speed abilities directly and effectively influence their performance of tactical and technical tasks. The present study showed that the Polish players covered the 30 m-straight sprint test in a significantly shorter mean time of 4.127±0.125 seconds than the South African players (4.244±0.148 sec). These results correspond with those obtained by other researchers who investigated the speed abilities of players from different soccer leagues in different continents (Kutlu *et al.,* 2012; Lago-Peñas *et al.,* 2014).

The players in the present study, however, displayed lower levels of their speed abilities than most elite players, whose mean time for the same test was 4.00±0.20 seconds; and a higher level of participation than amateur players, whose mean time amounted to 4.34±0.13 seconds (Wisloff *et al.,* 2004, Ferro *et al.,* 2014). The lower times achieved by the Polish players may be a attributed to developing greater peak power or having greater phosphagen reserves (Bishop & Girard, 2013, López-Segovia *et al.,* 2014) than South African players. Another possibility could be that collegiate players are being subjected to lower levels of selection and quality of their training (Dellal *et al.,* 2011), compared to higher levels of competition.

The Polish players also achieved lower times in the 30-m zig-zag test, with a mean of 9.05±0.33 seconds, compared to their South African counterparts (9.99±0.54 seconds). Sekulic *et al.,* (2013) recorded lower zig-zag test times by collegiate team sports players with a mean of 6.51±0.46 seconds than the players in the present study. The test results of other researchers ranged from 6.22 to 8.12 seconds over distances between 20 and 36.56 metres (Sporis *et al.,* 2010; Chaouachi *et al.,* 2012; Lockie *et al.,* 2013). These discrepancies may be the results of using different testing protocols, such as the zig-zag angles, number of changes of direction, measurements of distance, etc. A great benefit of using the zig-zag test in this study was that it allowed assessment of players' running speed in consecutive 5-metre segments, involving accelerations, decelerations and rapid changes of direction. The test also enables a comparison of performance for every 5-metre segment, with sudden changes of direction to the right or to the left. It needs to be emphasised that motor activities of this sort occur very often during match play. According to Sekulic *et al.* (2013), of the five running speed tests applied in their study, the most reliable was the Zig-zag test.

There are several determinants of speed test results. According to Haugen *et al.* (2012), the differences in the 30-m straight sprint test times might be attributed to the different location of the centre of gravity of the runners at the starting line. Lockie *et al.* (2013) also stress the importance of the starting position of the runner's body in speed tests. Leaning the body forward and thus lowering the centre of gravity during a direction change creates more optimal conditions for the functioning of leg muscles (Sekulic *et al.,* 2013; Haugen *et al.,* 2014). Despite the strict instructions given to the players regarding the starting position to be assumed, the location of the centre of gravity in players participating in the test and the shifts which it undergoes in the process of developing power over the first few metres of the test, could have affected the final test results.

Many authors claim that the ability to perform frequent and sudden changes of running direction is associated with the ability of maintaining body balance (Miller *et al.,* 2006; Sporis *et al.,* 2010). The ability to maintain body balance allows frequent and necessary adjustments of the body posture, during high- or maximal-intensity running activities. The authors cited above revealed that maintaining body balance is one of the most important abilities for performing rapid changes of direction, especially lateral changes of direction (Sekulic *et al.,* 2013).

Speed abilities are also affected by anthropometric variables (Sheppard & Young, 2006; Brughelli *et al.,* 2008; Chaouachi *et al.,* 2012). Increased body mass and adiposity may reduce the level of sprinting abilities, running speed and power development during training and competition. Chaouachi *et al.* (2012) reported that among elite team sports players, the body mass and percentage of fat lower the results of running tests, which involve changes of direction, such as the T-test, the 5-metre shuttle run-sprint and the 180-degree turn. Brughelli *et al.* (2008) and Chaouachi *et al.* (2012) found that shorter players were able to perform fast changes of direction more effectively than taller players. In the present study however, the mean body mass of the South African players was 7.1kg lower than that of the Polish players, while the South Africans were still significantly slower in both the 30m-straight and the 30m-Zig-zag sprint tests.

The measurement of running speeds in the 30m-straight and -zig-zag sprint tests over 5-metre segments revealed that the Polish players were faster than the South African players in both tests. The significance of this finding is that after 5 metres the Polish players developed greater anaerobic power. It is important to note that generating the greatest power in the first few metres of the distance to be run in the shortest time possible, in both sprinting and in moderate-intensity running, is indispensable for effective acceleration in straight or zig-zag running (Wheeler & Sayers, 2010; Lockie *et al.,* 2013). The differences between the two groups of players may be caused by a different structure of muscle fibres, in particular fast-twitch fibres.

It can be assumed that the South African players displayed better speed predispositions; however, the obtained data point to a better selection process of Polish college-level players in soccer. Ferro *et al.* (2014) maintain that the mean running speed over a 10-metre segment of the test distance can be an important indication for selecting players for particular positions on the pitch. It was surprising to find that in the 30m-zig-zag test, the running speeds decreased steadily over the first 25 metres among both groups of players, rather than increased or remained at the same level. As these findings have not been corroborated in the existing literature, they require further research.

PRACTICAL APPLICATIONS

Sprinting allows a soccer player to dodge an opposing player or enter an uncovered area of the pitch. Haugen *et al.* (2012) found that differences in times in the straight sprinting test over a distance of 20 metres were between 0.04 and 0.06 seconds, which in turn amounts to differences between 30cm and 50cm, which can be sufficient to outrun an opponent in a one-on-one play during a real match. Consequently, the ability to create sprinting situations in attack and defence can be crucial for winning a match. This finding also demonstrates very clearly the importance of speed skills in modern soccer.

There is a constant search for reserves of motor speed potential in present-day soccer. The originality and innovation of this study is represented by demonstrating the level of exercise capacity represented by the examined groups and whether there is a difference between them on two different continents. The results of the analysis of these differences can be used for assessment of effectiveness of athletes' speed skills and for adjustment of training loads.

In order to reduce the differences found between the sprinting speeds of South African players and their Polish counterparts over the first 5 metres of the test distances, the South African players need to practice more explosive exercises, which would enable them to develop greater anaerobic power. Both collegiate teams assessed in this study should focus on developing the greatest possible running with changes of direction by using more speed-endurance training loads and multiple repetitions in their training. Strength and conditioning specialists and coaches should implement these loads in their training programmes, and evaluate the effects of speed training. It is strongly recommended that apart from using the regular 30m-straight sprint test, zig-zag sprint tests should be used also, owing to the specificity of movements of players on the pitch during real matches. Accurate and state-of-the-art diagnostic systems, such as the Smart Speed System, can be used effectively for assessing the speed skills of players.

CONCLUSION

The results of the study showed that the Polish collegiate soccer players were 0.117 seconds faster than their South African counterparts, and that they attained significantly higher running speeds over each 5-metre segment of the measured distance in the 30m-straight sprint test. In the 30m-zig-zag sprint test, the Polish soccer players displayed a higher level of speed skills than the South African players, and the differences in speed and time between the two groups of players were even greater than in the 30-m straight sprint test. The results of both speed tests were indicative of a greater level of speed skill among Polish soccer players than among their South African counterparts.

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