Journal of Sports Sciences, 2010; 1–6, i*First* article

Routledge
Taylor & Francis Group

Sprinting analysis of elite soccer players during European Champions League and UEFA Cup matches

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(Accepted 1 September 2010)

Abstract

It has been suggested that assessment of high-intensity activities during a match is a valid measure of physical performance in elite soccer. Recently, sprinting activities have been analysed in more depth. The aim of this study was to develop a detailed analysis of the sprinting activities of different playing positions during European Champions League and UEFA Cup competitions. Altogether, 717 elite outfield soccer players were evaluated throughout 2002–2006 using ProZone® (Leeds, UK). Sprinting (explosive and leading) was analysed for each playing position. To compare positional differences, a Kruskal-Wallis analysis was performed. Differences were found among positions for total number of sprints and total sprint distance covered: wide midfielders > (attackers = wide defenders) > central midfielders > central defenders ($P < 0.001$), as well as for explosive sprints: (wide midfielders = attackers = wide defenders) > central defenders, wide midfielders > central midfielders > central defenders and attackers = wide defenders = central midfielders ($P < 0.001$), and leading sprints: wide midfielders > (attackers = wide defenders) > central midfielders > central defenders ($P < 0.001$). For each group, there were no differences in ratio of explosive to leading sprints. Wide midfielders performed a higher number of sprints in all five distance categories than all other positions. This study showed that sprinting characteristics are influenced by position. Wide midfielders have to complete additional high-intensity activities during training sessions compared with the other positions to achieve the performance level required during the match.

Keywords: *Soccer, playing positions, sprinting activity, leading sprint, explosive sprint*

Introduction

Over the last three decades, interest in match-analysis of soccer has increased, with the primary objectives being to record and analyse the physical demands of the players (Bangsbo, 1994; Mayhew & Wenger, 1985; Reilly & Thomas, 1976). During a match, elite soccer players cover the majority of the distance at low intensity (Rienzi, Drust, Reilly, Carter, & Martin, 2000). The average distance covered at high intensity is 10% (Carling, Bloomfield, Nelsen, & Reilly, 2008).

High-intensity activity has frequently been studied in soccer (Bangsbo, Norregaard, & Thorso, 1991; Reilly, 1990), as it is representative of the physical demands of specific activities in this sport (Mohr, Krustrup, & Bangsbo, 2003) and the distance covered by high-intensity running in matches is closely related to training status (Krustrup et al., 2003). Various authors have observed that players cover different distances at high intensity during a match depending on playing position (Bangsbo et al., 1991; Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009; Ekblom, 1986; Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007). Differences in high-intensity activity during a match are also observed by gender (Ekblom, 1986; Krustrup, Mohr, Ellingsgaard, & Bangsbo, 2005), training level (Krustrup & Bangsbo, 2001), period of competition (Mohr et al., 2003; Rampinini et al., 2007), level of competition, game style, and environmental factors (Reilly, 1996).

Sprinting constitutes one of the most important activities in soccer, even if it only represents 1–12%

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ISSN 0264-0414 print/ISSN 1466-447X online © 2010 Taylor & Francis
DOI: 10.1080/02640414.2010.521166

of the total distance covered in a match (Rienzi et al., 2000; Van Gool, Van Gerven, & Boutmans, 1988; Withers, Maricic, Wasilewski, & Kelly, 1982). Recently, sprinting has been divided into two different types, leading and explosive sprints, as studied during English Premier League matches (Di Salvo et al., 2009).

Researchers have focused their attention on high-intensity activities during matches in the different national leagues, in particular the English Premier League (Bradley et al., 2009; Di Salvo et al., 2009), the Spanish League (Di Salvo et al., 2007), the Italian League and Danish League (Mohr et al., 2003). Some research on national leagues has included Champions League matches in the same data analysis (Di Salvo et al., 2007; Mohr et al., 2003; Rampinini et al., 2007). No research to date has analysed high-intensity or sprinting activity during Champions League and UEFA Cup (now Europa League) competitions.

The high standard of the teams competing in Champions League and UEFA Cup competition represent the cream of each national league. In addition, the different rules of these competitions (i.e. away goals count double in the event of a tie) provide important information for coaches, since the data cover a wide sample with several games, nationalities of teams and players.

Therefore, the purpose of this study was to develop a detailed analysis of sprinting activities of elite soccer players during European Champions League and UEFA Cup games, paying particular attention to the type of sprint activities between different playing positions.

Methods

Players and match data

Physical performance data were collected from 67 European matches (European Champions League and UEFA Cup) throughout four seasons, from 2002 to 2006 (16.8 ± 1.7 matches per season). The data set included 20 different countries and 717 outfield players (1325 player data sets in total) from 58 teams: England ($n = 9$), France ($n = 6$), Germany ($n = 4$), Greece ($n = 2$), Netherlands ($n = 2$), Hungary ($n = 2$), Israel ($n = 1$), Italy ($n = 4$), Norway ($n = 1$), Portugal ($n = 3$), Romania ($n = 2$), Russia ($n = 4$), Scotland ($n = 2$), Spain ($n = 5$), Switzerland ($n = 3$), Turkey ($n = 2$), Ukraine ($n = 2$), Czech Republic ($n = 2$), Bulgaria ($n = 1$), and Austria ($n = 1$). Data were analysed for all players that took part in each match except goalkeepers. Only data for those players completing entire matches (i.e. 90 min) were included for analysis.

Sprinting activity was analysed for each playing position: central defenders, wide defenders, central midfielders, wide midfielders, and attackers. The profile of the different playing positions was based on the activities performed on the pitch and the primary area in which these activities were carried out, as in Di Salvo et al. (2007). The data used for this study were made available by ProZone Sports Ltd.® (Leeds, UK), who provided all information necessary for statistical analysis, maintaining the anonymity of the players and teams, following European Data Protection Law (European Parliament and the Council of the European Union, 1995). Written informed consent was obtained from participating teams, taking these standards into account.

Data collection and analyses

The physical performance of players during the matches was studied by means of a computerized, semi-automated, multi-camera image recognition system, provided by ProZone® (Version 3.0, ProZone Sports Ltd.®, Leeds, UK). Eight cameras (Vicon Surveyor 23× cameras dome/SV FT-W23) were installed at the top of each stadium. This system has been independently validated to verify the capture process and subsequent accuracy of the data (Di Salvo, Collins, McNeill, & Cardinale, 2006) and has been shown to have high intra-observer reliability (Di Salvo et al., 2009). The ProZone® system allows for the classification and analysis of different speed intensities. For the purposes of this study, we only considered sprinting activity ($> 25.2 \text{ km} \cdot \text{h}^{-1}$), assessing the total number of sprints, the total sprint distance covered, as well as the percentage of each sprint type. The types of sprint activity were the explosive and leading sprint. An axplosive sprint (characterized by a fast acceleration) was defined as the attainment of sprint speed from standing, walking, jogging or running without entering the high-speed run category during the previous 0.5 s. A leading sprint (characterized by a gradual acceleration) was defined as the attainment of sprint speed from standing, walking, jogging or running while entering the high-speed run category during the previous 0.5 s time period. In addition, these sprints were classified by distance category: 0–5 m, 5.1–10.0 m, 10.1–15.0 m, 15.1–20.0 m, and > 20 m.

To assess sprinting characteristics related to playing position, this analysis grouped the players into one of five field positions: central defenders ($n = 286$), wide defenders ($n = 255$), central midfielders ($n = 319$), wide midfielders ($n = 222$), and attackers ($n = 243$).

Statistical analysis

Unless otherwise stated, results are expressed as means ± standard deviations (s). Normal distribution of data was controlled by *P-P* plots. To determine differences between positions, Kruskal-Wallis tests were conducted and in the event of a significant difference, Mann Whitney *U*-tests were employed. The Bonferroni adjustment was used to eliminate the problem of an inflated type I error risk by adjusting the alpha level depending on the number of pair-wise comparisons. Two-sided significance for all results was set at a 5% level. In addition to the null hypothesis testing, effect sizes (Cohen's *d*; Cohen, 1988) were reported. Since not all players participated in the same number of games, data points are not independent, and thus contradict the assumptions of the Kruskal-Wallis analyses. All statistical analyses were conducted using SPSS version 15.0 for Windows (SPSS Inc., Chicago, IL).

Results

Explosive and leading sprints

Table I shows the total number of sprints, explosive and leading sprints performed by the different positions. Differences in the total number of sprints were found between all positions ($P < 0.001$) with the exception of attackers versus wide defenders. Wide midfielders undertook significantly more sprints, followed by attackers and wide defenders. Central midfielders performed fewer sprints than wide midfielders, attackers, and wide defenders ($P < 0.001$). Central defenders performed the fewest sprints. The number of explosive sprints made by central defenders was lower than for all other positions ($P < 0.001$). Central midfielders performed fewer sprints only compared with wide midfielders ($P < 0.001$). As for the total number of sprints, there were differences in leading sprints between all positions ($P < 0.001$), with the exception of attackers versus wide defenders. Wide midfielders performed the most leading sprints, followed by attackers, wide defenders, central midfielders, and central defenders (Table I). However, the ratio of explosive to leading sprints did not differ between playing positions (Figure 1).

Total sprint distance

The average total sprint distance covered was 205 ± 108 m. Differences were found between all positions with the exception of attackers versus wide defenders ($P < 0.001$, $d = 0.40$–1.69). Specifically, wide midfielders covered a higher total sprint distance, followed by attackers, wide defenders, and central midfielders (285 ± 111 m, 242 ± 106 m, 233 ± 98 m, and 163 ± 85 m, respectively). Central defenders had the lowest total sprint distance of all playing positions (131 ± 66 m).

Number of sprints in distance categories

Figure 2 displays the positional differences for each of the five distance categories considered (0–5 m, 5.1–10.0 m, 10.1–15.0 m, 15.1–20.0 m, and >20 m).

In the 0–5 m category, wide midfielders performed more (18.4 ± 9.4) and central defenders fewer (9.2 ± 6.0) sprints than all other positions (wide defenders 15.1 ± 7.9, attackers 15.1 ± 7.9, and central midfielders 13.7 ± 8.6; $P < 0.001$). In the 5.1–10.0 m category, central defenders and central midfielders performed fewer sprints (4.1 ± 2.6 and 5.3 ± 3.3, respectively) than all other positions (attackers 7.1 ± 3.6, wide defenders 7.3 ± 3.7, and wide midfielders 8.4 ± 3.8; $P < 0.001$). In the 10.1–15.0 m category, central defenders and central midfielders performed fewer sprints (1.8 ± 1.5 and 2.2 ± 1.8, respectively) than all other positions (wide defenders 3.0 ± 1.8, attackers 3.2 ± 2.1, and wide midfielders 3.8 ± 2.4; $P < 0.001$). Similarly, in the 15.1–20.0 m category, central defenders and central midfielders performed fewer sprints than all other positions, with wide midfielders performing more sprints than wide defenders and attackers (central defenders 1.1 ± 1.2, central midfielders 1.1 ± 1.2, attackers 1.9 ± 1.6, wide defenders 1.9 ± 1.7, and wide midfielders 2.5 ± 1.8; $P < 0.001$). For sprints >20 m, central defenders and central midfielders performed fewer sprints (0.9 ± 1.0 and 0.9 ± 1.1, respectively) than all other positions (wide defenders 1.7 ± 1.7, attackers 2.0 ± 2.0, and wide midfielders

Table I. Number of sprints by playing position (mean $\pm$ *s*).

	Central defenders	Wide defenders	Central midfielders	Wide midfielders	Attackers
Total sprints	17.3 ± 8.7	29.5 ± 11.7*	23.5 ± 12.2	35.8 ± 13.4	30.0 ± 12.0*
Explosive sprints	4.5 ± 4.2	7.2 ± 5.5	6.3 ± 5.8	8.4 ± 6.3	7.2 ± 5.7
Leading sprints	12.8 ± 6.0	22.4 ± 8.5	17.3 ± 8.2	27.4 ± 9.5	22.8 ± 8.8

*Total number of sprints differs between all positions with the exception of attackers vs. wide defenders: wide midfielders > (attackers = wide defenders) > central midfielders > central defenders ($P < 0.001$, $d = 0.46$–1.64). Differences were found for explosive sprints: (wide midfielders = attackers = wide defenders) > central defenders ($P < 0.001$, $d = 0.34$–0.72), central midfielders < wide midfielders ($P < 0.001$, $d = 0.35$), and leading sprints: wide midfielders > (attackers = wide defenders) > central midfielders > central defenders ($P < 0.001$, $d = 0.51$–1.34).

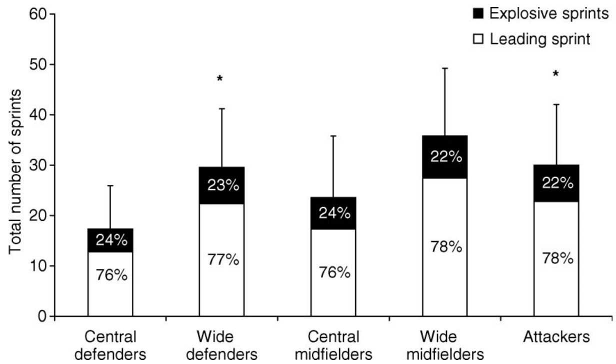

Figure 1. Ratio of explosive to leading sprints by playing position.

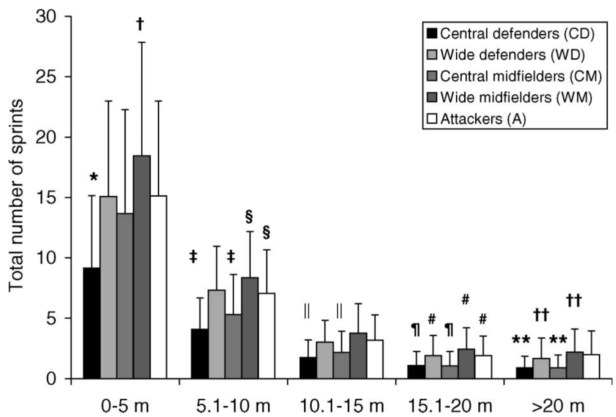

Figure 2. Positional differences for each of the five distance categories.

2.2 ± 1.9; $P < 0.001$). In this category as well as the 10.1–15.0 m category, wide defenders performed fewer sprints than wide midfielders ($P = 0.01$).

For percentages of sprints in distance categories, only central midfielders differed from the other positions. They performed a higher percentage of shorter sprints of 0–5 m (56.7 ± 16.2%, $P < 0.001$, $d = 0.33$–0.48) and a lower percentage of longer sprints of 15.1–20.0 m (4.8 ± 5.8%, $P \leq 0.03$, $d = 0.32$–0.42) and >20 m (4.1 ± 5.2%, $P < 0.001$, $d = 0.34$–0.47) than all other positions.

Discussion

This study was based on sprinting activity within a wide sample of soccer players during European Club competitions. Because of the influence that sample size has on null-hypothesis testing (Ferguson, 2009), Cohen's d was calculated for all significant differences. The effect sizes ranged from 0.32 to 1.85, indicating that the differences represent a "practically" significant effect (Cohen, 1988). However, the violation of the assumptions of the Kruskal-Wallis analyses is a limitation to this study.

Match analysis has indicated that high-intensity actions are the most important in soccer (Bangsbo et al., 1991; Bradley et al., 2009; Reilly, 1990). Nevertheless, few studies have focused specifically on high-intensity actions related to positional roles. This research is the first to focus on specific sprinting activities (>25.2 km $\cdot$ h^{-1}) in elite soccer players during the highest levels of European Club competitions.

Our results show that wide midfielders, attackers, and wide defenders covered a higher total sprint distance than central defenders and central midfielders. These results are in accordance with previous studies in which similarly elite players were assessed (Bradley et al., 2009; Di Salvo et al., 2007, 2009). However, our results are at odds with those of Mohr et al. (2003) and Rampinini et al. (2007), who observed that wide defenders and attackers covered a significantly greater distance and sprint time than midfielders. This difference could be explained by the fact that Mohr et al. (2003) and Rampinini et al. (2007) combined all midfielders (central and wide midfielders) into the same category. The need to split midfielders into central and wide midfielders is in accordance with recent studies (Bradley et al., 2009; Di Salvo et al., 2007, 2009), where significant differences were observed between the two positions.

There are difficulties in making comparisons between studies on match analysis because in soccer, different analysis systems have been used (position of cameras, technology applied), different intensities have been measured (threshold velocities and criteria time 0.5–1.0 s, for activity classification), different magnitudes have been used to analyse the activity (time or distance), and the criteria to classify the positions of the players have differed across studies (Bangsbo et al., 1991; Ekblom, 1986; Mohr et al., 2003; Rienzi et al., 2000).

Total number of sprints is another common variable used in studies on elite soccer players (Ekblom, 1986; Tumilty, 1993; Withers et al., 1982). The total number of sprints in the present study was similar to that in previous research, with wide midfielders performing the most sprints, followed by attackers and wide defenders. The central defenders performed the fewest sprints, followed by central midfielders (Table I). These results are in accordance with sprint numbers recently reported from players in the Spanish League and the English Premier League (Di Salvo et al., 2007, 2009).

The present study evaluated types of sprint activity, which has only recently been introduced into the match analysis literature (Di Salvo et al., 2009). In the present study, no significant differences were observed in the percentages of explosive and leading sprints (23% and 77%, respectively) between the different positions studied. These percentages are similar to those observed by Di Salvo et al. (2009) (30.5% and 69.5%, respectively) in a study that was the first to examine the number of explosive and leading sprints. Central defenders performed significantly fewer explosive and leading sprints than all other positions positions. In addition, wide midfielders completed the highest number of sprints in both categories (Table I).

In the scientific literature it has been suggested that the physical demands on soccer players during a match depend on variables such as success of the team (Di Salvo et al., 2009), tactics used, standard of competition (Rampinini et al., 2007), and playing positions (Bangsbo et al., 1991; Rienzi et al., 2000; Stølen, Chamari, Castagna, & Wisløff, 2005; Withers et al., 1982). It has been suggested that the sprint capacity profile of players is directly influenced by their positional role on the team (Reilly, 2003). It is evident that greater sprinting demands are made on wide midfielders and attackers (Di Salvo et al., 2009). The present study shows similar trends with wide defenders also performing elevated sprinting activities. This could be related to the tactical roles of wide defenders who are often required to perform sprints in both defensive and attacking phases of play. Among English Premier League players, Di Salvo et al. (2009) observed that central positions (central defenders and central midfielders) performed a higher percentage of explosive sprints, but this tendency was not observed in the present study. These differences could be related to the types of competitions studied (National League vs. European Club competitions). During the Champions League and the UEFA Cup, the different rules (i.e. away goals count double in the case of a tie, etc.) could affect the tactics used and therefore the physical demands of play. Further research on the differences in physical demands between European National Leagues is required to confirm this hypothesis.

This study revealed that wide midfielders, followed by attackers and wide defenders, performed the higher number of short sprints ($\geq$10 m). Central defenders, on the other hand, performed fewest sprints in each of the distance categories compared with all other positions (Figure 2). Furthermore, this study showed that the percentage of sprints in distance categories is a stable variable between the different playing positions, except for central midfielders, who varied between a higher percentage (0–5 m) and a lower percentage (15.1–20.0 m and $>$20 m). In general, our results are in line with previous research (Di Salvo et al., 2009) showing that elite soccer players perform more sprints over short distances (0–10 m) than over longer distances ($>$10 m). These physical differences generate the need to devise specific training programmes for each playing position, as has previously been suggested (Di Salvo & Pigozzi, 1998; Svensson & Drust, 2005).

In conclusion, the results of this study provide a useful insight into sprinting activity during Champions League and UEFA Cup matches and also demonstrate that sprinting characteristics are influenced by playing position. This study further demonstrates that the physical demands of the different playing positions are quite varied and may also assist the coaching staff in improving training methodologies.

Acknowledgements

The authors thank ProZone® (Leeds, UK) for their assistance with the data acquisition.

References

Bangsbo, J. (1994). The physiology of soccer: With special reference to intense intermittent exercise. *Acta Physiologica Scandinavica*, *619*, 1–155.

Bangsbo, J., Norregaard, L., & Thorso, F. (1991). Activity profile of competition soccer. *Canadian Journal of Sports Sciences*, *16*, 110–116.

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

Carling, C., Bloomfield, J., Nelsen, L., & Reilly, T. (2008). The role of motion analysis in elite soccer: Contemporary performance measurement techniques and work rate data. *Sports Medicine*, *38*, 839–862.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd edn.). Mahwah, NJ: Erlbaum.

Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine*, *28*, 222–227.

Di Salvo, V., Collins, A., McNeill, B., & Cardinale, M. (2006). Validation of ProZone®: A new video-based performance analysis system. *International Journal of Performance Analysis in Sport*, *6*, 108–109.

Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in Premier League soccer. *International Journal of Sports Medicine*, *30*, 205–212.

Di Salvo, V., & Pigozzi, F. (1998). Physical training of football players based on their positional roles in the team: Effects on performance related factors. *Journal of Sports Medicine and Physical Fitness*, *38*, 294–297.

Ekblom, B. (1986). Applied physiology of soccer. *Sports Medicine*, *3*, 50–60.

European Parliament and the Council of the European Union (1995). Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data. *Official Journal of the European Communities*, *281*, 31–50.

Ferguson, C. J. (2009). An effect size primer: A guide for clinicians and researchers. *Professional Psychology: Research and Practice*, *5*, 532–538.

Krustrup, P., & Bangsbo, J. (2001). Physiological demands of top-class soccer refereeing in relation to physical capacity: Effect of intense intermittent exercise *training*. *Journal of Sports Sciences*, *19*, 881–891.

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., et al. (2003). The yo-yo intermittent recovery test: Physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise*, *35*, 697–705.

Krustrup, P., Mohr, M., Ellingsgaard, H., & Bangsbo, J. (2005). Physical demands during an elite female soccer game: Importance of training status. *Medicine and Science in Sports and Exercise*, *37*, 1242–1248.

Mayhew, S. R., & Wenger, H. A. (1985). Time motion analysis of professional soccer. *Journal of Human Movement Studies*, *11*, 49–52.

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

Rampinini, E., Coutts, A. J., Castagna, C., Sassi, R., & Impellizzeri, F. M. (2007). Variation in top level soccer match performance. *International Journal of Sports Medicine*, *28*, 1018–1024.

Reilly, T. (1990). Football. In T. Reilly, N. Secher, P. Snell, & C. Williams (Eds.), *Physiology of sports* (pp. 371–426). London: E & FN Spon.

Reilly, T. (1996). Motion analysis and physiological demands. In T. Reilly (Ed.), *Science and soccer* (pp. 65–83). London: E & FN Spon.

Reilly, T. (2003). Motion analysis and physiological demands. In T. Reilly & A. M. Williams (Eds.), *Science and soccer* (pp. 59–72). London: 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.

Rienzi, E., Drust, B., Reilly, T., Carter, J. E., & Martin, A. (2000). Investigation of anthropometric and work-rate profiles of elite South American international soccer players. *Journal of Sports Medicine and Physical Fitness*, *40*, 162–169.

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

Svensson, M., & Drust, B. (2005). Testing soccer players. *Journal of Sports Sciences*, *23*, 601–618.

Tumilty, D. (1993). Physiological characteristics of elite soccer players. *Sports Medicine*, *16*, 80–96.

Van Gool, D., Van Gerven, D., & Boutmans, J. (1988). The physiological load imposed on soccer players during real match-play. In T. Reilly, A. Lees, K. Davies, & W. J. Murphy (Eds.), *Science and football* (pp. 51–59). London: E & FN Spon.

Withers, R. T., Maricic, Z., Wasilewski, S., & Kelly, L. (1982). Match analysis of Australian professional soccer players. *Journal of Human Movement Studies*, *8*, 159–176.