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THE EVALUATION OF SOCCER PLAYERS PERFORMANCE ON DIFFERENT REPEATED SPRINT TESTS: TRAINING AND TESTING IMPLICATIONS

OCENA USPEŠNOSTI NOGOMETAŠEV PRI RAZLIČNIH TESTIH PONAVLJAJOČIH SE ŠPRINTOV: POMEN ZA TRENINGE IN TESTIRANJA

ABSTRACT

The aim of the present study was to evaluate players performance on different repeated sprint test protocols according to the players' playing position. Twenty-seven U19 national team males' field soccer players were tested on 7 × 34.2 m repeated sprint test (RST), 12 × 20 m RST, and 6 × 40 m (20 + 20 m) RST. Results clearly show that forwards scored best on 7 × 34.2 m RST with 48.48 ± 3.12 s in total time, 6.53 ± 0.36 s in fastest time, and fatigue index of 6.12 ± 4.14%; Defenders scored best on 12 × 20 m RST with 66.28 ± 2.62 s in total time, 5.32 ± 0.22 s in fastest time, and fatigue index of 3.78 ± 1.92%; and midfielders scored best on 6 × 40 m (20 + 20 m) RST with 35.77 ± 0.77 s in total time, 5.80 ± 0.13 s in fastest time, and fatigue index of 2.87 ± 1.19%. Furthermore, the relationship detected between individual players results from test to test were trivial to moderate indicating that individual players score differently on different tests. Even though the tests were designed to measure the same qualities, the evaluation of the results supports the theory that different tests would outline different performance weaknesses and strength. However, even in team sports, individualizing the design and the implementation of the training program according to the player playing position could be a crucial factor in improving the overall performance of the player.

Key words: Assessment; Measurement; Team sport; RSA

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IZVLEČEK

Cilj raziskave je bil oceniti uspešnost igralcev pri različnih protokolih testiranja ponavljajočih se šprintov glede na njihov igralni položaj. V testiranje smo vključili 27 reprezentančnih nogometašev U19, in sicer testi ponavljajočih se šprintov (*repeated sprint test* – RST) 7 × 34,2 m, 12 × 20 m in 6 × 40 m (20 + 20 m). Rezultati so jasno pokazali, da so se napadalci najbolje odrezali pri 7 × 34,2 m RST s skupnim časom 48,48 ± 3,12 s, najhitrejšim časom 6,53 ± 0,36 s in indeksom utrujenosti 6,12 ± 4,14 %; branilci so se najbolj izkazali pri 12 × 20 m RST s skupnim časom 66,28 ± 2,62 s, najhitrejšim časom 5,32 ± 0,22 s in indeksom utrujenosti 3,78 ± 1,92 %; vezni igralci pa so bili najboljši pri 6 × 40 m (20 + 20 m) RST s skupnim časom 35,77 ± 0,77 s, najhitrejšim časom 5,80 ± 0,13 s in indeksom utrujenosti 2,87 ± 1,19 %. Poleg tega je povezava med rezultati različnih testov med posameznimi igralci rahlo do zmerno pokazala, da so imeli posamezni igralci pri različnih testih različne rezultate. Čeprav so bili testi pripravljeni za merjenje enakih značilnosti, ocena rezultatov podpira teorijo, da različni testi pokažejo različne slabosti in prednosti v uspešnosti. Ne glede na vse pa lahko individualno prilagajanje oblike in izvedbe programa treninga glede na igralni položaj igralca tudi v ekipnih športih predstavlja ključni dejavnik za izboljšanje igralčeve splošne uspešnosti.

Ključne besede: ocena, merjenje, ekipni šport, RSA (sposobnost ponavljajočih se šprintov)

INTRODUCTION

Over the past years, research within soccer has been very successful in investigating the fundamental processes that contribute towards improving the game and players. Scientific research shows that soccer players' performance depends on a number of characteristics and skills, of which the player's technical and tactical skills are the two major performance-determining factors for success (Turner & Stewart, 2014). Besides technical and tactical skills, the length of the soccer game and the high-intensity actions observed during the game outline the importance of both the aerobic and the anaerobic energy systems (Little & Williams, 2005; Vanderford, Meyers, Skelly, Stewart, & Hamilton, 2004).

The results of match analyses showed that a field player covers an average distance of 9–12 km during 90 min match (Bangsbo, 1994; Bradley et al., 2009; Vigne, Gaudino, Rogowski, Alloatti, & Hautier, 2010) with 9–11% covered at high-intensity (Bradley et al., 2009). The high-intensity actions were reported to have a duration of 2–3.8 s each (Bangsbo, Norregaard, & Thorso, 1991; Mohr, Krustrup, & Bangsbo, 2003; Spencer, Bishop, Dawson, & Goodman, 2005) and take place every 40–90 s (Spencer et al., 2005) with a total distance covered of 10–22.4 m per action (Reilly & Thomas, 1976; Spencer et al., 2005). Spencer et al. (2005) summarised the total sprinting bouts to be between 20–60 sprint per match, with a total sprinting distance of 700–1000 m. Furthermore, forward players tend to perform more sprints than back players and midfielders, and were reported to perform fastest on agility and repeated sprint tests (Bangsbo et al., 1991; Kaplan, 2010; Kaplan, Erkmen, & Taskin, 2009; Reilly & Thomas, 1976). However, a recent study showed that fullbacks conducted the highest number of high-intensity actions, followed by central midfielders (Bradley et al., 2009; Carling, Le Gall, & Dupont, 2012). Research further indicate that highly-trained soccer players performed 28% more high-intensity running compared to moderately-trained soccer players (Mohr et al., 2003), and successful teams have been reported to cover more distance at high-intensity than did less successful ones (Rampinini et al., 2009).

The repeated production of high-intensity sprints, with short recovery time, has been defined as repeated sprint ability (Girard, Mendez-Villanueva, & Bishop, 2011; Spencer et al., 2005). These repeated sprint actions during match play have been reported to cause a decline in performance (Girard et al., 2011), indicating that repeated sprint ability in soccer is characterised by single sprint speed and the ability to resist fatigue (Bishop, Girard, & Mendez-Villanueva, 2011). The decline in the number of sprints observed towards the end of soccer matches linked fatigue to the ability of repeatedly producing high-intensity sprints throughout the match (Mohr et al., 2003). Therefore, it was suggested that the ability to repeat sprints could be a crucial factor that could directly affect the match result toward the end of the match (Rampinini et al., 2009). Fatigue has been defined as a "decline in maximal sprint speed over the number of sprint repetitions" (Girard et al., 2011). Fatigue index has been calculated to measure the percentage decrement score of sprints in a repeated sprint test (Glaister, Howatson, Pattison, & McInnes, 2008), results showed a high relationship between the initial sprint speed (first sprint) and the occurrence of fatigue in repeated sprint exercise (Mendez-Villanueva, Hamer, & Bishop, 2008). On the other hand, players with higher aerobic capacity have been reported to have smaller decrements in repeated sprint tests (Aziz, Mukherjee, Chia, & Teh, 2007), and performance on repeated sprint tests was related to single sprint speed rather than aerobic capacity (Pyne, Saunders, Montgomery, Hewitt & Sheehan, 2008). To explain this relationship, it was suggested that players higher initial sprint speed have higher anaerobic metabolism contribution, which is highly related to performance decrements (Girard et al., 2011; Mendez-Villanueva et al., 2008). The task of sprint (e.g., duration, surface, number of repetitions, and environment) would also have an effect on fatigue resistance (Girard et al., 2011) and reported to be limited by neural factors (Mendez-Villanueva et al., 2008), muscular factors (Bangsbo & Iaia, 2013), energy supplies and lactate acid accumulation (Reilly, 2007).

Since a soccer game is not predictable in nature, and repeated sprint efforts could occur in any time during the match play, it was strongly advised to test and train this ability (Dawson, 2012; Haugen, Tonnessen, Hisdal, & Seiler, 2014; Silvestre, West, Maresh, & Kraemer, 2006). As a result, several repeated sprint test protocols were developed. However, the results of those tests have so far contributed little to the effectiveness of training design as they overlook the individual specific weaknesses according to the player playing position. Therefore, individual players may not perform as well on different repeated sprint tests. This difference in performance has not been well investigated in the literature of repeated sprint training for team sport and may have caused researchers and the strength and conditioning specialists within team sports to overlook the importance of such information. A question, however, needs to be answered: is it the right time to individualize repeated sprint training in team sports to better improve players performance? To be able to answer this question, soccer players were evaluated on three widely used repeated sprint tests as a function of playing position and the rank order of scores from each player on each test. We hypothesized that players would not perform differently on different repeated sprint test according to their playing position.

MATERIALS AND METHODS

Subjects

Twenty-seven U19 national team males' field soccer players volunteered to participate in our study. These consisted of eleven defenders aged (± SD) (17.6 ± 0.5 years), with body mass (74.8 ± 8.8 kg), height (182.9 ± 5.8 cm), and body fat (12.6 ± 2.1%); nine midfielders aged (17.6 ± 0.5 years), with body mass (70.4 ± 6.5 kg), height (178.0 ± 4.9 cm), and body fat (13.1 ± 1.6%); and seven forwards aged (17.4 ± 0.5 years), body mass (71.5 ± 3.9 kg), height (179.9 ± 4.9 cm), and body fat (13.4 ± 1.5%). In addition to the subjects' physical education classes at school, their soccer practice age was on average 9 years with training of 11 months a year, consisting of 5 sessions per week plus a match. In general, soccer-training sessions lasted ~1.5 hours, including about 15–20 min of warming up, low-intensity games and stretching exercises, 15–25 min of technical soccer exercises (kicking actions, dribbling, jumping, and running with fast accelerations and decelerations), 20-30 min of match practice, and 10 min of active recovery. None of the participants reported any current or ongoing neuromuscular diseases or musculoskeletal injuries specific to the ankle, knee, or hip joints, and none of them were taking any dietary or performance supplements that could have affected performance during the study. Written informed consent was received from all subjects after verbal and written explanation of the experimental design and potential risks. The study was conducted according to the Declaration of Helsinki and the study protocol was pre-approved by the local Ethics Committee of the Tunis University.

Procedures

We aimed to evaluate and compare soccer players' performance reproducibility on repeated sprint tests as a function of the individual player playing position and the rank order performance across tests. All subjects were tested as a part of their training using three repeated sprint test protocols, namely, the 7 × 34.2 m repeated sprint test (Bangsbo, 1994), the 12 × 20 m repeated sprint test (Cazorla, 2006), and the 6 × 40 m (20 + 20 m) repeated sprint test (Impellizzeri et al., 2008). Unlike linear sprinting tests, the repeated sprint test protocols used in this study were designed specifically for soccer players as they combine sprinting with changes of direction, stimulating the type of high intensity actions observed during match play (Bangsbo, 1994; Cazorla, 2006; Impellizzeri et al., 2008). Furthermore, to avoid the chronobiology bias on the subjects physical performance during the tests, all tests were performed during a two weeks training camp on a soccer field at 8 AM in the month of April under a temperature of 15°C–22°C. The subjects during the training camp had their balanced morning meal every day at 6 AM. To be able to maximize the reliability of the results, no more than one test was conducted on a given day, and each test day followed two days of light intensity training.

The subjects' body mass was measured to the nearest 0.1 kg using an electronic scale (Seca Instruments Ltd., Hamburg, Germany), height was measured to the nearest 0.5 cm using a stadiometer (Holtain Ltd., Crymych, UK), and body fat was measured by skinfold thickness at four sites (biceps, triceps, subscapular, and suprailiac) using Harpenden callipers (Lange, Cambridge, MA, USA). All sprint tests were assessed using the Brower Speed Trap II timing system (Brower Timing Systems, Utah, USA). The manufacturer of the Brower Speed Trap II timing system stated that its radio frequency was 27.145 MHz and that accutacy of its timing system was 1/100 s. The reducibility of the system has been assessed and reported in a separate study (Shalfawi, Tønnessen, Enoksen, & Ingebrigtsen, 2011).

- ***7 × 34.2 m repeated sprint test:***

Subjects started the test from a standing position 50 cm behind the starting photocell (time zero) and sprinted a total distance of 34.2 m involving a right or left swing after the first 10 m, then continued the sprint to the finish line where another photocell was placed (finish time). Subjects were asked to perform a 25 s active recovery consisting of jogging back to the starting line (Figure 1). Verbal feedback was provided to the subject during the recovery run every 10 and 20 s so the subject can be ready for the next run on time. The test leader said the word "ready" at approximately the 23rd second of the recovery time, and at the 25th second the test leader said the word "go". The procedure continued until the subject completed seven sprints (Bangsbo, 1994).

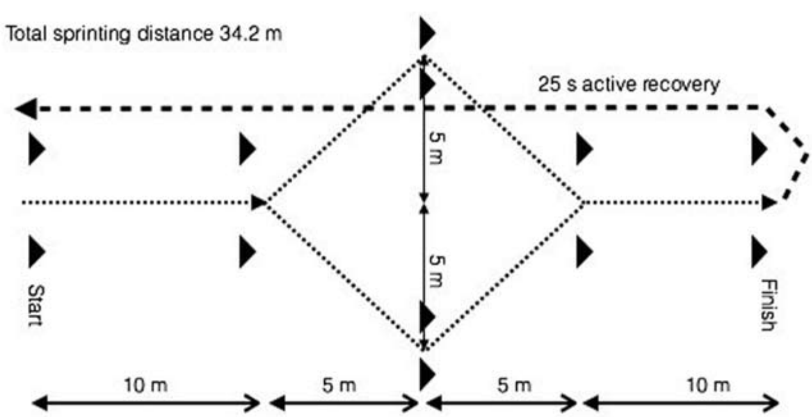

Figure 1: The 7 x 34.2 m repeated sprint test (Bangsbo sprint test).

• 12 × 20 m repeated sprint test:

Subjects started the test from a standing position 50 cm behind the starting photocell (time zero) and sprinted a total distance of 20 m involving left, right, left and right swings after the first 4.30 m, 3.20 m, 5 m and 3.20 m, respectively, then continued the sprint to the finish line where another photocell was placed (finish time). Subjects asked to perform a 40 s of passive recovery consisting of walking back to the starting line (Figure 2). Verbal feedback was provided to the subject during the recovery time at 20, 30, and 35 s so the subject could be ready for the next run on time. The test leader said the word "ready" at approximately 37th second of the recovery time, and at the 40th second the test leader said the word "go". The procedure continued until the subject completed twelve sprints (Cazorla, 2006).

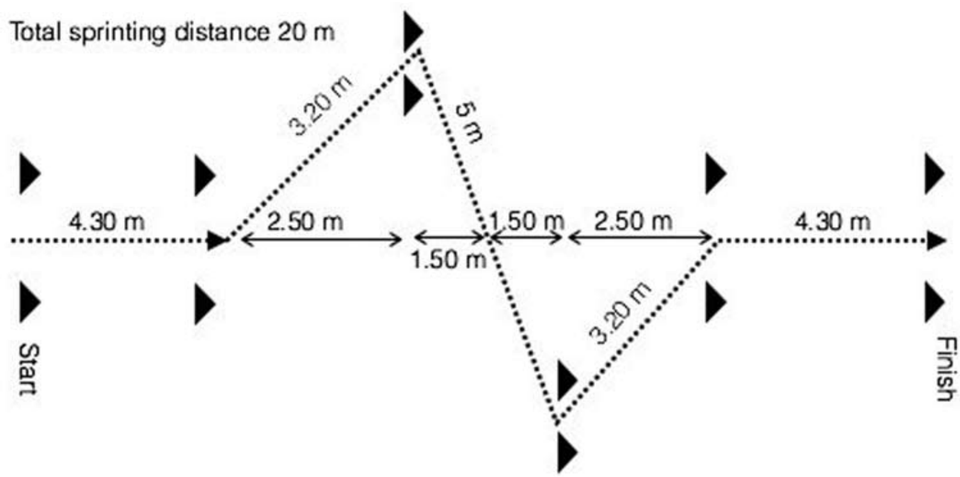

Figure 2: The 12 x 20 m repeated sprint test (Cazorla sprint test).

• 6 x 40 m (20 + 20 m) repeated sprint test:

Subjects started the test from a standing position 50 cm behind the start/finish photocell (time zero) and sprinted 20 m linearly, touched a line placed on the 20 m mark with a foot, turned and sprinted back to the starting line crossing the start/finish photocell (finish time). After 20 s of passive recovery, subjects were asked to start again. Verbal feedback was provided to the subject during the recovery time at 10 and 15 s so the subject could be ready for the next run on time. The test leader said the word "ready" at approximately 17th second of the recovery time, and at the 20th second; the test leader said the word "go". The procedure continued until the subject completed six sprints (Impellizzeri et al., 2008).

Statistical Analyses

Deterioration in performance expressed as percentage of speed decrement *(Dec%)* was calculated according to the approach used by Morin, Dupuy and Samozino (2011) for all the repeated sprint tests in this study.

Equation 1

$$Dec\% = 100 - (100 * [total\ sprint\ time \div (best\ time \times number\ of\ sprints)])$$

Then the data explored by histogram plot and the normality of distribution was tested using Shapiro-Wilk's test for each test results in this study. Next, descriptive statistics were calculated and reported as mean ± standard deviations (SD) of the mean for all subjects on each of the repeated sprint tests. For the data found to follow a normal distribution, the one-way ANOVA assessed followed by the Tukey's multiple comparisons test, with a single pooled variance. For the data that found not to follow a normal distribution, the Kruskal-Wallis test assessed followed by the Dunn's multiple comparisons test. However, for a better understanding of the results, all data were presented graphically using the mean difference and the 95% Confidence Interval with the effect size (Cohen *d*) calculated and defined as small when $d = 0.2 – 0.49$, medium when $d = 0.5 – 0.79$ and large when $d \geq 0.8$ (Cohen, 1988). Correlation matrix between all variables were determined using Pearson's *r*. Reliability assessed using a 2-way mixed intraclass correlation (ICC) for all measures. The alpha level for significance was set to *P* # 0.05 for all statistical examinations. The test re-test reliability for 7 × 34.2 m repeated sprint test was intra-class correlated (ICC) (ICC = 0.934, $P < 0.01$), for the 12 × 20 m repeated sprint test (ICC = 0.930, $P < 0.01$) and for the 6 x 40 m repeated sprint test (ICC = 0.886, $P < 0.01$).

RESULTS

Table 1. Mean ± standard deviations of the mean (SD) for all subjects on each of the repeated sprint tests.

	7 × 34.2 m RST			12 × 20 m RST			6 × 40 m (20 + 20) RST		
	Total Time	Fastest time	FI%	Total Time	Fastest time	FI%	Total Time	Fastest time	FI%
MF (n=9)	49.66 (1.97)	6.78 (0.26)	4.67 (4.00)	66.52 (2.46)	5.35 (0.22)	3.71 (2.97)	35.77 (0.77)	5.80 (0.13)	2.87 (1.19)
D (n=11)	49.90 (3.22)	6.93 (0.38)	2.86 (1.42)	66.28 (2.62)	5.32 (0.22)	3.78 (1.92)	36.18 (0.96)	5.90 (0.16)	2.32 (1.06)
F (n=7)	48.48 (3.12)	6.53 (0.36)	6.12 (4.14)	67.90 (0.60)	5.45 (0.13)	3.78 (2.20)	36.67 (1.32)	5.92 (0.14)	3.19 (1.89)
All (n=27)	49.45 (2.79)	6.78 (0.37)	4.31 (3.4)	66.78 (2.24)	5.37 (0.20)	3.76 (2.29)	36.17 (1.03)	5.87 (0.15)	2.73 (1.35)

RST = Repeated sprint test; FI% = Fatigue index in percent; MF = Midfielders; D = Defenders; F = Forwarders.

Within tests analyses:

Examining the results from the *7 × 34.2 m repeated sprint test* revealed that there was no statistical significant differences between players of the same playing positions. However, the effect size of the difference revealed that differences exist between playing positions (Figure 3). When examining the total time achieved, the results indicate that the differences between playing positions performance was trivial. However, examining the results for fastest times indicate that forwards had the fastest time with a large effect size difference compared to midfielders and defenders. The results further showed that forwards had a large percentage of speed decrement compared to defenders (Table 1 and Figure 3).

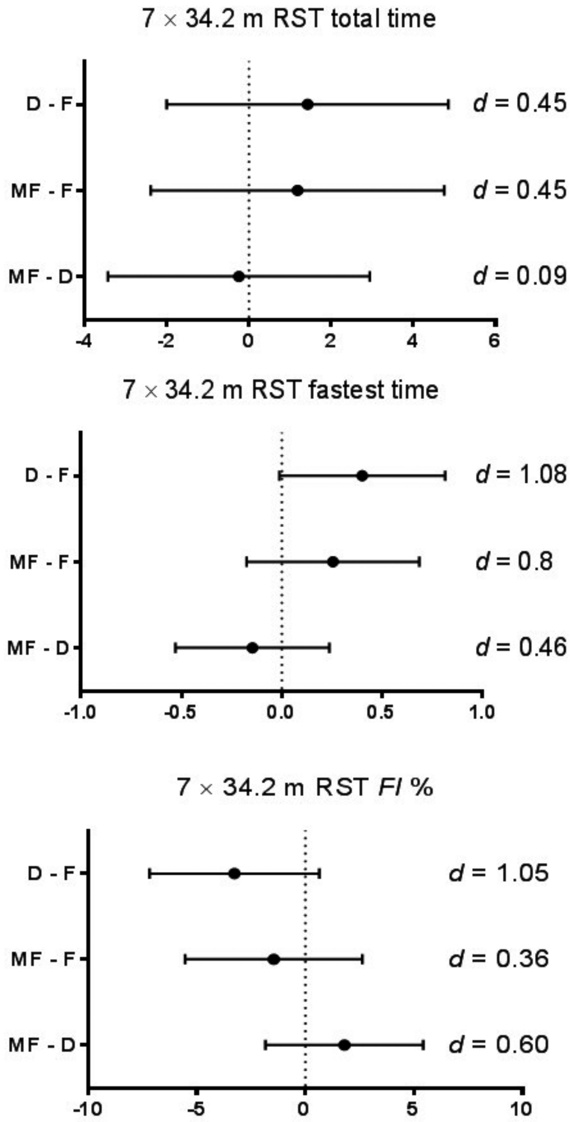

Figure 3: The 95% Confidence Intervals and the effect size of the difference between group means from the 7 × 34.2 m repeated sprint test.

While there was no statistical significant differences between players of the same positions in the 12 × 20 m repeated sprint test, the results showed a large difference in total time between forwards, midfielders and defenders, with defenders performing best (Figure 4). A medium effect difference in fastest time performance was observed between forwards, midfielders and defenders, with defenders performing best. Finally, a very trivial effect size in differences was observed in percentage of speed decrement between playing positions (Table 1 and Figure 4)

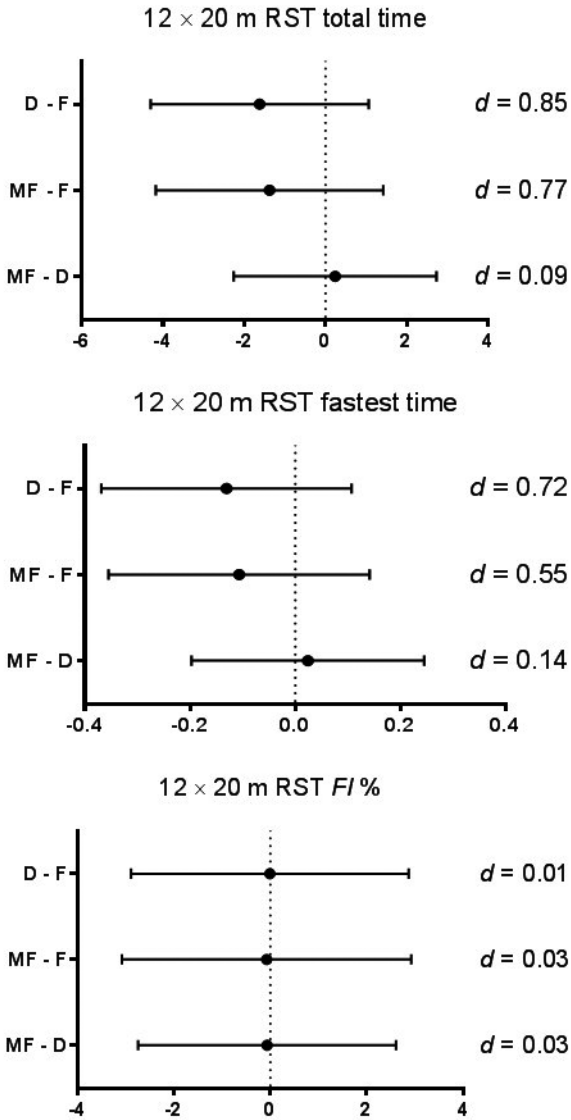

Figure 4: The 95% Confidence Intervals and the effect size of the difference between group means from the 12 × 20 m repeated sprint test.

The results from 6 x 40 m repeated sprint test (20 + 20 m) did not show any statistical significant differences between players' positions. The results, however, showed a large effect size difference in total time and fastest time between forwards and midfielders with midfielders scoring better on both. A medium effect size difference was observed between defenders' and midfielders' fastest times with midfielders scoring best. Finally, a medium effect size difference was observed between forwards and midfielders' percentage of speed decrement, with forwards having a higher percentage of speed decrement compared to midfielders (Table 1 and Figure 5).

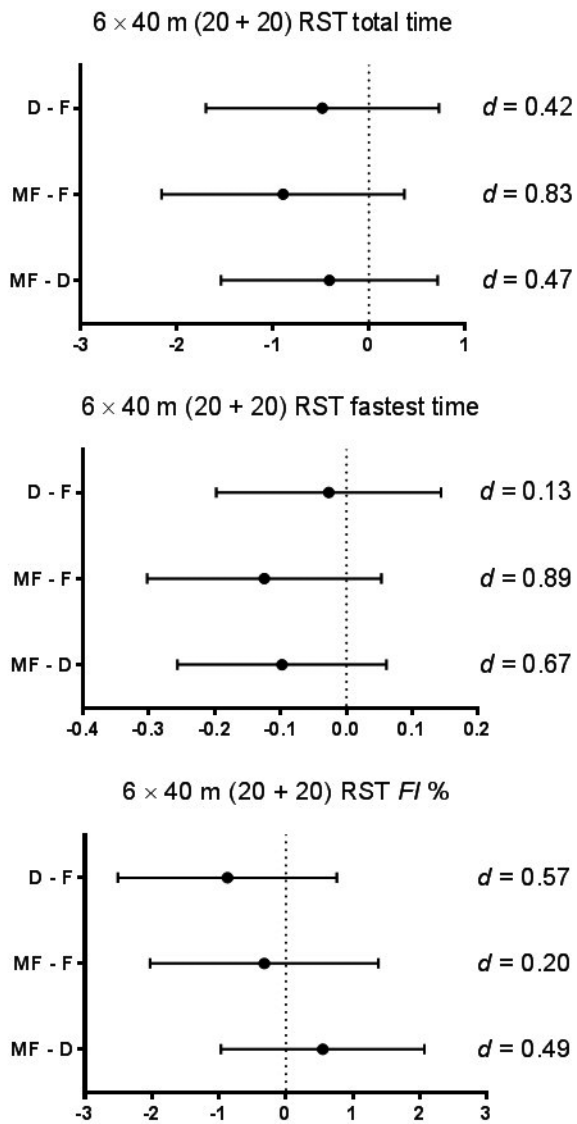

Figure 5: The 95% Confidence Intervals and the effect size of the difference between group means from the 6 × 40 m (20 + 20) repeated sprint test.

Performance relationship between tests:

A moderate significant relationship was detected ($r = 0.43$, $P = 0.0230$) between total time performance from the 6 × 40 m repeated sprint test and 7 × 34.2 m repeated sprint test (Figure 6). Furthermore, a moderate significant relationship ($r = 0.42$, $P = 0.0316$) was observed between percentage of speed decrement from the 7 × 34.2 m repeated sprint test and the 12 × 20 m repeated sprint test (Figure 7). No other marked relationships were observed between repeated sprint tests in the present study.

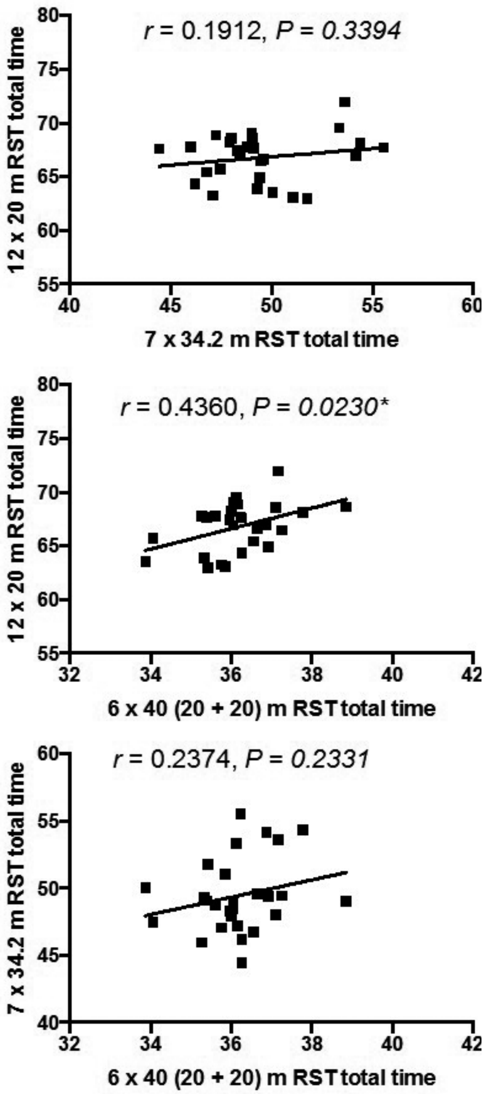

Figure 6: The relationship between repeated sprint total time performances across the repeated sprint tests.

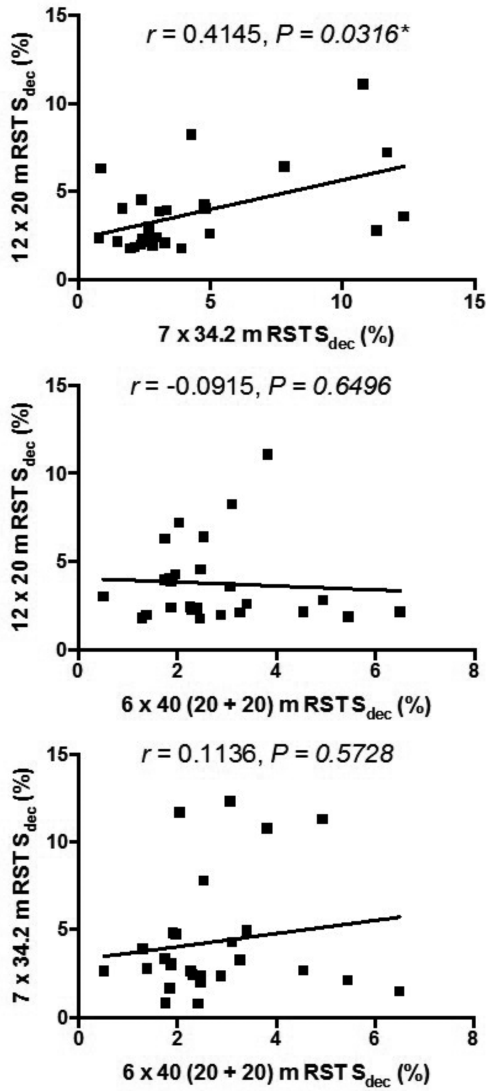

Figure 7: The relationship between groups' fatigue index scores from the repeated sprint tests.

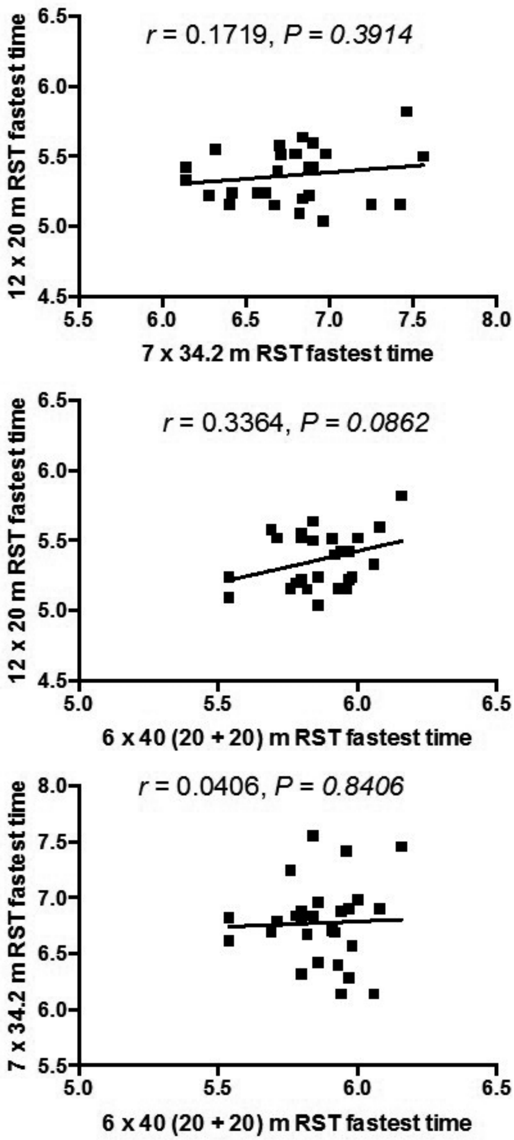

Figure 8: The relationship between groups fastest time from the repeated sprint tests.

DISCUSSION AND CONCLUSIONS

The main findings from the present investigation indicate that soccer players from different playing positions perform differently across repeated sprint tests. At the same time, they fail to show a strong relationship between performances, indicating that repeated sprint tests investigated in this study are specific and one test cannot entirely explain the results from the other tests (Figure 6, 7, 8). Examining the results further indicated no statistical differences in performance between players playing position. However, investigation of the effect size of the difference revealed that differences exist between players playing positions (Figure 3, 4, 5). Furthermore, the results showed the following: In 7 × 34.2 m repeated sprint test, forwards scored the fastest sprint time, the fastest total time and the highest fatigue index; in 12 × 20 m repeated sprint test, defenders scored the fastest sprint time, the fastest total time and the highest fatigue index; in 6 x 40 m repeated sprint test, midfielders scored the fastest sprint time, the fastest total time but not the highest fatigue index (Table 1). Forwards have been reported to score best on repeated sprint tests in studies that used distances of ~30 m (Kaplan, 2010) but not on distances ~40 m (Silvestre et al., 2006). This could explain forwards scoring the highest fatigue index in both 7 × 34.2 m and 6 x 40 m repeated sprint tests but not the best time either test. This explanation does not contradict the results of other studies where forward players tend to perform more sprints than back players and midfielders over a shorter distance compared to midfielders who conduct a higher number of high intensity actions and sprints over a longer distance (Bangsbo et al., 1991; Bradley et al., 2009; Carling et al., 2012; Reilly & Thomas, 1976). However, the results in this study are in line with those of other studies, which indicate that players who scored the best total time in one test score the best fastest time on the same test (Girard et al., 2011; Glaister et al., 2008; Mendez-Villanueva et al., 2008; Pyne et al., 2008). Nevertheless, the differences observed between performances across the repeated sprint tests could be attributed to the differences in the tests design, which indicate that those tests assess other qualities besides repeated sprint ability as the changes of direction differ from test to test. Furthermore, considering the different profile of each playing position points out different physiological workload, which demonstrate the importance of position-specific training programs (Kaplan et al., 2009).

To explain the differences better, one of the important purposes of assessing athletic performance is to point out specific weaknesses in performance using various splits and test protocols to be able to quantitatively determine athlete physical capacity, which in turns reflect on training program design to meet the desired outcome (Brown, Vescovi, & VanHeest, 2004). Repeated sprint testing has been reported to be a useful tool for soccer players as it simulates the most intensive game periods and gives an indication of the ability to sustain speed over time and resist fatigue (Haugen et al., 2014). However, while testing is recommended in order to assess athletes and point out their specific weaknesses in performance, it is important to consider the individual player's playing position, a factor which has been consistently overlooked by previous studies. In contrast, the results from this investigation showed that forwards performed better on mixed skill repeated sprint test where the path of the test is not entirely planned and the players had the choice of choosing the change of direction during the test and the distance is shorter than 35 m (Figure 1), whereas, defenders scored better on closed skill repeated sprint test where they have preplanned path (Figure 2), and midfielders scored better on mixed skill repeated sprint test that involve a longer linear sprinting distance (6 x 40 m (20 + 20 m) repeated sprint test). Despite the fact that the three repeated test protocols presented in this study were designed to measure soccer player ability to repeatedly sprint, they point out weaknesses that correlate to the player's playing position. It thus suggests that the same repeated sprint training program could be of little relevant to some of the players of a certain playing position when considering the type of skill to be developed (Kaplan et al., 2009). Research shows that after applying a physical training program, the physiological adaptation that reflects on performance transpires in the tissues and movement pattern that were exposed to training (Reilly, 2007). In soccer, strength and speed training could be seen as specific supplementary training, which is believed to provide training advantages and reduce the risk of injury (Harman, 2008). Therefore, it is reasonable to believe that the improvement of repeated sprint ability during match play could be achieved by selecting exercises similar to the repeated sprint activities observed in a soccer game, in terms of the specific skeleton region, muscle and joint movement, direction of movement, energy source used, and other external factors such as playing ground, shoes (Baechle & Earl, 2008; Harman, 2008; Ratamess, 2008). Thus, individualization of training according to playing position is highly recommended, and it is supported by the fact that this individualization promotes the highest training adaptation to the pre-identified variables in need for improvement (Kraemer, 2002). Research shows, for example, that agility and linear sprint are specific and independent qualities (Little & Williams, 2005; Sporis, Jukic, Milanovic, & Vucetic, 2010), and suggests that improving agility should be related to adaptations in the specific coordination of the neuromuscular system (Ross & Leveritt, 2001; Ross, Leveritt, & Riek, 2001). Wojtys, Huston, Taylor and Bastian (1996) reported a neuromuscular adaptation to agility training in the form of improved spinal reflex and cortical response times in typical lower limb muscles. However, the differences observed in performance from test to test and the relationship reported among repeated sprint tests (Figure 6, 7, & 8) highlights the importance of training the physical qualities in need of improvement, which is based on the single player capacity and areas in need for improvements according to playing position. Hence, different tests would outline different weaknesses and strengths, even though all tests are designed to measure the same quality.

CONCLUSION

In line with other studies, the results from the present investigation indicate that players who scored best on repeated sprint total time in one test has also scored best fastest time on the same test. Nevertheless, players scored differently on the different tests with according to their positions. These differences could be attributed to the differences in the tests design, which indicate that those tests assess other qualities besides repeated sprint ability. Forwards performed better on mixed skill repeated sprint test compared to defenders who scored best on closed skill repeated sprint test and midfielders who scored best on mixed skill repeated sprint test that involve a longer linear sprinting distance, which points out weaknesses relative to the player playing position according to the type of repeated sprint skill being tested. These results highlights the importance of training the physical qualities in need for improvement which is based on the single player capacity and type of skill in need for improvement according to playing position. The results suggest further that, even in team sports, strength and conditioning specialist should pay attention to the specificity, individuality according to players position when designing the strength and conditioning training program.

REFERENCES

Aziz, A. R., Mukherjee, S., Chia, M. Y., & Teh, K. C. (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), 401-407.

Baechle, T. R., & Earl, R. W. (2008). Anaerobic exercise prescription. In T. R. Baechle & R. W. Earl (Eds.), *Essentials of strength training and conditioning* (pp. 379-380). Champaign, IL: Human kinetics.

Bangsbo, J. (1994). *Fitness Training in Football*. Bagsværd: HO+Storm.

Bangsbo, J., & Iaia, F. M. (2013). Principles of fitness training. In M. A. Williams (Ed.), *Science and Soccer: Developing Elite Performers* (3rd ed., pp. 24 - 43). New York: Routlege.

Bangsbo, J., Norregaard, L., & Thorso, F. (1991). Activity profile of competition soccer. *Can J Sport Sci, 16*(2), 110-116.

Bishop, D., Girard, O., & Mendez-Villanueva, A. (2011). Repeated-sprint ability - part II: recommendations for training. *Sports Med, 41*(9), 741-756.

Bradley, P. S., Sheldon, W., Wooster, B., Olsen, P., Boanas, P., & Krustrup, P. (2009). High-intensity running in English FA Premier League soccer matches. *J Sports Sci, 27*(2), 159-168.

Brown, T. D., Vescovi, J. D., & VanHeest, J. L. (2004). Assessment of linear sprinting performance: a theoretical paradigm. *J Sports Sci Med, 3,* 203-210.

Carling, C., Le Gall, F., & Dupont, G. (2012). Analysis of repeated high-intensity running performance in professional soccer. *J Sports Sci, 30*(4), 325-336.

Cazorla, G. (2006, nov. 17/2006). *Evaluation physique et physiologigue du footballeur et orientations de sa preparation physique,* LILLE, Bordeaux.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences.* New York: Routledge.

Dawson, B. (2012). Repeated-sprint ability: where are we? *Int J Sports Physiol Perform, 7*(3), 285-289.

Girard, O., Mendez-Villanueva, A., & Bishop, D. (2011). Repeated-sprint ability - part I: factors contributing to fatigue. *Sports Med, 41*(8), 673-694.

Glaister, M., Howatson, G., Pattison, J. R., & McInnes, G. (2008). The reliability and validity of fatigue measures during multiple-sprint work: an issue revisited. *J Strength Cond Res, 22*(5), 1597-1601.

Harman, E. (2008). Biomechanics of resistance exercise. In T. R. Beachle & R. W. Earl (Eds.), *Essential of strength training and conditioning* (pp. 65-92). Champaign, IL: Human Kinetics.

Haugen, T., Tonnessen, E., Hisdal, J., & Seiler, S. (2014). The role and development of sprinting speed in soccer. *Int J Sports Physiol Perform, 9*(3), 432-441.

Impellizzeri, F. M., Rampinini, E., Castagna, C., Bishop, D., Ferrari Bravo, D., Tibaudi, A., & Wisloff, U. (2008). Validity of a repeated-sprint test for football. *Int J Sports Med, 29*(11), 899-905.

Kaplan, T. (2010). Examination of repeated sprinting ability and fatigue index of soccer players according to their positions. *J Strength Cond Res, 24*(6), 1495-1501.

Kaplan, T., Erkmen, N., & Taskin, H. (2009). The evaluation of the running speed and agility performance in professional and amateur soccer players. *J Strength Cond Res, 23*(3), 774-778.

Kraemer, W. J. (2002). Developing a strength training workout. In W. J. Kraemer & K. Hakkinen (Eds.), *Handbook of sport medicine and science, strength training for sport.* London: Wiley-Blackwell.

Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *J Strength Cond Res, 19*(1), 76-78.

Mendez-Villanueva, A., Hamer, P., & Bishop, D. (2008). Fatigue in repeated-sprint exercise is related to muscle power factors and reduced neuromuscular activity. *Eur J Appl Physiol, 103*(4), 411-419.

Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *J Sports Sci, 21*(7), 519-528.

Morin, J. B., Dupuy, J., & Samozino, P. (2011). Performance and fatigue during repeated sprints: what is the appropriate sprint dose? *J Strength Cond Res, 25*(7), 1918-1924.

Pyne, D. B., Saunders, P. U., Montgomery, P. G., Hewitt, A. J., & Sheehan, K. (2008). Relationships between repeated sprint testing, speed, and endurance. *J Strength Cond Res, 22*(5), 1633-1637.

Rampinini, E., Sassi, A., Morelli, A., Mazzoni, S., Fanchini, M., & Coutts, A. J. (2009). Repeated-sprint ability in professional and amateur soccer players. *Appl Physiol Nutr Metab, 34*(6), 1048-1054.

Ratamess, N. (2008). Adaptations to anaerobic training programs. In T. R. Baechle & R. W. Earl (Eds.), *Essentials of strength training and conditioning* (pp. 93-121). Champaign, IL: Human kinetics.

Reilly, T. (2007). *The science of training - soccer: A scientific approach to developing strength, speed and endurance*. New York: Routledge.

Reilly, T., & Thomas, V. (1976). A motion analysis of work rate in different positional. roles in professional football match-play. *Journal of human movement studies, 2,* 87-97.

Ross, A., & Leveritt, M. (2001). Long-term metabolic and skeletal muscle adaptations to short-sprint training: implications for sprint training and tapering. *Sports Med, 31*(15), 1063-1082.

Ross, A., Leveritt, M., & Riek, S. (2001). Neural influences on sprint running: training adaptations and acute responses. *Sports Med, 31*(6), 409-425.

Shalfawi, S. A. I., Tønnessen, E., Enoksen, E., & Ingebrigtsen, J. (2011). Assessing day-to-day reliability of the newtest 2000 sprint timing system. *Serbian Journal of Sports Sciences, 5*(3), 107-113.

Silvestre, R., West, C., Maresh, C. M., & Kraemer, W. J. (2006). Body composition and physical performance in men's soccer: a study of a National Collegiate Athletic Association Division I team. *J Strength Cond Res, 20*(1), 177-183.

Spencer, M., Bishop, D., Dawson, B., & Goodman, C. (2005). Physiological and metabolic responses of repeated-sprint activities:specific to field-based team sports. *Sports Med, 35*(12), 1025-1044.

Sporis, G., Jukic, I., Milanovic, L., & Vucetic, V. (2010). Reliability and factorial validity of agility tests for soccer players. *J Strength Cond Res, 24*(3), 679-686.

Turner, A. N., & Stewart, P. F. (2014). Strength and conditioning for soccer players. *Strength & Conditioning Journal, 36*(4), 1-13.

Vanderford, M. L., Meyers, M. C., Skelly, W. A., Stewart, C. C., & Hamilton, K. L. (2004). Physiological and sport-specific skill response of olympic youth soccer athletes. *J Strength Cond Res, 18*(2), 334-342.

Vigne, G., Gaudino, C., Rogowski, I., Alloatti, G., & Hautier, C. (2010). Activity profile in elite Italian soccer team. *Int J Sports Med, 31*(5), 304-310.

Wojtys, E. M., Huston, L. J., Taylor, P. D., & Bastian, S. D. (1996). Neuromuscular adaptations in isokinetic, isotonic, and agility training programs. *Am J Sports Med, 24*(2), 187-192.