BALTIC JOURNAL OF HEALTH AND PHYSICAL ACTIVITY
© Gdansk University of Physical Education and Sport in Gdansk, Vol. 5, No. 3, 2013, 191-198
ORIGINAL ARTICLE
DOI: 10.2478/bjha-2013-0018

Generic versus specific sprint training in young soccer players

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

Zbigniew Jastrzebski[1 (A, D, G)], Lukasz Radziminski[1 (B, E, F)], Robert Dargiewicz[1 (C, E)], Ewelina Jaskulska[1 (B)], Wojciech Barnat[2 (B)], Pawel Rompa[1 (A, B, D)]

[1] Gdansk University of Physical Education and Sport in Gdansk, Poland
[2] Malbork Football Academy, Poland

Key words: *soccer, speed, training.*

Abstract

Background: *The aim of this study was to examine the effect of two 8-week sprint training programs on the speed and sport-specific skills of young soccer players and to determine additional effects of 8 weeks' whole body rotation.*

Material/Methods: *Twenty-two Under-18 soccer players were divided into two groups: a running group (RG) and a ball group (BG). The RG completed sprint training without the ball, whereas the BG members trained with the ball. The 5-, 10-, 15-, 20- and 30-m sprint times and the level of soccer-specific skills were measured before and after completing the training programs.*

Results: *A significant ($p < 0.05$) time interaction was found in sprint times at all distances. The players from both groups achieved significantly better sprint times on the distances of 15 m and 30 m; additionally, an improvement in the 20 m sprint time was noted in the BG. No significant changes in the level of soccer-specific skills were found.*

Conclusions: *Sprint training performed with a ball might be equally efficient as a traditional non-ball method for developing players' speed. Moreover, soccer-specific sprint training may improve certain technical skills in young players.*

Word count: 3,107
Tables: 3
Figures: 1
References: 26

Received: August 2013
Accepted: September 2013
Published: October 2013

Corresponding author:
Prof. nadzw. dr hab. Zbigniew Jastrzębski
Gdansk University of Physical Education and Sport, Poland
80-336 Gdańsk, Poland, ul. K. Górskiego 1
Phone: +4858 554-71-38
E-mail: zb.jastrzebski@op.pl

Introduction

During a soccer match, a player performs different forms of physical activity, including turns, accelerations, jumps and stops, on average every 3-5 s or about 1200 times during a 90-minute game. Soccer players perform sprints every 90 seconds during the match (approximately 30-40 sprints in total), each lasting 2-4 s. Sprints comprise 1-11% of the total distance covered during the match and 0.5-3.0% of the effective match time (i.e., when a ball is on the pitch) [1, 2]. Another study confirmed the average single sprint distance length to be 15 m with a maximum of 40 m [3]. Professional soccer players of the English Premier League and the Italian A Series cover a 600-m distance by running quickly, at speeds greater than 5.5 m·s-1 [4, 5]. Their sprints, generally at speeds >7 m·s-1, can cover 400 m in total during a match, and such sprint speeds exceed those of mid-level players by 58%. A shorter total sprint distance covered during the match is observed among lower level players. However, previous studies suggest that the overall technical and tactical effectiveness is also an important factor determining success in soccer [6].

Each field position requires a unique activity profile according to the team level, tactical demands and ball management. An analysis of soccer players' movements during a match confirms that center backs perform less high intensity work and sprints than forwards during offensive play [7]. Despite this finding, Taskin [8] states that the time to complete a 30-m sprint in Turkish professional soccer players is independent of their field position. Therefore, sprint training of all of the players is an important element enabling them to approach the ball quickly. Better speed results in preventing rivals' offensive actions at the goal and enhances the ability of forwards to outrun the opponent and score goals. Thus, high-speed forwards may often decide about the match result [9]. Offensively, outrunning the defendant may yield field advantages resulting in creating a scoring opportunity.

During a match, the average intensity reaches a value close to the anaerobic threshold (80-90% HRmax), but 90% of the energy expenditure is supplied by aerobic respiration [10]. High-intensity work causes a decrease in the phosphocreatine concentration within muscles and triggers the release of lactic acid, resulting in a decreased pH [11]. This observation confirms that a portion of the energy generated during a soccer match is supplied by anaerobic respiration. Therefore, it appears important to prepare players to perform maximal intensity efforts with an ability to do it repeatedly throughout the entire match [12]. It is common knowledge that the proper quantity and quality of the training load during the preparatory and the competitive seasons have an important role in creating such results. Nevertheless, there is limited knowledge on the influence of various types of speed training methods regarding soccer players' acceleration potential [13]. Thus, it is assumed that simultaneous training for technical skill and speed conditioning may have a significant influence on the training outcomes in soccer players.

According to Bogdanis et al., [14] aerobic respiration supplies approximately 13% of the energy needed for maximum exertional efforts lasting 10 s. However, performing subsequent sprints after an insufficient rest period or sprinting 30 m or longer significantly increases the participation of the aerobic system in energy generation, which is why the succinate dehydrogenase (SDH) and citrate synthase (CS) concentrations increase during long sprint distances [15]. Additionally, Dawson et al. [16] noted that short sprint training can improve maximal oxygen consumption (VO_{2max}).

Coaches of every sport are focused on creating the optimal training means to develop physical capacity and fitness. Currently, modifications have been implemented in soccer training to more closely recreate match conditions. Increased training effectiveness occurs when fitness and technical skill development are targeted simultaneously, as opposed to using traditional running practice to develop aerobic capacity [17]. Therefore, searching for an alternative to traditional sprint training appears to be justified. Previous studies [16, 18, 19] validated the effectiveness of traditional speed training; however, to our knowledge, there was no attempt to assess the effectiveness of speed training with a ball.

The aim of this work was to assess the effectiveness of either an 8-week general or specific training program on the speed and sport-specific skills of young soccer players.

Based on the aim, the following hypotheses were evaluated:

1. sprint times of both groups (running with or without balls) will decrease as an effect of the training programs.
2. the improvement in sport-specific skills will be greater in the group training with balls.

Material and methods

Subjects

This study was conducted on a sample of twenty-two male soccer players in the U-18 age category. The subjects were divided into two homogeneous groups, with no significant differences in anthropometric data, of 11 members each. The running group (RG; age, 17.1 ± 0.68 y; body mass, 65.9 ± 7.22 kg; and height, 178.5 ± 4.95 cm) practiced speed drills without balls, while the ball group (BG; age, 17.3 ± 0.73 y; body mass, 62.1 ± 5.77 kg; and height, 173.8 ± 7.83 cm) practiced speed drills with balls. All of the players possessed sportsman medical cards. According to the directives of the Declaration of Helsinki, the players and their parents were informed of the research procedures and they provided written informed consent to participate in the study. The study was approved by the Ethics Committee of the Regional Medical Chamber in Gdansk.

Study design

Based on the speed tests conducted at the beginning of the experiment (each player performed 5 sprints of 5 m, 10 m, 15 m, 20 m and 30 m), the players were divided into two groups of 11 players. The boys were classified into the groups based on the ranking list created by summing the rank position of each player in relation to the entire team for each test.

The paired division according to the above-described statistical classification was conducted. The highest position was given to the fastest athlete and the lowest position to the slowest athlete. Subjects from the following ranking positions were allocated into the RG: 1, 4, 5, 8, 9, 12, 13, 16, 17, 20, and 21. All of the others were placed into the BG. The aim of this division was to create two groups with an equal number of participants and a similar overall level of speed. After completing a 4-week comprehensive training program, both groups performed an 8-week experimental training program that comprised of 24 sprint training units (Table 1). The players covered short distances (5 m, 10 m, 15 m, 20 m, or 30 m) three times a week (Mondays, Wednesdays and Fridays). One group (RG) trained without balls and the other group (BG) with balls. Each training unit was started with a 15-min initial warm-up consisting of coordination and technical drills, followed by one sprint each of 5 m, 10 m, 15 m, 20 m, and 30 m. On Tuesdays and Thursdays, all of the players trained together. The study was conducted during the preparatory season.

Table 1. The effective training time before the experiment (4 weeks) and after the experiment (8 weeks)

Drill	Pre-training [min]	8 weeks training [min]
Games	107	69
Running	63	70.2
Coordination	32	17
Technical drills	92	98
Active recovery & stretching	32	35
Tactical drills	15	40
Strength	40	0
Match	0	90

Procedures

The subjects were subjected to fitness tests during the weeks preceding and following the experiment. The aim of these tests was to measure the participants' sprint times and to assess their sport-specific skills parameters. To avoid the influence of fatigue on the results, the tests were conducted during two sequential days in the same order before and after the experiment. The speed test was performed on Monday and the specific tests on Tuesday morning.

The speed tests and specific skills tests were conducted on a soccer pitch with a synthetic surface during similar weather conditions (wind < 1 m·s-1, temperature 15-18°C, humidity 60-63%, and barometric pressure 1016-1020 hPa).

Speed tests

The participants performed a 15-min warm-up followed by 3 sprints of 30 m, 25 m and 20 m prior to the test. After a 10-min recovery, the athletes stretched and completed the performance test: sprints of 5 m, 10 m, 15 m, 20 m, and 30 m. A set of photocells was used (Tag Heuer, la Chaux-de-Fonds, Switzerland, model HL 2-31) with a double light beam at the starting and finishing lines. The subjects began the run with their front leg on the starting line. The recovery time was dependent on the distance covered: the longer the distance, the longer the recovery time (5 m: 1 min 30 s; 10 m: 2 min; 15 m: 2 min 30 s; and 20 m: 3 min).

Specific skills

The German Soccer Association test (DFB-Deutscher Fussball Bund Test) [20] was used to assess the specific skills of the players. This test consists of 7 trials: juggling, rotation kick, center pass of the ball to a defined point, dribbling, heading to the goal, bench kick, and a precise kick from the penalty kick line. The player can score 60 points in each trial, and the total score determines his technical skill level.

Training program

The 8-week experiment consisted of performing 5 series of 3, 4 and 5 sprints of 5 m, 10 m, 15 m, 20 m, and 30 m during the training unit 3 times a week (Mondays, Wednesdays and Fridays) (Tab. 2). One group (RG) performed the sprints without balls, and the other group (BG) sprinted with balls. The fastest runners of both groups performed simultaneously to increase their sense of rivalry. The participants began to run on the coach's signal.

The training unit started with a 15-min warm-up activity consisting of coordination and technique drills followed by one sprint of 5 m, 10 m, 15 m, 20 m and 30 m each by both groups. Next, the experimental sprints were performed by each group member. Then, all the players jointly participated in the final part of the training. On Tuesdays and Thursdays, the same training program was applied to all of the players. Each training unit lasted 90 min.

Table 2. Sprint number for each sprint distance, related recovery time and the total recovery time between sequential speed training units

Weeks I, II, and VIII		Weeks III, IV, and VII		Weeks V and VI		Recovery time [s]
Number of repetitions	Distance [m]	Number of repetitions	Distance [m]	Number of repetitions	Distance [m]	
3	5	4	5	5	5	20
3	10	4	10	5	10	50
3	15	4	15	5	15	85
3	20	4	20	5	20	140
3	30	4	30	5	30	260
Total	240	Total	320	Total	400	
Recovery time [min]	28	Recovery time [min]	37	Recovery time [min]	47	

During the first 2 weeks, 3 repetitions of sprints at each distance were performed. The total covered distance was 240 m. The sprinting portion of the training unit, including recovery breaks, lasted 29 min. During the third and the fourth weeks, the sprint number was increased to 4 repetitions. The total sprint covered distance was 320 m, and the total time of this portion of the training was 39 min. During the fifth and sixth weeks, the players performed 5 repetitions and covered 400 m in total during 50 min. During the seventh week, the sprint repetitions were reduced again to 4, similarly to the 3rd and 4th weeks. Finally, during the eighth week, the number decreased to 3, similarly to the 1st and 2nd weeks of the experiment (Tab. 2). The running distance administered to the players resembled the distances covered by them during a match. The different running lengths during sequential weeks were applied to adapt the participants gradually to the speed regimes. The aim of the reduced sprint repetitions during the 7th and 8th week was to avoid chronic fatigue.

Statistical analyses

The Statistica 9 program was used for statistical analysis. Additionally, the Kolmogorov-Smirnov and Shapiro-Wilk tests were applied to check the homogeneity of dispersion with normal distribution of all of the results with a 95% confidence level. The Wilcoxon test was used to compare two dependent sets. Prior to the parametric statistics, when the data were normally distributed, Levene's test was used to check the homogeneity of variance. A two-way repeated measures ANOVA was applied to analyze the inter-group (RG and BG) and intra-group (pre- and post-training) effects. The effect size (eta squared, η^2) for the analysis of variance was calculated to provide an estimate of meaningfulness of comparisons between groups. Post-hoc analyses using the HSD Tukey test were performed when interaction effects were significant. The significance level was set at $p<0.05$.

Results

A significant time interaction was found in sprint times at all distances. HSD Tukey statistics demonstrated a relevant improvement in 15- and 30-m sprints was observed in both groups. Additionally, the significant pre to post changes in 20-m sprint time were noted in the BG (Tab. 3). The results of DFB test increased by 3.8% in RG and by 6.6% in BG. However, these changes were not significant (Fig. 1).

Table 3. The effects of 8 weeks of sprint training for the running group (RG) and ball group (BG)

Test	RG		BG		Differences	ES
	pre	post	pre	post		
Sprint test [s]						
5 m	1.16 ± 0.05	1.12 ± 0.05	1.17 ± 0.05	1.12 ± 0.08	time	0.24
10 m	1.91 ± 0.07	1.87 ± 0.06	1.90 ± 0.04	1.87 ± 0.07	time	0.23
15 m	2.60 ± 0.11	2.54 ± 0.09*	2.58 ± 0.09	2.53 ± 0.09*	time	0.35
20 m	3.25 ± 0.13	3.18 ± 0.09	3.25 ± 0.11	3.16 ± 0.13*	time	0.35
30 m	4.54 ± 0.19	4.44 ± 0.19*	4.51 ± 0.18	4.41 ± 0.17*	time	0.42
DFB test [points]	332.9 ± 23.89	345.4 ± 23.19	346.5 ± 20.98	369.5 ± 23.34	-	-

**Significant pre to post changes at p < 0.05*

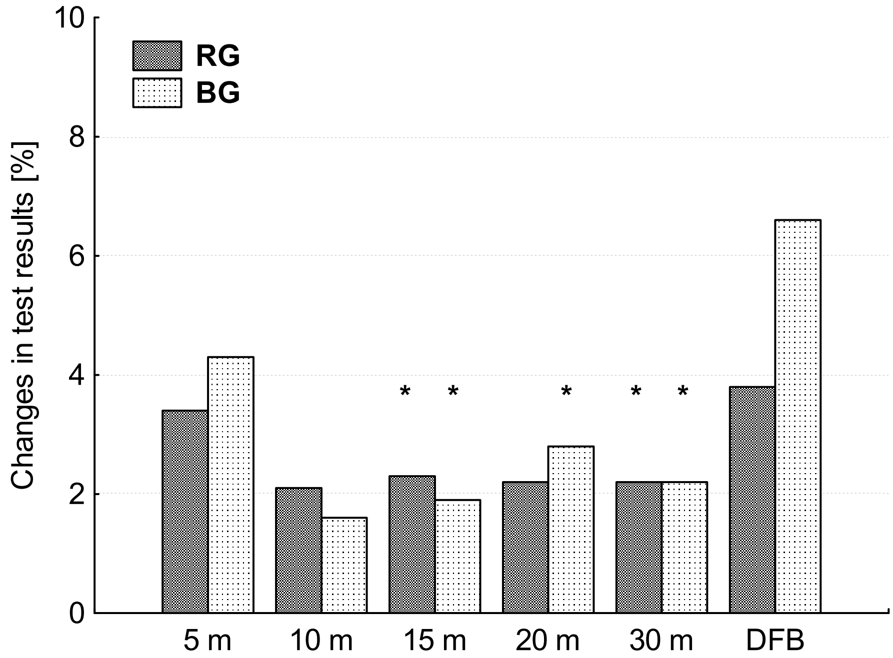

Fig. 1. Changes of sprint times and DFB test results in the running group (RG) and the ball group (BG)
** Significant pre to post changes at p < 0.05*

Discussion

The aim of this work was to assess the effects of two different sprint training programs on the speed and sport-specific skill level of young soccer players. The results show that practicing sprints with balls may be equally effective in speed development compared with sprints without balls. Moreover, running with a ball may have a positive effect on such soccer-specific skills as dribbling.

According to Mohr et al., [1] sprints performed during a match last less than 4 s. Thus, such distances were set in this study to be tested so that their completion would range between 1 s and 4.5 s. The number of repetitions was set to make the total covered distance similar to a match sprint distance. Although 5- to 15-m sprints comprise most important sprints, 20-m to 30-m runs also occur during offensive and defensive counter-attacks and when following the opponent after losing the ball.

Current publications proved the effectiveness of traditional speed drills [5, 15, 19] and showed that even one speed training unit per week can significantly improve speed. However, 6-week or shorter experimental programs revealed no relevant changes in speed parameters. Allaimer et al. [21] applied 30-s sprints on a cycloergometer 2 to 3 times a week during a 6-week period. In a similar experiment [22] subjects performed 30-s sprints on a cycloergometer with a 20-min recovery. The assumed effects were not achieved, likely because the experimental period (3-6 weeks) was too short.

In our study, a statistically significant ($p < 0.05$) time improvement at 15- and 30-m distances in the RG is consistent with the results of the abovementioned studies. Therefore, it could be assumed that 3 training units per week targeted at developing speed improve a player's ability to run short distances (15 m) and longer distances (30 m). Few authors [23] recommend a combination of speed drills and strength drills. Developing both of these components during one training unit 3 times a week results in relevant improvements in both areas.

Reilly [24] claims that the energy expense of running with the ball exceeds that without the ball by approximately 8%. This finding is likely related to a higher step frequency and a diminished leap distance. However, the differences reflect runs performed at lower speeds than 14 km·h-1, which is much less than those applied in this study. Carling [25] analyzed professional soccer players' profiles during a match and stated that the distance covered with the ball is 191.0 ± 80.3 m, a mere 1.7 ± 0.7% of the total distance covered during a match. It was also confirmed that 34.3% of ball dribbling occurs during a fast run or sprint (>19.1 km·h-1). Both distances covered on the field with the ball and the mean speed value achieved with the ball are dependent on the player's position. Wide-midfielders cover relatively longer distances with the ball than players in other positions. The highest mean speed value with the ball achieved during a match was registered for wide-midfielders and forwards (13.9-14.0 km·h-1). To our knowledge, no studies regarding the effectiveness of soccer-specific speed training methods have been published. Developing speed in this way enables simultaneous improvements in ball control. The BG players significantly improved their time results on 15-m, 20-m and 30-m sprints. No significance was stated for the time improvements at 5 or 10 m.

The soccer-specific skills test (DFB) was applied to verify the effectiveness of sport-specific drills in this experiment. The analysis of the total points scored showed non-significant improvements in RB and BG (3.8% and 6.6% respectively). During a fast run with the ball, the players performed acyclical step lengths. Such efforts performed at maximal speed develop coordination and likely result in technical skill improvement.

Conclusion

Speed is widely known as one of the strongest predictors of talent in soccer [26]; therefore, its effective development is one of the basic aims for coaches. Certain trainers claim that it is impossible for a player performing with a ball to reach maximal running speeds, which may have a negative effect on speed development. However, results of our 8-week investigation prove that systematic speed training performed with a ball may significantly improve sprint abilities of young soccer players.

This work should encourage coaches to apply such drills, thereby significantly developing the speed abilities of the players. Moreover, drills incorporating balls may result in technical skill improvement. Furthermore, other valuable advice for coaches is that putting players to practice in pairs can introduce rivalry and guarantee maximal commitment and motivation. Lastly, sprints performed with a ball develop technique, including fast ball dribbling, which is indispensable during counter-attacks or 1-on-1 duels.

References

1. Mohr M, Krustrup P, Bangsbo J. Match performance of high-standard soccer players with special reference to development of fatigue. J Sport Sci. 2003;21(7):519-528.
2. Wisloff U, Castagna C, Helgerud J, Jones R, Hoff J. Strong correlation of maximal squat strength with sprint performance and vertical jump height in elite soccer players. Brit J Sport Med. 2004;38:285-288.
3. Ekblom B. Handbook of Sports Medicine and Science, Football. London: Blackwell Scientific Publications; 1994.
4. Bradley P, Sheldon W, Wooster B, Olsen P, Boanas P, Krustrup P. High-intensity running in English FA Premier League soccer matches. J Sport Sci. 2009;27(2):159-168.
5. Rampinini E, Impellizzeri FM, Castagna C, Coutts AJ, Wisloff U. Technical performance during soccer matches of the Italian Serie A league: effect of fatigue and competitive level. J Sci Med Sport. 2009;12(1):227-233.
6. Di Salvo V, Gregson W, Atkinson G, Tordoff P, Drust B. Analysis of high intensity activity in Premier League soccer. Int J Sports Med. 2009;30(3):205-212.
7. Di Salvo V, Baron R, Tschan H. Calderon Montero FJ, Bachl N, Pigozzi F. Performance characteristics according to playing position in elite soccer. Int J Sports Med. 2007;28(3):222-227.
8. Taskin H. Evaluating sprinting ability, density of acceleration, and speed dribbling ability of professional soccer players with respect to their position. J Strength Cond Res. 2008;22(5):1481-1486.
9. Rosch D, Hodgson R, Peterson L, et al. Assessment and evaluation of football performance. Am J Sport Med. 2000;28:29-39.
10. Stolen T, Chamari K, Castagna C, Wisloff U. Physiology of Soccer. An Update. Sports Med. 2005;35(6):501-536.

11. Krustrup P, Mohr M, Steensberg A, Bencke J, Kjaer M, Bangsbo J. Muscle and blood metabolites during a soccer game: implications for sprint performance. Med Sci Sport Exer. 2006;38(6):1165-1174.
12. Iaia FM, Rampinini E, Bangsbo J. High-intensity training in football. J Sport Sci. 2007;25(6):659-666.
13. Spinks CD, Murphy AJ, Spinks WL, Lockie RG. The effects of resisted sprint training on acceleration performance and kinematics in soccer, rugby union, and Australian football players. J Strength Cond Res. 2007;21:77-85.
14. Bogdanis GC, Nevill ME, Lakomy HKA, Boobis LH. Power output and muscle metabolism during and following recovery from 10 and 20 s of maximal sprint exercise in humans. Acta Physiol Scand. 1998;163:261-72.
15. MacDougall JD, Audrey L, Hicks AL, et al. Muscle performance and enzymatic adaptations to sprint interval training. J Appl Physiol. 1998;84(6):2138-42.
16. Dawson B, Fitzsimons M, Green S, Goodman C, Carey M, Cole K. Changes in performance, muscle metabolites, enzymes and fibre types after short sprint training. Eur J Appl Physiol. 1998;78:163-169.
17. Hill-Haas SV, Dawson BT, Impellizzeri FM, Coutts AJ. Physiology of small-sided games training in football. Sports Med. 2011;41(3):199-220.
18. Anderson JL, Klitgaard H, Saltin B. Myosin heavy chain isoforms in single fibres from m. vastus lateralis of sprinters: influence of training. Acta Physiol Scand. 1994;151:135-42.
19. Tonnessen E, Shalfawi SA, Haugen T, Enoksen E. The effect of 40-m repeated sprint training on maximum sprinting speed, repeated sprint speed endurance, vertical jump, and aerobic capacity in young elite male soccer players. J Strength Cond Res. 2011;25(9):2364-70.
20. Jastrzebski Z, Barnat W, Konieczna A, Rompa P, Radziminski L. Changes of physical capacity and soccer-related skills in young soccer players within a one-year training period. Baltic Journal of Health and Physical Activity. 2011;3(4):248-261.
21. Allemeier CA, Fry AC, Johnson P, Hikida RS, Hagerman FC, Staron RS. Effects of sprint cycle training on human skeletal muscle. J Appl Physiol. 1994;77(5):2385-90.
22. Esbjornsson-Liljdahl M, Holm I, Sylven C, Jansson E. Different responses of skeletal muscle following sprint training in men and women. Eur J Appl Physiol. 1996;74:375-83.
23. Kotzamanidis C, Chatzopoulos D, Michailidis C, Papaiakovou G, Patikas D. The effect of a combined high-intensity strength and speed training program on the running and jumping ability of soccer players. J Strength Cond Res. 2005;19(2):369-375.
24. Reilly T. Physiological aspects of soccer. Biol Sport. 1994;11:3-20.
25. Carling C. Analysis of physical activity profiles when running with the ball in a professional soccer team. J Sport Sci. 2010;28(3):319-326.
26. Reilly T, Williams AM, Nevill A, Franks A. A multidisciplinary approach to talent identification in soccer. J Sport Sci. 2000;18(9):695-702.