Goal scoring patterns over the course of a match and season: An analysis of the 2009-2010 English Premier League (no winter break) and German Bundesliga (winter break) seasons.

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Declaration

DECLARATION: This dissertation is the product of my own work and does not infringe the ethical principles set out in the University’s Handbook for Research Ethics. I agree that it may be made available for reference via any and all media by any and all means now known or developed in the future at the discretion of the University.

Signed:

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Date:
PROPOSED STUDY AGREEMENT FORM

The precise details of the method / research question(s) have been discussed and agreed by both myself and my dissertation advisor.

Name: Michael Haines

Student’s signature: _________________________ Date: ___/___/20___

On the basis of the proposed study, I am happy for the above named student to continue with this dissertation.

Name: Debbie Cox

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Abstract

Previous research suggests that a relationship between time and goal scoring frequency (GSF) exists, with GSF highest in the second half (46-90+ min) of matches and peaking in the last 15 minutes (76-90+ min). However, to our knowledge no research appears to have investigated whether such a pattern is present in the English Premier League (EPL) and the German Bundesliga (DBL), or whether GSF is consistent throughout a season. The purpose of this study was to investigate whether the same pattern of GSF was observed in the EPL and DBL and whether the inclusion of a winter break has an effect on GSF. Following institutional ethical approval, the time of all 1919 goals from the 686 matches of the 2009-2010 season of the EPL and DBL were recorded according to the time indicated by the British Broadcasting Corporation’s Sport (BBC) website and the official website of the DBL. The data was entered into a Microsoft Excel spreadsheet to create frequency counts for each minute of play from 1 to 90+ min. Chi-square analysis was used to determine any statistically significant differences in GSF per 45 minute period, per 15 minute period and between the last 15 minutes of play per half season for each league. Chi-square analysis was also used to look for statistically significant differences in GSF during the last 15 minutes of matches in the second half of the season between the two leagues, for an effect of league, time of season and a league x time interaction. The level of significance in all cases was set at p ≤ 0.05. Chi-square analysis revealed GSF was significantly greater in the second half of matches (EPL: 56.1% v 43.9%, p < 0.001; DBL: 56.1% v 43.9%, p < 0.001) and greatest in the last 15 minute period (76-90+ min) of matches compared to all other 15 minute periods in both the EPL and DBL (EPL: 23.5%, all at p < 0.05; DBL 22.1%, all at p < 0.05). Although non-significant, GSF during the last 15 minutes of matches in the EPL was greater in the second half of the season compared to the first (26.5% v 20.7%, p = 0.227). Conversely GSF during the last 15 minutes of matches in the DBL was lower in the second half of the season compared to the first, although again this difference was not significant (20.6% v 23.6%, p = 0.613). No significant difference in GSF in the last 15 minutes of play in the second half of the season was observed between the EPL and DBL (26.5% v 20.6%, p = 0.384). The league x time interaction was not significant (p = 0.240) although a main effect for league on GSF during the last 15 minutes of play was found (p = 0.010). By showing its existence in two previously unstudied leagues the results provide further support for a relationship between time and GSF, which may be explained by deterioration in physical conditioning, tactical play and lapses in concentration. The study further adds to existing knowledge with the observation that GSF in the last 15 minute period of play in the second half of the season increased by 5.8% in the EPL and decreased by 3.0% in the DBL when compared to the first half of the season. This 8.8% swing between EPL and DBL suggests a rest factor may be involved in GSF when considered over the course of a season. The results suggest that most goals are scored during the second half of matches and specifically during the last 15 minute period of play in both the EPL and DBL. They also suggest that a winter break may reduce GSF in the last 15 minutes of play in the second half of the season compared to the first, and that the lack of a winter break may increase GSF in the last 15 minutes of play in the second half of the season compared to the first, although further investigations are required and should compare leagues with the same number of matches in order to increase statistical power.
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Finally I would like to dedicate this piece of work to my late Nan and Grampy who passed away last year. Hopefully I will achieve the degree classification I promised you I would.
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Chapter 1

Introduction

1.1 Background

Association football is the world’s most popular sport, played at many levels in every nation (Bangsbo, 1994; Sporis, Jukic, Ostojic & Milanovic, 2009; Stolen, Chamari, Castagna & Wisløff, 2005). Matches are often characterised by a low frequency of goal scoring (Abt, Dickson & Mummery, 2002; Yiannakos & Armatas, 2006), making the ability to score goals perhaps the most important requirement for success (Jinshan, Xiaoke, Yamanaka & Matsumoto, 1993) and suggesting that investigations into the characteristics of goal scoring are of importance (Yiannakos & Armatas, 2006). Previous research has reported a relationship between time and goal scoring frequency (GSF), whereby more goals are scored in the second half of matches than the first and the final 15 minutes of play (76-90+) sees the greatest GSF (Abt et al., 2002; Acar et al., 2009; Armatas & Yiannakos, 2010; Armatas, Yiannakos, Papadopoulou & Skoufas, 2009; Armatas, Yiannakos & Sileloglou, 2007; Grant, Williams & Reilly, 1999a; Jinshan et al., 1993; Reilly, 2003; Ridder, Cramer & Hopstaken, 1994; Yiannakos & Armatas, 2006). Aspects of play which change over the course of a match including tactics, physical condition and mental condition have been cited as the primary causes of this relationship, with implications for team and player preparation (Abt et al., 2002). This relationship has been reported in club and international competitions worldwide, however studies have yet to investigate the English Premier League (EPL) or the German Bundesliga (DBL) - two of the highest profile leagues in Europe (UEFA, 2011). Furthermore, little attention has been paid to the questions of whether goal scoring patterns are the same at the beginning of a season as at the end and whether a winter break has any effect on the relationship. This is perhaps surprising given that deteriorations in physical and mental condition are linked to the relationship between time and GSF over the course of a
single match and are known to be exacerbated by the demands of consecutive matches in the EPL, resulting in regular calls for a winter break to be introduced (Odetoyinbo, Wooster & Lane, 2009). The present introduction will therefore argue the importance of carrying out further analyses of goal scoring patterns, the importance of understanding whether they are the same at the beginning of a season as at the end and the potential impact of a winter break on the relationship.

Morris (1981) was the first to report a relationship between time and GSF. Morris (1981) investigated English league and cup matches and reported that GSF increased with time and was greatest in the final 15 minutes of play. Building upon this work, subsequent studies identified the same relationship at club and international level across the world (Abt et al., 2002; Acar et al., 2009; Armatas & Yiannakos, 2010; Armatas, Yiannakos, Papadopoulou & Skoufas, 2009; Armatas, Yiannakos & Sileloglou, 2007; Grant et al, 1999a; Jinshan et al., 1993; Reilly, 2003; Ridder, et al., 1994; Yiannakos & Armatas, 2006). To the author’s knowledge only one study has reported no immediate correlation between time and GSF. This study of goals scored at the 1986 World Cup reported that GSF was greatest between 60-75 minutes (Jinshan, 1986, as cited in Jinshan et al., 1993, p.205), as opposed to 76-90+ minutes as reported in other studies. Despite this finding, the range of studies reporting a relationship between time and GSF indicates that this pattern is evident worldwide at many levels of the game. However, none have investigated the EPL or DBL which is perhaps surprising given their standing in world football as the first and fourth ranked leagues in Europe by UEFA coefficient (UEFA, 2011).

Whilst much attention has been paid to the relationship between time and GSF during a season or competition as a whole, no research has considered whether the relationship is the same at the beginning of a season as at the end. The only study to have considered GSF over a longer period (Abt et al., 2002) investigated four seasons of the Australian National Soccer League (ANSL) from 1994-1998, reporting that GSF was greater in the second half of
matches compared to the first and greatest during the final 15 minutes of play. The reasons asserted for these findings were multi-factorial and related to aspects of play which change over the course of a match, particularly physical and mental condition and team tactics (Abt et al., 2002). Further research has provided a strong evidence base for this assertion with the physiological demands of different playing positions shown to cause defenders to suffer greater deteriorations in physical condition than other positions, affecting their ability to carry out high-intensity actions (Krustrup et al., 2006; Mohr, Krustrup & Bangsbo, 2003; 2005; Mohr, Krustrup, Nybo, Nielsen & Bangsbo, 2004; Reilly, 2007) and causing lapses in concentration (Reilly, 2007). This coupled with no effect on shooting ability (Abt, Zhou & Weatherby, 1998; Zeederberg, et al., 1996) places attackers at a potential advantage in the latter stages of matches with implications for GSF. An increased urgency in attacking play during the closing stages of matches has also been suggested to occur as teams seek to score and gain a positive result, which increases the likelihood of a goal being scored (Abt et al., 2002; Carling, Williams & Reilly, 2005; Reilly, 1997).

Previous investigations have assumed the pattern of GSF is consistent over the course of a competition or season and to date none have considered whether the pattern is the same at the start of a season as at the end. Since the effects of physical and mental fatigue developed over the course of a match have been reported to be exacerbated over the course of a season (Odetoyinbo et al., 2009; Prozone, 2009), it is possible that these factors may be of greater significance at the end of a season compared to the beginning and may contribute to an increase in GSF in the final 15 minutes of matches. Odetoyinbo et al. (2009) and Prozone (2009) for example, reported that when required to perform in consecutive matches with little recovery as demanded by the league schedule, players in the EPL suffered reductions in physical capacity with reduced total distance covered, distance covered at high-intensity, number of sprints, distance covered by sprinting, amount of total work performed both with and without the ball and increased recovery time required between activities. These studies suggest that deteriorations in physical condition over the course of a match may be
exacerbated over consecutive matches causing residual fatigue, which given the links between physical condition and GSF may increase the potential for increased GSF during the final 15 minutes of matches as the season progresses.

Another issue not yet considered in goal scoring research is that of a winter break. In injury research one study comparing leagues with and without a winter break reported that injury incidence was significantly higher in leagues without a break due to the accumulation of residual fatigue over a season (Ekstrand, Lewin, Hägglund & Walden, 2004). This suggests that residual fatigue may be reduced to some extent by the inclusion of a winter break allowing a period of recovery, which may have an effect on GSF later in a season.

A wide range of existing research has reported a relationship between time and GSF, where GSF is greater in the second half of matches compared to the first and greatest in the final 15 minutes. Aspects of play which change over the course of a match are cited as the main causes of this pattern, which has implications for team and player preparation (Abt et al., 2002). It has been suggested that these aspects of play may be exacerbated over the course of a season, with an accumulation of fatigue increasing the potential for greater GSF at the end of a season compared to the beginning. However no studies have investigated whether the relationship between time and GSF is the same at the beginning of a season as at the end, or the effect of a winter break. Further examination of goal scoring patterns is warranted since the findings have implications for coaches and players due to the constantly evolving nature of professional football (Yiannakos & Armatas, 2006) and the implications of the links made between physical condition and GSF (Abt et al., 2002). Furthermore this study will contribute to the area of research by increasing understanding of goal scoring patterns over the course of a season and specifically whether patterns are the same at different stages of a season - a research direction of importance suggested by Abt et al. (2002) - as well as informing future research into the suitability of introducing a winter break to the EPL schedule.
The aim of this study was to investigate whether the same relationship between time and GSF observed by previous studies was present in the EPL and DBL and whether the inclusion of a winter break in the DBL affected GSF.

1.2 Research questions

1. Are goal scoring patterns different in the first half compared to the second half of a match?

2. Is goal scoring frequency greatest during the final 15 minutes of matches?

3. Are goal scoring patterns in the final 15 minutes of matches different in the first half of the season compared to the second in each league?

4. Are goal scoring patterns in the final 15 minutes of matches during the second half of the season different between the EPL and DBL?

1.3 Hypotheses

Null hypothesis \((H_0)\): There is no significant difference in goal scoring frequency in the first half compared to the second half of matches.

Null hypothesis \((H_0)\): There is no significant difference in goal scoring frequency between the six 15 minute periods of matches.

Null hypothesis \((H_0)\): There is no significant difference in goal scoring frequency in the final 15 minutes of matches in the EPL or DBL.
Null hypothesis ($H_0$): There is no significant difference in goal scoring frequency in the final 15 minutes of matches in the second half of the EPL season compared to the DBL.
Chapter 2

Literature Review

2.1 Performance analysis in football

Hughes and Franks (2004) describe notational analysis as “the analysis of movement, technical and tactical evaluation and statistical compilation” (p.67). Initially notation analysis systems were hand based and vulnerable to errors, but the introduction of computer based analysis systems allowed more detailed and accurate data to be recorded (James, 2006). Today the use of analysis systems in professional football is widespread, with all English league matches recorded (James, 2006) and 14 EPL, 19 npower Championship and 9 npower League 1 clubs currently using Prozone analysis solutions alone (Prozone, 2011). Before the development of analysis systems coaches relied upon subjective observations to inform their decisions; however it has been shown that coaches cannot accurately recall all of the critical events occurring in a match (Franks & Miller, 1986; Laird & Waters, 2008). Laird and Waters (2008) reported that even experienced coaches - despite being more able to accurately recall critical events than their novice counterparts - were still only able to accurately recall 59.2% of critical events during 45 minutes of play. Such findings highlight the need for the objective and reliable mechanism of analysing performance which performance analysis systems provide (James, 2006).

2.2 The influence of original research

Reep and Benjamin’s (1968) research is widely regarded as pioneering in the analysis of football. This particular study encompassed data from 3,213 World Cup and English League matches played from 1953-1968; measuring shots, passing sequences and goals scored. It was reported that 50% of goals were scored from possessions of one pass or less; that 80% of
goals were scored from possessions of three passes or less and that it took on average 10 shots to score one goal. From these findings a style of play emphasising movement of the ball into shooting positions in and around the penalty area quickly, using the fewest passes possible was recommended, with the idea being that the more times the ball entered these areas the more chance there was of scoring (James, 2006). Such a style was termed “long ball” or “direct” and became popular amongst British clubs, particularly in the lower divisions. Watford and Wimbledon are considered to have achieved a measure of success using such tactics, as are Eire and Norway on the international stage; however it has been noted that other than Greece’s Euro 2004 victory using a modification of a direct style of play against technically superior teams (Carling et al., 2005) few teams have achieved success at the highest level playing in this manner (Hughes & Franks, 2005).

Bate’s (1988) review supported and developed Reep and Benjamin’s (1968) findings using data from England Senior and Youth international matches, the 1982 World Cup and the 1985-1986 English Third Division season. Bate (1988) concluded that a low number of consecutive, long, forward passes into the attacking third of the pitch or the space behind the defence was the most effective method of creating goal scoring opportunities. Bate (1988) concluded that the “possession football” style used by many European and South American teams at the time was not supported by empirical data. However the data from which this conclusion was drawn was gathered predominantly from matches involving English teams who did not play possession football, therefore it is perhaps unsurprising that the findings of this review supported the use of a direct style.

Studies investigating playing styles at major competitions since the 1990 World Cup (Grant, Williams & Reilly, 1999b; Hook & Hughes, 2001; Hughes & Franks, 2005) appear to indicate a shift away from the use of direct tactics at the top level. Hughes and Franks (2005) analysed all 104 matches from the 1990 and 1994 World Cups and despite initially finding similar to Reep and Benjamin (1968) that approximately 80% of goals were scored after
three or less passes, found limitations to the methods used which had influenced the results. It was argued that the reason for Reep and Benjamin’s (1968) finding that 50% of goals were scored from possessions of one pass or less was because most possessions were of one pass or less. Hughes and Franks (2005) attempted to remove this issue by calculating the number of goals scored for each length of possession per 1000 possessions, subsequently finding possessions of between three and seven passes were most likely to result in goals. Hughes and Franks (2005) also reported that successful teams utilised longer passing sequences and produced more goals per possession as a result. Similarly it was reported that successful teams at the 1998 World Cup had more attempts on goal arising from possessions of four or more passes and completed more passes on average per game (362.7 v 308.9) than unsuccessful teams (Grant et al., 1999b). A possession style of play was also favoured by successful teams at Euro 2000 (Hook & Hughes, 2001) and most recently at the 2010 World Cup (Prozone, 2010). Analysis of the 2010 World Cup revealed that Spain won the tournament by dominating passing and possession, averaging 527 passes per game compared to the tournament average of 343, achieving the greatest passing success rate (89%), number of penalty box entries and number of shots per game (15.7), all of which have been cited as major reasons for their success (Prozone, 2010).

That possession based styles could be so successful differs markedly from the original findings of Reep and Benjamin (1968) and led Hughes and Franks (2005) to the conclusion that this original work had not resulted in a full understanding of the influence of possession length on goal scoring. As asserted by James (2006) it is reasonable to suggest that when it is possible to play good quality passes into goal threatening positions a possession approach should be adopted, however when it is not possible a more direct and speculative approach should be adopted due to the element of chance that goal scoring opportunities will be produced, as suggested by the findings of Reep and Benjamin (1968) and Bate (1988).
2.3 Goal scoring patterns

Whilst many studies have investigated goal scoring to identify the characteristics of successful teams, there has also been much interest in goal scoring patterns and in particular whether a relationship between time and GSF exists. Most research has concluded that such a relationship does exist, with GSF being greater in the second half of matches than the first and greatest in the final 15 minutes of play. This relationship has been reported in the 1990 World Cup (Jinshan et al., 1993), the 1991-1992 Dutch professional league (Ridder et al., 1994), the 1991-1992 Scottish League season (Reilly, 2003), the ANSL 1994-1998 (Abt et al., 2002), the 1998 World Cup (Grant et al., 1999a), the 1998, 2002 and 2006 World Cups (Armatas et al., 2007), Euro 2004 (Yiannakos & Armatas, 2006), the 2006 World Cup (Acar et al., 2009; Armatas & Yiannakos, 2010) and the 2006-2007 Greek “SuperLeague” (Armatas et al., 2009). The range of competitions in which this relationship has been reported indicates its prevalence across the world. The only study to report no immediate relationship reported that during the 1986 World Cup GSF was greatest between 60-75 minutes, with all other periods displaying a similar number of goals scored (Jinshan, 1986, as cited in Jinshan et al., 1993). This finding may be explained by the balance between attack and defence throughout matches during this tournament, unlike during the 1990 World Cup which saw teams perform cautiously during the first half leading to just 29.6% of goals being scored during the first half compared to 66.9% in the second half of matches (Jinshan et al., 1993). Such findings indicate the influence evolving tactical approaches to the game can have on GSF.

Morris (1981) was the first to report a relationship between time and GSF, using data on 9,000 goals scored in English league and cup matches between April 1978 and November 1980, increases in GSF with each 15 minute period of play were reported. Although Morris’s (1981) findings match many subsequent studies, the methods of data collection and analysis were not reported, making it impossible to assess the validity of the findings.
In a study of the 115 goals scored during the 1990 World Cup, Jinshan et al. (1993) reported GSF to be greater during the second half of matches compared to the first (66.9% v 29.6%, p < 0.05) and greatest between 76-90+ minutes. For each goal the time, attacking method and shooting technique were reported; however the methods used were not which is indicative of a general lack of consistency and standardisation in the collection and reporting of goal scoring data in previous literature. For example, no information was provided by Morris (1981), Jinshan et al. (1993) or Abt et al. (2002) regarding how the time of each goal was determined, simply indicating that it was recorded. Other studies (Armatas et al., 2007, Yiannakos & Armatas, 2006) indicated in more detail how data was collected making it possible for researchers to replicate those studies should they wish. Regarding the presentation of data, some studies (Armatas & Yiannakos, 2010; Armatas et al., 2007; Armatas et al., 2009; Yiannakos & Armatas, 2006) presented GSF per half or per 15 minute period as a percentage with data analyses conducted using absolute figures, some (Acar et al., 2009) presented data as both a percentage and an absolute figure, whilst others presented data as absolute figures only (Abt et al., 2002). Presenting frequencies as percentages for example can conceal differences in absolute size which complicates the interpretation of individual studies (Argyrous, 2005). Furthermore, none of the studies mentioned discussed the methods used for presenting data and the fact that different methods were used complicates the comparison of results further.

Only two studies (Abt et al., 2002; Armatas et al., 2007) have focused solely on the relationship between time and GSF. Armatas et al. (2007) studied the 192 matches played during the World Cups of 1998, 2002 and 2006 using video recordings of each match and determined the time of each goal according to the researcher’s personal observation using the Sportscout video-analysis program. At each tournament GSF was greatest during the second half of matches and greatest during the final 15 minutes, although during the 2006 World Cup the difference in GSF in the second half compared to the first was not significant (52.5% v 47.5%, p > 0.05).
Abt et al. (2002) studied the 2,065 goals scored during four seasons (1994-1995 to 1997-1998) of the ANSL and reported a significant ($p < 0.001$) increase in GSF during the second half of matches compared to the first and a significant ($p < 0.01$) upward trend across consecutive 15 minute periods of play, with the greatest GSF occurring in the final 15 minutes. However this study was limited by the inability to determine whether goals scored in the 47th minute for example, were scored in the 2nd minute of added time in the first half, or the 2nd minute of the second half, which may have reduced GSF recorded prior to half time. Despite this, the large sample size enabled Abt et al. (2002) to conclude that the findings provided strong support for a relationship between time and GSF and that changes in physical and mental condition and team tactics over the course of a match were strongly linked.

### 2.4 Physiological demands

Time-motion analysis applied to football reports outfield players typically cover between 8-13km per match (Di Salvo et al., 2007; Rampinini, Impellizzeri, Castagna, Coutts & Wisløff, 2009; Reilly, 2003; Stolen et al., 2005) in an intermittent fashion, with typical work-to-rest ratios of between 1:6 and 1:10 (Little & Williams, 2007; O’Donoghue, Boyd, Lawlor & Bleakley, 2001) and around 1000 to 1400 changes in activity (Mohr, Krstrup & Bangsbo, 2003). The total distance is covered by a combination of walking (24%), jogging (36%), cruising (20%), sprinting (11%) and moving backwards (7%) (Strudwick & Reilly, 2001). As these movement patterns suggest approximately 90% of energy demands are met via aerobic metabolism (Bangsbo, 1994), with players typically operating at 70-75% VO2max (Bangsbo & Krstrup, 2009). Although a small percentage of energy (10%) is provided by the anaerobic system (Bangsbo, 1994), its importance is significant since high-intensity efforts such as sprinting occur every 30 s (Reilly, 2007) and are critical to the outcome of matches (Sporis et al., 2009; Stolen et al., 2005; Stone & Kilding, 2009). The ability to
perform repeated high-intensity actions is vital and highlighted by the consistent finding that elite players perform significantly more high-intensity running than sub-elite players (Bangsbo, Nøregaard & Thorsøe, 1991; Ekblom, 1986; Mohr et al., 2003).

Playing position affects the demands placed on individual players due to the activities required to fulfil their role. Goalkeepers aside; central defenders perform the least high-intensity running (Mohr et al., 2003) and cover the least distance since their role is traditionally purely defensive (Reilly, 2003). Midfielders have consistently been reported to cover the greatest distance (Bangsbo, 1994; Clark, 2010; Ekblom, 1986; Mohr et al., 2003), although recent research suggests full-backs and attackers cover similar distances with attackers sprinting the most and full-backs performing the most high-intensity activity, indicating an evolution in tactics and positional roles as the intensity of modern football has increased (Clark, 2010; Mohr et al., 2003). Individual differences amongst players of the same position also exist, making it difficult to generalise by position. A holding midfielder, whose primary role is to protect the defence, may not cover as much ground as a box-to-box midfielder (Reilly, 2007). This was illustrated by the study of Mohr et al. (2003) which reported one midfielder covered 10.8km with 2.0km covered at high-intensity and another covered 12.3km with 3.5km at high-intensity.

2.4.1 The impact of resultant fatigue

2.4.1.1 Physiological performance

The physiological demands of the game cause fatigue which can be defined as a decline in physical, mental and technical performance as a result of the requirement to sustain performance (Carling et al., 2005). A large evidence base suggests fatigue developed over the course of a match causes physical performance to deteriorate (Krustrup et al., 2006; Mohr et al., 2003; 2004; 2005), with distance covered, bouts of sprinting and high-intensity
running reduced in the second half of matches, particularly in the final 15 minutes (Mohr et al., 2003). Players with high levels of aerobic fitness suffer less decrement in work-rate as matches progress and whilst training can improve this, other factors including muscle glycogen levels (Saltin, 1973), muscular strength (Rahnama, Reilly, Lees & Graham-Smith, 2003; Rahnama, Lees & Reilly, 2006), team tactics and climatic conditions (Reilly, 2007) must also be considered. Fatigue is not only experienced in the latter stages of matches but also after periods of high-intensity activity, resulting in reduced performance in the minutes immediately afterwards (Reilly, 2007) as shown by Mohr et al. (2003), who reported that after 5 minutes of high-intensity running, performance was reduced by 12% for the following 5 minutes.

2.4.1.2 Technical performance

Most studies have focused on the influence of fatigue on physical performance; however a recent study by Rampinini et al. (2009) investigated the influence on technical skills during a match. Decreases in the number of passes, successful passes and involvements with the ball during the second half compared to the first were reported and it was concluded that fatigue reduced technical skills, although fatigue was more likely reducing the ability to get involved with the ball rather than the actual performance of technical skills (Rampinini et al., 2009). The study was also unable to determine whether the decreases were a result of cognitive function, muscular fatigue, strength or endurance capacity. Zeederberg et al. (1996) and Abt et al. (1998) have shown that shooting ability may be unaffected by fatigue indicating an advantage for attackers over defenders as a match progresses.

2.4.1.3 Cognitive performance

Dehydration as a match progresses can impair cognitive performance (Maughan & Leiper, 1994) and as Burke (1997) asserts, the nature of competitive matches places additional
importance on ensuring adequate hydration since the rules do not allow for regular stoppages for rehydration, increasing the possibility of reduced cognitive performance in the latter stages of matches. Moderate dehydration and sweat losses of 2% body weight are known to impair concentration and vigilance (Baker, Conroy & Kenney, 2007) which would negatively affect performance with lapses in concentration and decision-making errors opening up goal scoring opportunities (Reilly, 2007).

2.5 Tactics

Play often becomes more urgent in the closing stages of matches as the team that is losing commits players forward in an attempt to score, leaving themselves more open to conceding goals themselves (Reilly, 1997) and possibly contributing to increased GSF in the final 15 minutes of matches.

A team’s playing style also affects the physiological demands on players. A slow tempo style, emphasising possession and waiting for opportunities to exploit the defensive line requires players with great speed to exploit openings, whereas a more direct style requires a high tempo with frequent high-intensity actions increasing the overall workload (Carling et al., 2005; Reilly, 2003). Different styles are known more prevalent in different regions of the world, such as in South America where players typically cover around 1.5km less distance per game than their EPL counterparts (Rienzi, Drust, Reilly, Carter & Martin, 2000).

2.5.1 Substitutions

Teams are permitted to make three substitutions during a match which are mainly used to replace tired or injured players, or to make tactical adjustments (Pearce & Hughes, 2001). A study of the 174 substitutions made during Euro 2000 (Pearce & Hughes, 2001) reported that the most common time to make a substitution was between 75-80 minutes. Substitutes
entering a game at this time have an advantage over players who started a match and have been reported to exhibit higher work-rates and cover 25% more distance during the final 15 minutes of play as a result of having maximal strength and full energy stores (Mohr et al., 2003). Similarly Saltin (1973) reported glycogen depleted Swedish club players covered 25% less overall distance than other players. Therefore a fresh attacking substitute may give team an advantage and increase the chances of a goal being scored. However it is also possible that the opposition may introduce a fresh defender to protect a lead, although this can disrupt a cohesive defence (Pearce & Hughes, 2001).

2.6 Residual fatigue

A typical week for a player involves training, tapering, a competitive match and a short period of recovery (Reilly, 2007). If one game is scheduled for the week players will likely train six times in five days with the day after the match free (Bangsbo, Mohr & Krstrup, 2006). However elite players have additional domestic and European cup competitions, as well as international matches which create an irregular and busy schedule. Therefore the demands of matches are exacerbated by a schedule requiring players to perform in consecutive matches with little recovery. In the case of the EPL 50% of the matches played between August and December are played in November and December (not including domestic cup, European and international matches), with the Christmas period being particularly intense when up to four matches may be scheduled over 7-8 days (Odetoyinbo et al., 2009). Playing with insufficient recovery in this manner affects physical performance in subsequent matches (Odetoyinbo et al., 2009), increasing the potential for goal scoring opportunities to arise out of defensive errors. In a study of EPL players performing in three matches over a five day period, Odetoyinbo et al. (2009) observed decreased player work-rates both with and without the ball by the third match. This was considered indicative of a tendency to “cruise” through matches during intense fixture periods perhaps in the knowledge that another game in quick succession was imminent (Odetoyinbo et al., 2009).
Distances covered in each game were similar although the distance covered at high-intensity had decreased by the third game, whilst the distance covered by jogging increased indicating the impact of residual fatigue and implications for performance due to the importance of high-intensity activity for success. A follow-up study by Prozone (2009) using data from the 2008-2009 EPL season reported trends from October to December of decreased total distance covered, fewer high-intensity activities, less distance covered by high-intensity running, less distance covered by sprinting, fewer sprints and increased recovery time taken between bouts of activity. A decrease in first time passing success was also reported (Prozone, 2009) indicating that perhaps fatigue had a residual effect on this skill, but as with the other trends observed it is possible that players were “cruising” through matches in the knowledge that they had others to play in quick succession.

2.7 The impact of a winter break?

Whilst the EPL season runs continuously from August to May, the DBL includes a winter break marking the mid-point of the season (Deutsche Welle, 2008). The main arguments in support of a winter break are that it coincides with poor weather conditions and enables players to recover somewhat from the first half of the season (Reilly, 2007). An eight week winter break was first introduced to the DBL in 1986 to improve the attractiveness and quality of play over the course of the season by avoiding matches being played on poor quality surfaces (Stolz, 2009). For the 2009-2010 season the break was reduced from six weeks to three and a half weeks so that the season could end sooner and allow the German national team to have a longer break before the 2010 World Cup (Deutsche Welle, 2008). The break ran from December 21st to January 14th, coinciding with the busy Christmas and New Year period in the EPL during which time 24 matches (BBC Sport, 2010) were scheduled. Players in Germany usually spend the first week of the break resting at home before returning to a winter training camp, friendly matches and indoor tournaments (Knight, 2011; DFL – German Football League, 2009). During the 2009-2010 winter break, 16 of the
18 teams held training camps commencing December 27\textsuperscript{th} at the earliest and January 3\textsuperscript{rd} at the latest. Of these, 14 held training camps outside Germany in locations including Spain, Turkey, Austria, South Africa and Dubai. Training camps are generally held in warmer climates than Germany to ensure maximum training time, but increasingly training camps have become more sponsorship and promotion oriented reducing the time players are able to spend resting (Knight, 2011). For example Bayern Munich’s 2011 tour was scheduled to involve two 90 minute training sessions per day, a friendly match and numerous promotional activities (Knight, 2011).

Few studies have compared leagues with a winter break with those without. Although a UEFA study (Ekstrand et al., 2004) reported injury incidence was significantly higher during the second half of the season in leagues without a winter break compared to those with one (14.8 v 7.8 injuries per 100 hours of exposure, p < 0.05). The difference in injury incidence was even greater when the final two months of the season were compared (25.8 v 6.5 injuries per 1000 hours of exposure, p < 0.01) and may be indicative of the impact of residual fatigue over a season. To date no studies have investigated goal scoring patterns over the course of a season, or the influence of a winter break on goal scoring patterns.

2.8 Summary

Performance analysis is widespread in professional football and studies have influenced the tactics adopted by teams (James, 2006), signifying the level of importance it is given. Although a general lack of standardisation in the reporting of the methods used to investigate goal scoring patterns exists, a large body of research provides strong support for a relationship between time and GSF, with more goals scored in the second half of matches compared to the first half and more goals scored in the final 15 minutes than any other period (Abt et al., 2002; Acar et al., 2009; Armatas & Yiannakos, 2010; Armatas et al., 2009; Armatas et al., 2007; Grant et al., 1999a; Jinshan et al., 1993; Reilly, 2003; Ridder et al.,
The explanations asserted for this relationship are multi-factorial, centring on factors which change over the course of a match such as physical and mental condition and tactics (Abt et al., 2002). Whilst a pattern over the course of a match is clearly evident, it is not known whether goal scoring patterns are the same at the beginning of a season as at the end of a season since previous studies have only investigated a season or competition as a whole. Residual fatigue has been shown to be carried over from one match to the next (Odetoyinbo et al., 2009) which may increase GSF in the latter stages of matches at the end of a season. Also yet to be considered is the potential impact of a winter break, which may allow players to return for the second half of the season in a less fatigued state with implications for GSF.
Chapter 3

Methods

3.1 Matches

All 380 matches played in the EPL and all 306 matches played in the DBL during the 2009-2010 season were studied, making a total of 686 matches. The EPL season ran from August 15th 2009 to May 9th 2010 for a total of 268 days. The DBL season ran from August 7th 2009 to May 8th 2010, with a 25 day winter break between December 21st and January 14th. The first half of the season ran for 136 days and the second for 114 days making a total of 250 days.

3.2 Research design

The time of each goal in the EPL was recorded according to the time indicated by the EPL results page (BBC Sport, 2010) of the British Broadcasting Corporation’s Sport website. The time of each goal in the DBL was recorded according to the time indicated on the official website of the DBL (DFL – German Football League, 2010). This goal scoring data was then entered into a Microsoft Excel 2007 (Excel) (Microsoft Corporation, Redmond, Washington) spreadsheet to create frequency counts for each minute of play from 1 to 90+ for each half of the season and totalled for each league. Goals scored during first half stoppage time were recorded as having been scored in the 45th minute (45+) and goals scored during second half stoppage time were recorded as scored in the 90th minute (90+), in line with previous studies (Abt et al., 2002; Armatas & Yiannakos, 2010; Armatas et al., 2009; Armatas et al., 2007, Yiannakos & Armatas, 2006). For the purpose of the analysis both league seasons were divided into a first and second half. In the DBL the halfway point of the season was denoted by the winter break, by which point each team had played half of their matches resulting in
two equal halves containing 153 matches each. A halfway point was created for the EPL and
defined as having occurred once half of the total 380 matches had been played; resulting in
two equal halves containing 190 matches each.

Once frequency counts had been created for each minute of play Excel was used to calculate
the following for each league per half and full season:

a) Goal scoring frequency per 45 minutes (a. First half plus stoppage time (1-45+), b. Second half plus stoppage time (46-90+)).

b) Goal scoring frequency per 15 minutes (a. 1-15, b. 16-30, c. 31-45 plus stoppage
time, d. 46-60, e. 61-75, f. 76-90 plus stoppage time).

In order to ensure the availability of data in the event of a website becoming unavailable, the
date, fixture, result and time of goals for every match was recorded in two separate
spreadsheets and backed up on a university network, an online backup and on two
computers.

3.3 Reliability evaluation

This study required the design of a new data collection method, which needed to be shown to
be both accurate and repeatable to demonstrate reliability (Hughes, Cooper & Nevill, 2002).
Both an inter-operator and an intra-operator reliability study were carried out to establish the
objectivity of the method, which is acknowledged to be an important component of reliable
studies (O’Donoghue, 2010).

Whilst a good level of agreement in intra-operator reliability studies merely shows that the
operator is skilled at using the particular system accurately (O’Donoghue, 2007), it was still
important to carry out an intra-operator reliability study to identify whether changes needed to be made to the data collection procedures before undertaking an inter-operator reliability study (O’Donoghue, 2007). The intra-operator reliability study involved the collection of goal scoring data for all 686 matches to be used in the study on two separate occasions by the same operator. Chi-square analysis of this data resulted in perfect agreement ($p = 1.000$) between both data collections. The inter-operator reliability study involved goal scoring data for all 686 matches to be used in the study being collected by two different operators using the data collection procedures designed for this study. Chi-square analysis of both sets of data produced by these operators also resulted in perfect agreement ($p = 1.000$). The results of both the intra and inter-operator reliability studies indicated that the research design developed for this study was repeatable, objective and appropriate.

3.4 Data analysis

Data was analysed using SPSS 16.0 (SPSS Inc., Chicago, Illinois). Chi-square analysis was used to determine any statistically significant differences in GSF per 45 minute period, per 15 minute period, and between the final 15 minutes of play per half season for each league. Chi-square analysis was also used to identify any statistically significant differences in GSF during the final 15 minutes of matches in the second half of the season between the two leagues, for an effect of league, time of season and a league x time interaction. The level of significance in all cases was set at $p \leq 0.05$. 
A total of 1,919 goals from 686 matches were analysed. As shown in Figure 1, chi-square analysis revealed a significant difference in goals scored in the second half compared to the first half in both the EPL and DBL (EPL: 56.1% v 43.9%, p < 0.001; DBL: 56.1% v 43.9%, p < 0.001).

Figure 1. The frequency of goals scored in the first and second halves of matches in the EPL and DBL during the 2009-2010 season. * Significantly different from first half at p < 0.001. ** Significantly different from first half at p < 0.001.

In both leagues most goals were scored during the final 15 minute period (Figure 2) and chi-square analysis revealed significant differences between the final 15 minute period and the first (EPL: 23.5% v 11.3%, p < 0.001; DBL: 22.1% v 12.6%, p < 0.001), second (EPL: 23.5% v 14.4%, p < 0.001; DBL: 22.1% v 13.9%, p < 0.001), third (EPL: 23.5% v 18.1%, p = 0.007; DBL: 22.1% v 17.4%, p = 0.031), fourth (EPL: 23.5% v 16.5%, p < 0.001; DBL:
22.1% v 17.1%, p = 0.020) and fifth (EPL: 23.5% v 16.1%, p < 0.001; DBL: 22.1% v 17.0%, p = 0.017) periods for both leagues.

Figure 2. The frequency of goals scored in each 15 minute period of play during matches in the EPL and DBL during the 2009-2010 season. * Significantly different from all other 15 minute periods all at p < 0.05. ** Significantly different from all other 15 minutes periods all at p < 0.05.

A 5.8% increase in GSF during the final 15 minutes of play in the second half of the EPL season compared to the first was observed, with chi-square analysis revealing this was not statistically significant (26.5% v 20.7%, p = 0.227). A 3% decrease in GSF was observed during the same final 15 minute period of play during the second half of the DBL season compared to the first and chi-square analysis revealed this difference was not significant (20.6% v 23.6%, p = 0.613). The 5.8% increase in EPL and 3% decrease in DBL GSF represents an 8.8% swing, although no significant difference in GSF during the final 15 minute period of play during matches in the second half of the season was observed between the EPL and DBL (26.5% v 20.6%, p = 0.384) as shown in Figure 3.
Figure 3. The frequency of goals scored during the final 15 minutes of matches played in the first half of the season compared to the second half of the season in the EPL and DBL during the 2009-2010 season.

Analyses revealed no league x time interaction (p = 0.240) and no effect for time of season (p = 0.570). As shown in Figure 4 there was an effect for league on GSF during the final 15 minutes of play (p = 0.010).

Figure 4. Effect of league on total number of goals scored during the final 15 minutes of matches in the second half of the season compared to the first in the EPL and DBL during the 2009-2010 season.
Chapter 5

Discussion

5.1 Main findings

The results of the present study indicate that in both the EPL and DBL GSF was significantly greater in the second half of matches (EPL: 56.1% v 43.9%, p < 0.001; DBL: 56.1% v 43.9%, p < 0.001; Figure 1) and greatest in the final 15 minutes of matches compared to all other 15 minute periods (EPL: 23.5%, all at p < 0.05; DBL 22.1%, all at p < 0.05; Figure 2). Although no significant differences were observed in GSF in the final 15 minutes of matches in the second half of the season compared to the first in either league (EPL: 26.5% v 20.7%, p = 0.227; DBL: 20.6% v 23.6%, p = 0.613), GSF in the EPL increased by 5.8% in the final 15 minutes of matches in the second half of the season compared to the first, whereas GSF in the DBL during the same period decreased by 3% (Figure 3). These findings represent an 8.8% swing between EPL and DBL which was supported by the finding of a main effect for league (p = 0.010) on GSF during the final 15 minutes of play in the second half of the season (Figure 4), although no league x time interaction (p = 0.240) was observed (Figure 4). Therefore the inclusion of a winter break in a competitive league schedule appears to result in a reduction in GSF in the final 15 minutes of matches during the second half of the season when compared with a league without such a break.

5.1.1 Goal scoring over the course of a match

The findings of the present study add further support to the concept of a relationship between time and GSF, where GSF is greater in the second half compared to the first and greater in the final 15 minutes of matches than all other periods (Abt et al., 2002; Acar et al., 2009; Armatas et al., 2007; Armatas & Yiannakos, 2010; Armatas et al, 2009; Grant et al., 1999a;
Jinshan et al., 1993; Reilly, 2003; Ridder et al., 1994; Yiannakos & Armatas, 2006). Previous research has reported the same pattern in the 1990 World Cup (Jinshan et al., 1993), the 1991-1992 Dutch professional league (Ridder et al., 1994), the 1991-1992 Scottish League season (Reilly, 2003), the Australian National Soccer League (ANSL) 1994-1998 (Abt et al., 2002), the 1998 World Cup (Armatas et al., 2007; Grant et al., 1999a), the 2002 and 2006 World Cups (Armatas et al., 2007), the 2004 European Championship (Euro 2004) (Yiannakos & Armatas, 2006), the 2006 World Cup (Acar et al., 2009; Armatas & Yiannakos, 2010) and the 2006-2007 Greek “SuperLeague” (Armatas et al., 2009), indicating its prevalence worldwide at top international, major club and semi-professional levels of the game. The present study adds to this evidence base by identifying its presence in the EPL and DBL, neither of which had previously been investigated. A number of factors relating to aspects of play which change over the course of a match such as physical and mental condition and team tactics have been strongly linked as causative factors of this relationship (Abt et al., 2002).

5.1.1.1 Physiological factors

From a physiological perspective, the development of fatigue over the course of a match and the subsequent deterioration in physical performance in the latter stages has received much support (Krustrup et al., 2006; Mohr et al., 2003; 2004; 2005). Time-motion analyses have reported reductions in distance covered, bouts of sprinting and high-intensity running in the second half of matches (Bangsbo et al., 1991; Bangsbo, 1994; Mohr et al., 2003) which are particularly evident during the final 15 minutes (Mohr et al., 2003). Such reductions in physical performance could affect GSF during matches, although the precise magnitude of such an impact on GSF is unknown (Abt et al., 2002). The degree to which fatigue affects individual players also differs depending on their playing position and role in the team. For example, the demanding nature of modern football requires attackers and defenders to perform more anaerobic activities than midfielders (Carling et al., 2005), whilst defenders
typically perform less high-intensity running and sprinting (Mohr et al., 2003). Despite similarities in the activity profiles of defenders and attackers, Reilly (2003) reported that defenders experience a greater deterioration in physical condition than other positions, which coupled with the suggestion that shooting ability is unaffected by fatigue (Abt et al., 1998; Zeederberg et al., 1996) affords attackers an advantage over defenders in the latter stages of matches, increasing the likelihood of goals being scored. Although shooting ability may be unaffected by fatigue (Abt et al., 1998; Zeederberg et al., 1996) it has been asserted that other aspects of technical performance such as the number and success rate of short passes are affected due to reduced cognitive function, muscular strength or endurance capacity (Rampinini et al., 2009), which may cause an increasing number of defensive errors or turnovers of possession presenting goal scoring opportunities.

Dehydration due to physical exertion can impair cognitive performance (Maughan & Leiper, 1994) and result in lapses in concentration and decision making, thus increasing the likelihood of defensive errors increased GSF (Reilly, 2007). A study of the ANSL (Abt et al., 2002) attributed increased GSF prior to half time and in the final 5 minutes of matches to such lapses in concentration. The present study similarly reports that GSF during the period prior to half time (31-45+ min) exhibited the second highest GSF of the six periods, suggesting that perhaps the conclusion drawn by Abt et al. (2002) that players’ attention is disrupted by the prospect of half-time may be applicable. However it is perhaps more likely that these findings can be explained by the manner in which both studies were conducted, with goals scored during time added on at the end of the half recorded as occurring in the 45th minute (45+) making it unsurprising that this minute should see a high GSF.

5.1.1.2 Tactical factors

From a tactical perspective, the style of play adopted by a team can affect the physiological demands placed on its players and their subsequent work-rate. A slow tempo, possession
style, involving probing for opportunities to penetrate the defence requires players to be able
to perform high speed movements when such an attacking opportunity presents itself,
whereas a more direct style requires players to perform at a high tempo at all times both with
and without possession increasing the overall work-rate required (Carling et al., 2005; Reilly,
2003). A high tempo and increased urgency in the latter stages of matches has been
suggested to contribute to the trend for increased GSF in the final 15 minutes of matches
since it is during this period that losing teams become increasingly likely to commit players
forward in an attempt to score, making them more vulnerable to conceding themselves (Abt
et al., 2002; Carling et al., 2005; Reilly, 1997). It has also been reported that the greatest
amount of critical incidents requiring players to contest possession occur during the final 15
minutes (Carling et al., 2005) which may contribute to greater fatigue and increases in goal
scoring opportunities during this period.

Substitutions are used by coaches to influence the outcome of matches, with the most
common time to make a substitution (75-80 minutes) reported by Pearce and Hughes (2001)
during Euro 2000 corresponding with the time during which GSF is greatest (76-90+
minutes). Substitutes entering a match at this time have an advantage since they have full
energy stores, with muscular strength (Mohr et al., 2003) and glycogen stores (Saltin, 1973)
greater than those players who started the match. Furthermore it has been reported that
during the final 15 minutes of play substitutes may cover 25% more distance than players
who started a match (Mohr et al., 2003). This advantage may result in greater GSF during
this period if substitutions are utilised by the coach to take advantage of matching up a fresh
attacker against a tiring defence (Pearce & Hughes, 2001).

5.1.2 Goal scoring over the season

Whilst no significant differences were observed in GSF during the final 15 minutes of
matches in the second half of the season compared to the first in either the EPL or DBL
(EPL: 26.5% v 20.7%, p = 0.227; DBL: 20.6% v 23.6%, p = 0.613), the present study adds to existing knowledge since it is the first to investigate whether GSF differs at the start of a season to the end of a season. Previous research has investigated goal scoring patterns predominantly by reporting the results based on a season or competition as a whole (Abt et al., 2002; Acar et al., 2009; Armatas et al., 2007; Armatas & Yiannakos, 2010; Armatas et al., 2009; Grant et al., 1999a; Jinshan et al., 1993; Reilly, 2003; Ridder et al., 1994; Yiannakos & Armatas, 2006). Although no significant differences were found, a 5.8% increase in final 15 minute GSF in the EPL and a 3% decrease in the DBL were found when comparing the second half of the season to the first, representing an 8.8% swing. A main effect for league (p = 0.010) on GSF during the final 15 minutes of play during the second half of the season was also reported (Figure 4) indicating this 8.8% swing should be of interest. These results indicate that a rest factor as a result of a winter break may be at play in the DBL. Similar to the goal scoring patterns present over the course of a single match, the reasons for the difference in GSF between the two leagues over the course of the season may also be multifactorial.

5.1.2.1 Residual fatigue

From a physiological perspective, the demands of matches are exacerbated by league schedules which require players to play consecutive matches with little recovery. If only one match is scheduled for a week, players are typically required to train six times in five days (Bangsbo et al., 2006); however when domestic and European cup and international matches are considered, clearly additional demands are placed on players providing little opportunity for recovery. In the case of the EPL, 50% of the matches scheduled between August and December are played in November and December, including the Christmas period when up to four matches may be scheduled over 7-8 days (Odetoyinbo et al., 2009). Such an intense schedule has been shown to affect the performance of players, with total distance covered, distance covered at high-intensity, number of sprints, distance covered by sprinting, the
amount of work performed both with and without the ball and an increase in recovery time between activities reported (Prozone, 2009; Odetoyinbo et al., 2009). Furthermore, this apparent residual fatigue has been linked to a reduction in first time passing success rate (Prozone, 2009) indicating an impact on technical performance. Given the links between fatigue and defensive errors and resultant increases in goal scoring opportunities it is reasonable to suggest that the residual fatigue caused by playing consecutive matches with insufficient recovery may lead to an increase in GSF in the final 15 minutes as the season progresses. Whilst the demanding EPL schedule places demands on players which may cause a residual fatigue negatively impacting subsequent performances, the potential for players to pace their effort or “cruise” through matches during particularly intense fixture periods must also be considered. Pacing of effort could for example explain the increased amount of time spent jogging and decreased time performing high-intensity activity reported by Prozone (2009) during such periods.

As the 2009-2010 DBL schedule incorporated a three and a half week winter break between December 21st and January 14th (Deutsche Welle, 2008); no fixtures were played at a time when the EPL schedule included 24 matches (BBC Sport, 2010). The fact that players in the DBL were able to rest whilst EPL players were continuing to play through a congested fixture period, may have contributed to the 8.8% swing and main effect for league on GSF observed in the current study and further suggests a rest factor which may have allowed DBL players to recover somewhat from the first half of the season (Reilly, 2007). Although in the case of the DBL players don’t necessarily rest for the duration of the winter break. Players traditionally get the first week of the break off to rest, before returning to a mix of a winter training camp, friendly matches and indoor tournaments (Knight, 2011; DFL – German Football League, 2009). An increasing number of training camps undertaken by DBL teams are in warm climates to allow the maximum amount of training time and in some cases are specifically chosen to provide lucrative sponsorship and promotional opportunities (Knight, 2011). The inclusion of players in promotional activities, added to their requirements to train
and participate in scheduled friendly matches means that although they are not playing in competitive matches players get less time to rest and prepare for the second half of the season than they could (Knight, 2011).

Further evidence for the existence of residual fatigue and the effect of a winter break can be found in injury incidence literature. A UEFA study (Ekstrand et al., 2004) reported injury incidence was significantly higher during the second half of the season in leagues without a winter break than those with one, especially in the final two months of the season (25.8 v 6.5 injuries per 1000 hours of exposure, p < 0.01), further suggesting the rest period afforded by a break lessens the impact of residual fatigue.

5.1.2.2 Tactics

From a tactical perspective it is possible that the increased urgency suggested to occur at the end of matches (Abt et al., 2002; Carling et al., 2005; Reilly, 1997) is even greater during the closing stages of a season, when teams attempting to win a championship, qualify for European competition or avoid relegation become more likely to adjust their tactics to enable them to score and win matches. Similarly teams may approach particular matches towards the end of a season simply seeking not to be beaten, and set themselves up to be defensively strong, such as was observed during the first round of matches at the 2010 World Cup resulting in few goals being scored (Gibson, 2010). The author is not aware of any studies which have investigated such issues, which should be considered for future research.

5.2 Practical implications

A number of practical implications arise from the results of the present study. It has been shown that an advantage can be gained if a team’s players are better able to perform for the duration of a match with less fatigue than their opponents, particularly during the final 15
minutes of matches. Coaches can implement a number of strategies to achieve this including training, nutritional, and tactical interventions.

5.2.1 Training

It is known that players with high levels of aerobic fitness are better able to sustain work-rates, recover more quickly from high-intensity efforts (Reilly, 2007) and express their technical skills to their fullest (Reilly & Doran, 2003), therefore appropriate, periodized fitness training throughout a season should be implemented (Mohr et al., 2003) incorporating elements of endurance, strength, speed, power, agility and flexibility (Barnes, 2007; Reilly, 2007). Whilst the physical preparation of players aims to maintain an optimal level of fitness throughout a season there is evidence to suggest significant reductions in fitness occur towards the end of a season due to the lack of opportunities for specific fitness training due to the tactical preparations required for matches (Casajus, 2001; Clark, Edwards, Morton & Butterly, 2008; Mohr, Krstrup & Bangsbo, 2002). Therefore time must be managed effectively by ensuring tactical practices are conducted at intensities appropriate to stress the appropriate energy systems to allow fitness levels to be maintained whilst also allowing sufficient recovery between matches (Gamble, 2007).

5.2.2 Nutrition

Since the primary cause of fatigue and a reduction in work-rate is energy availability, and pre-match glycogen stores have a protective effect against fatigue (Saltin, 1973), nutritional preparation and a reduction in training volume and intensity in the days immediately preceding a match to maintain glycogen stores, the consumption of sports drinks containing glucose and a post-match nutritional strategy to promote recovery which are known to improve players’ ability to last 90 minutes (Burke, 1997; Carling et al., 2005) are advisable. There is a significant body of research suggesting a high carbohydrate meal eaten 3-4 hours
before a match will elevate carbohydrate stores and enable improved performance (MacLaren, 2003), whilst post-match the immediate considerations should be to replenish fluid and carbohydrate losses in the first two hours post-exercise since glycogen-synthesizing enzymes are most active at this time (Ivy, 2004; MacLaren, 2003).

5.2.3 Squad rotation

Substitutions can be utilised by a coach in order to replace fatigued players, with the advantage being that the player being introduced will have full muscle glycogen stores and be better able to sustain a work-rate than both the player being withdrawn and the players who have been on the pitch from the kick-off (Carling et al., 2005). Therefore if a fresh attacking player is brought on this player will have an advantage over the defence and increase the possibility of a goal being scored, although it is also possible that the opposition may bring on a fresh defender to preserve a lead, although this has been shown to potentially disrupt a cohesive defence (Pearce & Hughes, 2001). Coaches may also consider a policy of squad rotation to minimise the impact residual fatigue may have on player performance throughout a season (Abt et al., 2002) and to ensure players are in peak condition for the most important games.

5.3 Study limitations

The present study was limited by a lack of statistical power when testing for significant differences in GSF between the leagues, since percentage values had to be used rather than actual GSF. Converting actual GSF to percentages required standardising actual GSF to a base value of 100 which may have concealed differences in absolute numbers therefore limiting statistical power (Argyrous, 2005). However, using percentages was necessary when comparing GSF between the two leagues to eliminate the effect of the difference in the number of matches played in each league. Actual GSF was used for all other data analyses.
within the leagues. Also since the present study used secondary sources for goal scoring times it was not possible to ascertain exactly who collected the data, how it was collected or how it was determined whether a goal was scored in one minute or another. This is a limitation shared with many studies of goal scoring patterns.

5.4 Conclusion

In conclusion, the same pattern of goal scoring was reported in both the EPL and DBL with most goals scored in the second half of matches and specifically during the final 15 minutes of matches. Furthermore the inclusion of a winter break in the DBL resulted in a reduction in GSF in the final 15 minutes of matches in the second half of the season which was part of an 8.8% swing between the EPL and DBL, suggesting the winter break affected GSF by introducing a rest factor. These findings add to the body of knowledge reporting a relationship between time and GSF, as well as suggesting that goal scoring patterns are different at the beginning of a season compared to the end and that the inclusion of a winter break affects GSF by introducing a rest factor.

The practical implications of this study centre primarily on the ability of players to perform at their best for a full match throughout the season. Players who can minimise the effects of fatigue during a match and residual fatigue throughout a season will gain an advantage over their opponents. A number of strategies including training, nutritional and tactical interventions can help minimise the effects of fatigue.

5.5 Future research recommendations

Research into goal scoring patterns is of continued importance due to the constantly evolving nature of professional football and the implications for coaches and players. Future studies should consider comparing leagues with an equal number of games as this will increase
statistical power. Similar studies could be carried out investigating additional performance indicators such as player work-rate to see if changes in GSF are correlated with changes in work-rate. Adding injury data to work-rate data would enable the development of a more accurate measure of how a league schedule affects these variables which would have implications for national team preparation and performance at summer tournaments.
Chapter 6

References


Chapter 7

Appendices

Appendix 1: Dissertation tutorial record sheets