Sports Medicine & Doping Studies

Sporis et al., J Sport Medic Doping Studie 2012, S2
http://dx.doi.org/10.4172/2161-0673.S2-001

Research Article Open Access

Relationship between Functional Capacities and Performance Parameters in Soccer

Goran Sporis[2]*, Zoran Milanovic[1], Nebojsa Trajkovic[1], Marko Erceg[3] and Dario Novak[2]

[1]*Faculty of Sport and Physical Education, University of Nis, Nis, Serbia*
[2]*Faculty of Kinesiology, University of Zagreb, Zagreb, Croatia*
[3]*Faculty of Kinesiology, University of Split, Split, Croatia*

Abstract

Aim of this study was to determine the relationship between functional capacities and skills performance among young soccer player. The research was conducted on a sample of 22 players aged U-14, members of the elite junior soccer club. Players were tested for aerobic capacities (Soccer specific endurance tests, Beep test), anaerobic capacities (Sprint test, Repeated sprint test, 300 meter run test) and skill performace in phase of attack and defense. Anaerobic capacity of players explain 37% of the variance ($p = 0.03$) for defensive tactical elements, while the set of functional aerobic variables (Hoff test, $p = 0.18$; beep test, $p = 0.93$) has explained 37% ($p = 0.03$) of defensive players ability. Set of predictors of functional anaerobic variables (Sprint test, Repeated Sprint Ability, 300 meter run test) explain 32% ($p = 0.04$) criteria, while the set of predictors of functional aerobic variables (Hoff test, 20m multi-stage shuttle run test) explain 26% ($p = 0.03$) criteria. On the basis of the research we can conclude that there is a strong correlation between the players' performance and tactical skill, whether it is a tactical-technical element of the phase of attack or defense. Therefore, coaches need to develop both components to achieve desired results in the competition games.

Keywords: Repeated sprint ability; Skill; Hoff test; Aerobic capacities

Introduction

Soccer has apart from aerobic endurance, that is represented by distance covered [1] a tremendous need for the type of anaerobic work like sprints, acceleration, duel games that have a direct impact on the final outcome [2]. Although soccer is dominated by the activities of aerobic character, key situations during the match takes place under anaerobic conditions [3-5]. Lower aerobic activity among players leads to early fatigue, which directly affects the decline in technical skills of players [6].

Technique or sport-specific technical skill takes great part in the development of talented young players of many team sports including soccer [7]. Tactical skills include technical elements applied in different situations such as a variety of gross movements, measures and procedures carried out with the aim of solving certain tasks in the course of the game. However, as soccer belongs to polystructural sports, physiological and technical skills are both important for performance [8]. Despite recent attempts [9] data on the importance of the technical components of the young players are practically unexplored [10]. Their role during the game may have a decisive impact on the final outcome of the match. It must be emphasized that success in soccer certainly depends on how the individual functional, motor and technical skills fit into the whole in order to obtain a coherent team. There are studies that analyze the impact of and correlation between specific tactical techniques and structural elements and performance of the soccer team [11-13].

The current methodology requires specific training exercises that will include tactical, technical and physical capabilities of players. Hoff, Wisloff, Engen, Kemi, Helgerud [14] have shown that the polygon within which the players perform dribbling with the ball and play in a small space satisfies the same conditions of intensity and endurance training to enhance the intensity of 90-95% maximum heart rate for 3 to 5 minutes. According to that fact it can be seen how the endurance training in a soccer game should be organized so that it is more like a soccer match.

Aerobic capacity significantly affects the technical performance and tactical decisions. Helgerud, Engen, Wisloff, Hoff [15] showed that an increase in maximal oxygen (for 5 ml / kg / min) and running economy (7%), significantly affects players performance during the game. To be successful in soccer, endurance is of great importance, but what a top player must own is a good basic level of skills and sense of timing. Correlation between functional capacity and technical elements as in the defense phase as well in the attack phase according to the author's knowledge has not yet been sufficiently explored, although this field is extremely important because these skills during the game permanently intertwined with the players. Aim of this study was to determine the relationship between functional capacities and skills performance among young soccer player.

Methods

Subjects

The research was conducted on a sample of 22 (mean age 13.19±0.32; height 166.04 ± 6.00 cm; body mass 55.19 ± 9.41 kg) players aged U-14, members of the elite junior club. All subjects were given parental consent to access testing. Each of the participants could leave the testing protocol if they wanted. The protocol of this study was approved by the Ethical Committee of the Faculty of Kinesiology, University of Zagreb and according to the revised Declaration of Helsinki. Each player had at least 4 years of training experience, corresponding to 2 hour training sessions, and at least one competition per week.

Testing procedure

Each athlete performed a standardized 15 minute warm-up

***Corresponding author:** Goran Sporis, PhD Assist, Faculty of Kinesiology, Horvacanski zavoj 15, 10000 Zagreb, Croatia, Tel: 00385 99 21 21 220; Fax: 00385 1 3634 146; E-mail: gsporis@kif.hr

Received November 13, 2011; **Accepted** January 13, 2012; **Published** January 17, 2012

Citation: Sporis G, Milanovic Z, Trajkovic N, Erceg M, Novak D (2012) Relationship between Functional Capacities and Performance Parameters in Soccer. J Sport Medic Doping Studie S2:001. doi:10.4172/2161-0673.S2-001

consisting of general movements and dynamic and static stretching before the testing. Players underwent physical tests assessments in an outdoor stadium. During the test air temperature ranged from 22°C to 25˚C. It began at 10 am and finished by 1 pm. Players were instructed not to be involved in strenuous exercise for at least 48 hours before the fitness testing session and consume their normal pre-training diet before the testing session. None of the subjects were injured 6 months before the testing. There was no supplement addition regarding the nutrition of players. In addition, subjects were not taking exogenous anabolic-androgenic steroids and other drugs that might be expected to affect physical performance or hormonal balance. After the general warm-up, players performed assessments of sprint ability (sprint test), repeated sprint ability and soccer specific ability in random order. Sprint test, repeated sprint test, 300 meters run test run and soccer-specific test were performed on the same day in the morning between 10 and 13h for all participants. After 3 days testing was done in the test 20-m multi-stage shuttle run test how the accumulation of fatigue of previous tests would not be reflected in the results. Measurements were taken on Tuesday morning because the athletes had rested after the weekend match. The testing session began with anthropometric measurements. Testing for sprint, repeated sprint, 300 meters run test, soccer-specific test and functional capacity was carried out in 3 days. Sprint test was measured with 3 particles, and the mean was taken as the true value, which was used in data processing. Tests for assessment repeated sprint abilities, anaerobic capacity, soccer-specific capacity and functional capacity were measured with only 1 particle. On the first day, subjects were tasted in the following order of tests: sprint test, repeated sprint test, 300 meters run and soccer specific test. Recovery between the tests in each subject was in a 1:10 ratio (work: rest ratio). After that all subjects had one day rest period. 20 meter multi-stage shuttle run test was performed on the third day to avoid the accumulation of fatigue.

Functional capacities

Sprint test protocol: The fastest sprint assessed with the seven-sprint protocol [16] was the measure of running speed. The test consists of seven separate sprints (each section is 34.2m including slalom sprint) with a break of 25 seconds between each sprint during which participants can walk or jogging to the starting line (Figure 1). Verbal feedback is given to each respondent for 5, 10, 15, 20 and 25 seconds of recovery. Photoelectric cell timing system (Globus Ergo Tester Pro, Codognè, Italy) was used to measure each sprint interval and recovery time with an accuracy of 0.001 seconds. This system was positioned on the opposite side of the test field at start and finish line (Figure 1). Photoelectric cell was conected with PC and software for digital measure. The subjects started with her head immediately behind the "start" line.

Repeated sprint test: Each subject performed twelve repetitions maximum sprint section of 20 meters. Pause between each sprint is 20 seconds, during which time the participants jog or walk to the starting line. This test was chosen because it is the best way to simulate conditions that occur during a soccer match [17,18]. Verbal feedback is given to each participant for 5, 10, 15, 20 and 25 seconds of recovery. Photoelectric cell timing system (Globus Ergo Tester Pro, Codognè, Italy) was used to measure each sprint interval and recovery time with an accuracy of 0.001 seconds. This system was positioned on the opposite side of the test field at start and finish line. Photoelectric cell was conected with PC and software for digital measure. The subjects started with her head immediately behind the "start" line.

300 meter run test: This test is used to assess anaerobic capacity because the anaerobic capacity is the first determinant of performance in maximal all-out efforts eliciting exhaustion between 30 and 60 s [19]. The test is performed on open track length of 400m and the time is recorded manually. Each participant was told to run the section as fast as possible.

Soccer specific endurance tests: The track for the performance was proposed for the first time by Hoff, Wisloff, Engen, Kemi, Helgerud [14] for training purposes. The Hoff test, or circuit as it's often called, includes multiple changes in direction, ball lifting and dribbling in reverse (Figure 2). Recent studies [14] have shown that the Hoff test possesses criterion validity and sensitivity to aerobic fitness development in youth soccer players. His work has shown that this program can be used as a part of regular training to improve fitness. As proposed by Hoff, Wisloff, Engen, Kemi, Helgerud [14] the player moved a soccer ball through the track by dribbling. They then move around the next set of cones. Between point A and B the players turn and dribble backwards while controlling the ball. The purpose of the test was to cover the maximum distance during a 10 minute period. Depending on the exact layout of the course, the total distance covered is about 290m. Five subjects were tested at a time. Four days before the first Hoff test, the subjects performed a pre-test in order to get used to the testing pace so as to obtain maximum performance during the experiment.

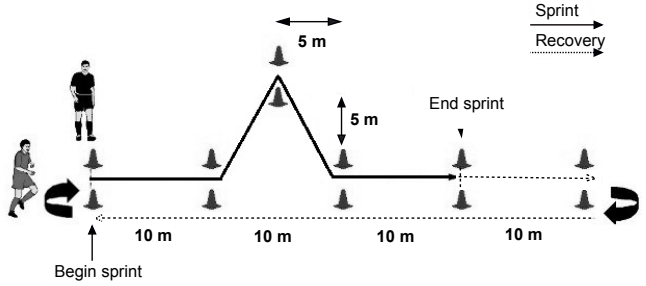

Figure 1 : Diagram of sprint test protocol

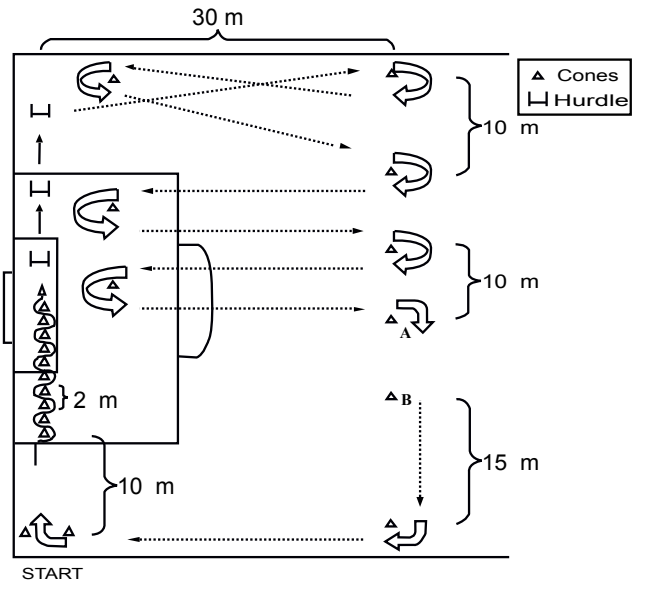

Figure 2: Hoff test

20-m multi-stage shuttle run test: The 20-m shuttle run test is a field test that predicts aerobic fitness (VO_{2max}) and has been shown to be a reliable and valid indicator of aerobic power in various populations [20]. This test was conducted as previously described by Davis, Brewer, Atkin [20]. The main reason for the use of this test for the evaluation of aerobic fitness in the present study, and for its great popularity among soccer coaches, is that the back and forward runs performed in the test mimic the movement pattern of soccer. Players run between lines 20 feet distant in the pace of them sets the "beep" signal from the compact disc (20-m Shuttle Run Test CD, Australian Sports Commission). Tempo running is progressively increasing every minute. The total distance covered is being marked for each player and represents the end result of the test. The objective of the test was to perform as many shuttles as possible; the score corresponded to the total meters covered until the athlete was no longer able to maintain the required speed. Each subject's VO_2 was derived by the formula, y = 6.0x - 24.4, where y equals the predicted VO_{2max} and x equals the maximum speed achieved [20].

Soccer skills

Ten soccer experts assessed the importance of tactical techniques that define the structure of soccer. A soccer coach, an expert advisor, a top player or a college professor teaching soccer at the Faculty of Kinesiology, a coach of a soccer team competing in the European Football Club championships, a coach or a member of expert staff of the national soccer team participating in the European Championships or World Cups, a footballer from a team competing in the European Football Club championships or a member of the national team participating in the European Championship or World Cup were regarded experts in the research study. Relying on their own experience and using the assessment system with values ranging from 0 to 5 the experts graded the impact of tactical techniques on the properties (attributes) of soccer, attack and defense. Competitive match (11 vs. 11) was played on a regular sized synthetic grass soccer pitch over 2 halves each lasting 30 minutes (10- minute interval). Match air temperature and relative humidity were 22.8 ± 1.8°C and 40 ± 9.8%, respectively. We were filmed the match and then analyzed every tactical and technical elementsfor each player.

Variables to assess the real quality of players in the transition phase of attack and in the positioning attack: ball control, passing skills, advancing with ball, play without ball, success in attack transition, ability to play in multiple positions in attack, success in break game phases in attack, shots during active play.

Variables to assess the real quality of players in the transition phase of defense and positioning defense: The level of pressure in the defense, assist in defense, take possession of the ball, success during breaks in defense, success in the defense transition, ability to play in multiple positions in defense, preventing shots, success in offside traps.

Statistical analysis

The statistical Package for Social Studies SPSS (v17.0., SPSS Inc., Chicago, IL) was used for statistical analysis. Prior to the factor analysis, the normality of the distribution of variables was examined by the Kolmogorov-Smirnov test. The objectivity of the expert group in the process of assessing the importance of the tactical techniques of attack and defense was established for every variable and expressed as Chronbach's alpha. The condensed expert assessment results were expressed as the arithmetic mean. To determine the relation between functional capabilities and players performance multiple regression analyzes was applied. In addition, we have applied factor analysis with varimax rotation to determine the latent structure of the applied structure of instruments (quality players in attack and defense). Latent structure for the set of variables was separately determined for players in attack, and especially for the defense. Relying on their own experience and using the assessment system with values ranging from 0 to 5 the experts graded the impact of tactical techniques on the properties (attributes) of soccer, attack and defense. The statistical significance was set at $p<0.05$.

Results

All the variables had normal distribution. Factor structure of the variables (Table 3) has showed that anaerobic variables contribute significantly ($p = 0.03$) in determining the game capabilities in defense phase. The same significance was observed among the aerobic variables ($p = 0.03$) so we can conclude that aerobic and anaerobic components have an equal share in the defense phase. Anaerobic capacity of players explain 37% of the variance ($p = 0.03$) for defensive tactical elements, while the set of functional aerobic variables (Hoff test, $p = 0.18$; beep test, $p = 0.93$) has explained 37% ($p = 0.03$) of defensive players ability.

Table 3 show that both coefficients of multiple correlation factors for technical quality of players in attack were statistically significant. Based on the coefficient of determination it can be concluded that a set of predictors of functional anaerobic variables (Sprint test, Repeated Sprint Ability, 300 meter run test) explain 32% ($p = 0.04$) criteria, while the set of predictors of functional aerobic variables (Hoff test, 20m multi-stage shuttle run test) explain 26% ($p = 0.03$) criteria. However, individually only the values obtained by Hoff test statistically present a significant factor in the attack phase ($p = 0.05$), while the defense phase values obtained by this test does not represent a statistically significant factor ($p = 0.18$). Other variables do not individually show a statistically significant value in the phase of the defense and attack. The results show that it is necessary to possess a good aerobic and anaerobic capacity so that they together influence the tactical and technical manifestation of the defense and attack phase.

	Factor
Ball control	-0.75
Passing skills	-0.86
Advancing with ball	-0.88
Play without ball	-0.71
Success in attack transition	-0.85
Ability to play in multiple positions in attack	-0.87
Success in break game phases in attack	-0.86
Shots during active play	-0.75
Expl.Var	5.28
Prp.Totl	0.66

Table 1: Factorial analysis in the transition phase of attack and in the positioning attack.

	Factor
The level of pressure in the defense	-0.91
Assist in defense	-0.94
Take possession of the ball	-0.92
Success during breaks in defense	-0.81
Success in the defense transition	-0.89
Ability to play in multiple positions in defense	-0.92
Preventing shots	-0.88
Success in offside traps	-0.77
Expl.Var	6.23
Prp.Totl	0.78

Table 2: Factorial analysis in the transition phase of defense and positioning defense.

	ATTACK		Adjusted			DEFENSE		Adjusted		
	β	p	R	R^2	p	β	p	R	R^2	p
Sprint test protocol	-0.05	0.87				0.29	0.36			
Repeated Sprint Ability	-0.47	0.20	0.56	0.32	0.04	0.01	0.97	0.61	0.37	0.03
300 meter run test	-0.04	0.90				0.34	0.29			
Hoff test	-0.47	0.05	0.51	0.26	0.03	-0.29	0.18	0.61	0.37	0.03
20m multi-stage shuttle run test	-0.01	0.97				-0.02	0.93			

Table 3: Multiple regression analyzes in the phase of defense and attack.

For the success in technical and tactical elements of attack and defense in soccer the most important factor is to have a dimension factor for energy regulation and control of movement. The energy component is important in the movement of players with equal representation of both aerobic and anaerobic capacity (p = 0.03 vs. p = 0.03) in defense, (p = 0.03 vs. p = 0.04) in attack, while the movements of a player with the ball present the significance of both components with the preponderance of one or another (Table 1, 2).

Discussion and Conclusion

Generally speaking, we can only state that the aerobic and anaerobic capacities of players are equally important for their actions in the stage of defense and attack. But almost all the variables, if we look at individually, Sprint test (p = 0.87), Repeated Sprint Ability (p = 0.20), the 300 meters run test (p = 0.90), 20 m multi-stage shuttle run test (p = 0.97), not impact the tactical movements because they are statistically insignificant. The only test that showed a statistical significance individually was Hoff test (p = 0.05) which is understandable because it contains elements which required great technical ability of players. This test has specific aerobic nature and it is designed especially for soccer players [14]. However, its significance is reflected only in the phase of the attack. The explanation lies in the fact that we have isolated at the stage of attack variables such as: ball control, passing skills, advancing with ball that are part of the test [14]. Defensive assignments were predominantly without ball so it is understandable why this specific test showed no statistically significant correlation (p = 0.18) with defensive assignments.

The importance of aerobic fitness in soccer is reflected in the fact that movement is mainly dominated by the aerobic activities [18]. Tactical element of attack and defense are taking place under conditions of constant alternation of aerobic and anaerobic activity [21]. When performing a quick attack and counterattack (stage attacks) among players with or without the ball comes to the accumulation of lactate, which eliminates the over-intensity aerobic activity [18]. Therefore, good aerobic fitness is desirable and from this research it could be seen that they can influence the technical abilities of players in both the technical skills and tactical characteristics of defense phase (p = 0.03) and stage attacks (p = 0.03). Sprint abilities of football players are extremely important because they take place every 90 seconds and usually the sprint lasts 2-4 seconds [3]. Percentages on the activity of anaerobic character during soccer match is 1-11% with the effective time of the game (the time when the ball is in possession of) almost 0.5-3% [3,15]. Although we can see that the anaerobic capacity is less represented, their role is reflected in key situations, both in the defense and in attack phase. Our results have shown that the players must have the ability to multi-dimensional manifestation of anaerobic activity (sprint performance, repeated sprint performance and run performance), as observed individually these abilities do not affect the defensive and offensive elements. The importance of short sprints (Sprint test protocol) and repeated sprint ability should be especially emphasized during the match because the players perform from 1000-1400 mainly short activities, changing every 2-4 seconds [3]. In our research, we see that these values of repeated sprint ability is much more important in tactical elements of the attacks (p = 0.20) than in the defense phase (p = 0.97). The smallest impact of the attack phase has been showed in a variable 300 meter run test (p = 0.90) which can be attributed to time players during a game not required for expression of high-intensity activity on such a large distance but the greatest number of sprint action ends in the range of 20-40 meters.

The limitation of this research was a lack of sprint 5, 10, 20 and 30m, because they are mostly the distance at which players perform sprinting during the game. So that future research should examine how they influence the technical characteristic and tactical skill elements.

On the basis of the research we can conclude that there is a strong correlation between the players' performance and tactical skill, whether it is a tactical-technical element of the phase of attack or defense. Players in soccer must possess a comprehensive aerobic and anaerobic capabilities how would their joint actions affect the technical characteristics and tactical skills. Therefore, coaches need to insist on the all round fitness training and their actions should be reflected in the technical abilities of players. The high level of functional ability, aerobic or anaerobic is a prerequisite for successful execution of technical-tactical skills in the process of defense and attack. The results of this study show us the complexity of functional abilities since they viewed themselves; do not affect the performance of the technical elements but only integrally.

References

1. Kemi OJ, Hoff J, Engen LC, Helgerud J, Wisloff U (2003) Soccer specific testing of maximal oxygen uptake. J Sports Med Phys Fitness 43: 139-144.
2. Little T, Williams AG (2005) Specificity of acceleration, maximum speed, and agility in professional soccer players. J Strength Cond Res 19: 76-78.
3. Bangsbo J, Norregaard L, Thorsoe F (1991) Activity profile of competition soccer. Can J Sports Sci 16: 110-116.
4. Ben Abdelkrim N, El Fazaa S, El Ati J (2007) Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. Br J Sports Med 41: 69-75.
5. Sporis G, Vuleta D, Vuleta D, Milanović D (2010) Fitness profiling in handball: physical and physiological characteristics of elite players. Coll Antropol 34: 1009-1014.
6. Sporis G, Ruzic L, Leko G (2008) The anaerobic endurance of elite soccer players improved after a high-intensity training intervention in the 8-week conditioning program. J Strength Cond Res 22: 559-566.
7. Malina RM, Cumming SP, Kontos AP, Eisenmann JC, Ribeiro B, et al. (2005) Maturity-associated variation in sport-specific skills of youth soccer players aged 13-15 years. J Sports Sci 23: 515-522.
8. Fernandez-Gonzalo R, De Souza-Teixeira F, Bresciani G, Garcıa-Lopez D, Hernandez-Murua JA, et al. (2010) Comparison of technical and physiological characteristics of prepubescent soccer players of different ages. J Strength Cond Res 24: 1790-1798.
9. Rostgaard T, Iaia FM, Simonsen DS, Bangsbo J (2008) A test to evaluate the physical impact on technical performance in soccer. J Strength Cond Res 22: 283-292.
10. Castagna C, D'Ottavio S, Abt G (2003) Activity profile of young soccer players during actual match play. J Strength Cond Res 17: 775-780.

11. Bishovets A, Gadjiev G, Godik M (1993) Computer analysis of the effectiveness of collective technical and tactical moves of footballers in teh matches of 1988 Olympics and 1990 World Cup. In T Reilly, J Clarys A Stibbe (eds) Science and Football II. E & FN Spon, London.
12. Yamanaka K, Hughes M, Lott M (1993) An analysis of playing patterns in the 1990 World Cup for association football. In T Reilly, J Clarys, A Stibbe (eds) Science and Football II. E & FN Spon, London.
13. Hughes M (1996) Notational Analysis. In T Reilly (Ed), Science and soccer. E & FN Spon, London.
14. Hoff J, Wisloff U, Engen LC, Kemi OJ, Helgerud J (2002) Soccer Specific Aerobic Endurance Training. Br J Sports Med 36: 218-221.
15. Helgerud J, Engen LC, Wisløff U, Hoff J (2001) Aerobic endurance training improves soccer performance. Med Sci Sports Exerc 33: 1925-1931.
16. Bangsbo J (1994) Fitness Training for Football: A scientific approach. HO+Storm, Bagsverd.
17. Reilly T (1994) Motion characteristics. In: Football (Soccer). B Ekblom (ed) Blackwell Scientific Publications, London.
18. Stolen T, Chamari K, Castagna C, Wisloff U (2005) Physiology of soccer. Sports Med 35: 501–536.
19. Calbet JA, De Paz JA, Garatachea N, Cabeza De Vaca S, Chavarren J (2003) Anaerobic energy provision does not limit Wingate exercise performance in endurance-trained cyclists. J Appl Physiol 94: 668-676.
20. Davis JA, Brewer J, Atkin D (1992) Pre-season physiological characteristics of English first and second division soccer players. J Sports Sci 10: 541-547.
21. Milanovic Z, Trajkovic N, Barisic V, Dujic I, Ljubicic M, et al. (2011) Discriminant analysis of soccer tactical elements in the phases of attack and defense determined by cluster analysis. Homosporticus 13: 12-20.

This article was originally published in a special issue, **Sport Management** handled by Editor(s). Dr. Kamal Bali, Epworth Hospital, Australia