The effect of dismissals on work-rate in English FA Premier League soccer

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Abstract

The current paper studies the effect of dismissals on work-rate in English FA Premier League soccer. The study included 28 matches where a team had a player dismissed while they were winning by a single goal or the score was level. Two types of match were compared; matches where the team reduced to 10 players maintained the drawing or winning score-line until the end of the match and matches where they failed to do so. Similar reductions in work-rate variables were observed for teams reduced to 10 players and for their opponents after the dismissal irrespective of the outcome of the match. A significant interaction effect of team (the team reduced to 10 players v the team that played with 11 players throughout the match), match period (before v after the dismissal) and type of match was found on the percentage of time spent in the defending and attacking thirds (p < 0.05). The teams reduced to 10 players tended to spend more time in the defending third and less time in the attacking third after the dismissal. This pattern was observed to a greater extent in matches where the 10 players successfully maintained or improved the score between the dismissal and the end of the match. This suggests that outnumbered teams played strategically to defend the match status, rationing their efforts after the dismissal.

Key words: situational variables, high speed running, sprinting.

1. Introduction

Soccer is a team game that involves repeated bouts of high intensity activity performed on a backdrop of low intensity recovery activity (Reilly, 2003). It is important to understand the physical aspects of soccer in order to inform the development of conditioning aspects of players training programmes (Carling et al., 2008). There has been a considerable volume of research into the activity involved in competitive soccer using a variety of methods (Carling and Bloomfield, 2013). Positional role has been found to influence the distance covered by soccer players using high intensity running and sprinting (Di Salvo et al., 2009; Bradley et al., 2009; Gregson et al., 2010). Situational variables, including venue, quality of opposition, period within the game, match status (score-line) and the type of competition, influence sports performance at the behavioural level (Gómez et al., 2013). Furthermore, combinations of these situational

variables have been found to influence sports performance (Taylor et al., 2008; Gómez et al., 2013). Quality of opposition influences both tactical aspects of soccer as well as the outcomes of on-the-ball events (Taylor et al., 2008). With respect to physical aspects of the game, teams finishing in the top 5 positions of the English FA Premier League cover significantly less distance using high speed running when opponents have the ball than other teams in the league (Di Salvo et al., 2009). Teams in the top 5 positions also cover significantly less distance sprinting than other teams in the league (Di Salvo et al., 2009). Match status has been found to influence work-rate in soccer with players spending a greater percentage of match time performing high intensity activity when the score was level than when their teams were winning or losing (Clark and O'Donoghue, 2013).

One factor that was not covered in Gómez et al.'s (2013) review of situational variables influencing sports performance is numerical superiority. When a soccer team has a player dismissed, it has to compete with a numerical disadvantage. Dismissals are often critical to the outcomes of matches but there are still occasions where teams perform well despite being outnumbered. It is often said "it is sometimes harder to play against 10 men than against 11" and there is evidence that teams are becoming more effective when they have to play with fewer men than the opponents (http://www.theguardian.com/sport/blog/2010/feb/11/the-question-teams-better-10-men, accessed 15/7/15). Therefore, the performance of teams in matches where players have been dismissed is an important aspect of soccer that is worth investigating. Carling and Bloomfield (2010) analysed the work-rate of 7 players who played a full match where there was a dismissal after 5 minutes. They found an increase in distance covered using high intensity running from the first 15 minutes to the remainder of the first half with a significant reduction in high intensity running distance in the second half. The main limitation of the study was that it involved a single match where a dismissal occurred and so the findings are difficult to generalise. The work-rate of the team with a player sent off was not compared with that of the opponents who had numerical superiority. Therefore, further research is needed to investigate soccer matches where players have been dismissed.

Knowledge is needed about differences in work-rate between teams that perform relatively successfully and unsuccessfully in matches where there have been dismissals. Therefore, the purpose of the current investigation was to compare soccer performance before and after a dismissal for both teams within matches of different outcomes.

2. Methods

2.1. Hypotheses
The current investigation has impact by distinguishing matches where teams capitalised from having a numerical advantage after a dismissal from matches where they failed to do so. Analysis of real-world sports performance does not have the rigor of controlled laboratory experiments. However, the proposed approach of distinguishing matches of different outcomes brings performance analysis research closer to experimental designs while maintaining the advantage of ecological validity through analysing actual sports performance. The outcome of matches with respect to the team that had a player dismissed is included as a factor. This factor is referred to as "match type" and is included

as an independent variable. Technically outcome of the match is not known until the end of the match, but we hypothesise that teams achieving different outcomes have done so with differing work-rates during matches. There are three independent variables of interest within the study:

- Type of match – matches where the team reduced to 10 players achieved different results.
- Team – the team that was reduced to 10 players and the team that played with 11 players for the entire match.
- Period of the match – before the dismissal and after the dismissal.

There are 3 main effects and 4 interaction effects that can be tested. However, some of these do not involve the dismissal event. Therefore, the current investigation tested the following hypotheses:

- Null Hypothesis 1. The interaction of team, match type and period of the match has no significant effect on any work-rate variable. If this hypothesis is rejected it means that the two teams were influenced in different ways by the dismissal and that this also differed between matches of differing outcomes.
- Null Hypothesis 2. The interaction of team and period of the match has no significant effect on any work-rate variable. If this hypothesis is rejected it means that the two teams were influenced in different ways by the dismissal but this did not differ between matches of differing outcomes.
- Null Hypothesis 3. The interaction of match type and period of the match has no significant effect on any work-rate variable. If this hypothesis is rejected it means that the dismissal has influenced the match in a similar way for each team but that matches of different outcomes were influenced in different ways.

2.2. Matches

The scope of the study was English FA Premier League matches where there was a single red card that occurred in the first 60 minutes of the match. A further delimitation was that matches where a team was already losing before they had a player sent off as well as matches where a team was winning by more than a single goal when they had a player sent off were excluded from the study. The matches of interest were classified into the following four types:

- Matches where a team was level when a player was dismissed and they ended up losing.
- Matches where a team was level when a player was dismissed and they were able to avoid losing.
- Matches where a team was leading by a single goal when a player was dismissed and they failed to hold onto their lead.
- Matches where a team was leading by a single goal when a player was dismissed and they were able to hold onto their lead.

The authors identified 28 matches from the 2012-13, 2013-14 and 2014-15 seasons that satisfied the criteria for inclusion in the study. There were 14, 5, 5 and 4 matches for the

four match types identified above respectively. It was, therefore decided to use two broader groups of matches:

- Matches where a team was winning by a single goal or drawing when they had a player sent off and failed to maintain the match status to the end of the match (n = 19).
- Matches where a team was winning by a single goal or drawing when they had a player sent off and maintained (or improved) the match status by the end of the match (n = 9).

2.3. Data Sources

Prozone Sports provided the player trajectory data for all 28 matches satisfying the criteria for inclusion in the study. The data have been through the manual verification process described by Di Salvo et al. (2009) whereby an average of 42% of a players' data are manually corrected. The data recorded by the Prozone^{TM} system have been validated against data recorded by electronic timing gates (Di Salvo et al., 2006) as well as manual recording of occasions where players perform cross boundaries between different areas of the playing surface (O'Donoghue and Robinson, 2009). Both studies concluded that Prozone data are sufficiently reliable for the data to be used for practical and research purposes.

2.4. Variables

The work-rate of the players was represented by a set of 12 dependent variables that were expressed per minute to allow comparisons between match periods of different lengths before and after dismissals:

- Distance covered (m.min^{-1}).
- High speed running (HSR) distance covered (m.min^{-1}).
- Sprinting distance (m.min^{-1}).
- The percentage of sprints that are explosive (as opposed to leading) sprints.
- Number of sprints performed per minute.
- Number of sprints of 0m to less than 10m per minute.
- Number of sprints of 10m to less than 20m per minute.
- Number of sprints of 20m or further per minute.
- Percentage time spent in the defending third.
- Percentage time spent in the middle third.
- Percentage time spent in the attacking third.

High speed running distance includes all movement at speeds of 5.5 m.s^{-1} (19.8 km.hour^{-1}) or greater and sprint distance includes all movement at speeds of 7 m.s^{-1} (25.2 km.hour^{-1}) or faster. Di Salvo et al.'s (2009) definitions of sprints were used in the current investigation. Sprints counted in the current investigation had a duration of 0.5s or longer. An explosive sprint is one where the acceleration to sprinting speed (7 m.s^{-1}) from a speed of less than 4 m.s^{-1} (14.4 km.hour^{-1}) was achieved in less than 0.5s prior to the sprint. All other sprints were classified as leading sprints. The current study considers team performance based on the average outfield player rather than individual player performances.

The English FA Premier League aim to standardise pitch size to 105m x 68m (http://www.theguardian.com/football/blog/2014/oct/29/pochettino-pitch-size-does-matter, accessed 8/10/15). Therefore, the middle third of the pitch was considered to be the middle 35m of the pitch. The percentage of time spent in each third of the field was determined for the average outfield player on each team.

A system was developed in Matlab version 8.5.0 (Mathworks Inc., Natick, MA) to read each player trajectory file and determine the dependent variable values for match periods before and after the dismissals. The matches in which player performances occurred as well as details of the teams they played for and the times of red cards were stored in a comma separated file that was loaded into the Matlab system.

2.5. Data Analysis
There were 776 players who competed in the 28 matches included in the current investigation. Once this processing had been completed, the goalkeepers were removed from the data leaving 718 outfield player performances.

The mean for each distance, frequency and percentage time variable before and after the red card event was determined for each team within the 28 matches reducing the data to 56 team performances. These variables were then standardised to be distances and frequencies per minute to account for the different times before and after dismissals. Statistical analysis was then done using SPSS version 22 (SPSS: an IBM company, Amarouk, NY). The residual values of these 12 dependent variables were saved during an exploratory ANOVA test that included team and match period (before or after the red card) as repeated measures and type of match (according to outcome) as a between subjects effect. The residual values were tested for normality using a series of Shapiro-Wilk tests applied to each variable for each of the 2 x 2 repeated measures of interest. There were 41 of these 48 tests where the variables were deemed to be sufficiently normal ($p > 0.05$). Therefore, parametric procedures were applied to allow the main effects and interactive effects of interest to be investigated. The unit of analysis for the study was match. Team was included as a repeated measure of 2 values (the team that was reduced to 10 players and the team that had 11 players throughout the match). Match period was an additional repeated measure of 2 levels (the period before the dismissal and the period after the dismissal). Type of match was a grouping variable that classified matches according to whether the team reduced to 10 men held on to (or improved) the match status from the time of dismissal to the end of the match or not.

An independent samples t-test revealed no significant difference between the time of 34 ± 19 minutes when dismissals occurred in the 9 matches where the team with 10 men held on to (or improved) the match status and the 34 ± 14 minutes in the other 19 matches ($p = 0.981$). Therefore, the authors decided not to include the time of the dismissal as a covariate within the study. A p value of less than 0.05 was deemed to be significant for all variables except the frequency of the three different lengths of sprint (where p values less than 0.017 were deemed to be significant) and the percentage of time players spent in different thirds of the pitch (where p values of less than 0.017 were deemed to be significant). These lower threshold p values were used to avoid Type I Error inflation. Partial eta squared values (η^2) were computed as effect sizes for any statistically significant results.

3. Results

Table 1 shows the 8 movement variables before and after dismissals for the team reduced to 10 players and the team that played with 11 players throughout the match for both types of match. The distance covered per minute ($F(1,26) = 35.8$, $p < 0.001$, $\eta^2 = 0.58$) and the high speed running distance per minute ($F(1,26) = 6.7$, $p = 0.016$, $\eta^2 = 0.21$) were significantly lower after the dismissal than they were before the dismissal. No other variables shown in Table 1 were significantly influenced by match period ($F(1,26) < 2.6$, $p > 0.05$). Neither team nor type of match had a significant influence on any of the dependent variables ($F(1,26) \leq 2.9$, $p > 0.05$) and there were no interaction effects on any of the dependent variables shown in Table 1 ($F(1,26) \leq 2.5$, $p > 0.05$).

Table 1. Dismissal Results.

Performance variable	Matches where 10 players failed to hold onto match status (n=19)				Matches where 10 players held on to win or draw (n=9)			
	Team with 10 players		Team with 11 players		Team with 10 players		Team with 11 players	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Distance (m.min^{-1})	118.6±4.6	112.0±4.3	117.7±7.5	110.0±3.7	119.2±6.2	111.1±4.0	118.1±6.4	110.1±5.8
HSR Distance (m.min^{-1})	11.3±1.5	10.4±1.7	11.4±2.8	10.5±1.8	11.8±2.3	10.2±1.9	11.0±1.8	10.4±1.7
Sprint Distance (m.min^{-1})	2.9±0.7	2.8±0.8	3.1±0.9	2.8±0.6	3.1±1.2	2.8±0.9	2.9±0.8	2.7±0.9
Sprint.min^{-1}	0.43±0.14	0.41±0.13	0.43±0.16	0.42±0.12	0.47±0.22	0.41±0.15	0.43±0.13	0.40±0.14
%Explosive sprints	61.6±17.9	66.8±8.5	63.0±12.4	67.0±7.6	65.8±14.8	64.2±8.5	65.3±9.3	66.2±6.2
Sprints of 0 to less than 10m.min^{-1}	0.37±0.14	0.36±0.12	0.38±0.16	0.37±0.12	0.42±0.22	0.37±0.17	0.37±0.15	0.35±0.14
Sprints of 10 to less than 20m.min^{-1}	0.05±0.02	0.04±0.01	0.05±0.02	0.04±0.01	0.04±0.02	0.04±0.01	0.05±0.02	0.04±0.01
Sprints of 20m or further.min^{-1}	0.01±0.01	0.01±0.00	0.01±0.01	0.01±0.00	0.01±0.01	0.01±0.01	0.01±0.01	0.01±0.00

Figures 1 and 2 show the percentage of match time that players spent in different thirds of the pitch before and after the dismissal in the two types of match. The percentage of time spent in each third of the pitch was significantly influenced by team ($F_{(1,26)} \geq 11.2$, $p \leq 0.002$, $\eta^2 \geq 0.30$), period of the match ($F_{(1,26)} \geq 31.5$, $p < 0.001$, $\eta^2 = 0.55$) and the interaction of team and period of the match ($F_{(1,26)} \geq 28.0$, $p < 0.001$, $\eta^2 = 0.52$). Neither type of match, the interaction of team and type of match nor the interaction of type of match and period of the match had a significant influence on the percentage of time spent in any third of the pitch ($F_{(1,26)} \leq 1.7$, $p > 0.017$). There was a significant interaction between team, type of match and period of the match on the percentage of time spent in the defensive ($F_{(1,26)} = 6.9$, $p = 0.014$, $\eta^2 = 0.21$) and attacking thirds ($F_{(1,26)} = 7.6$, $p = 0.011$, $\eta^2 = 0.23$) but not in the middle third ($F_{(1,26)} = 2.8$, $p = 0.108$). Teams reduced to 10 players spent less time in the attacking third and more time in the defensive third after the dismissal occurred than before. The pattern for the team with 11 players was the opposite. There was a difference between matches where teams reduced to 10 players maintained (or improved) the match status and matches where they failed to do so. Specifically in matches where teams reduced to 10 players maintained the match status, there was a greater increase in the percentage of time they spent in the defensive third and a greater decrease in the time they spent in the attacking third than in matches where they failed to maintain the match status. The opposing team with 11 players had a greater decrease in the percentage of time they spent in the defending third and a greater increase in the amount of time they spent in the attacking third in matches where they failed to capitalise on their numerical advantage than in matches where they did capitalise.

	DEF	MID	ATT
Pre-Dismissal	29.7 ± 8.1 %	55.1 ± 4.8 %	15.2 ± 5.9 %
Post-Dismissal	38.8 ± 8.5 %	49.1 ± 4.1 %	12.5 ± 6.1 %

(a) Team reduced to 10 players

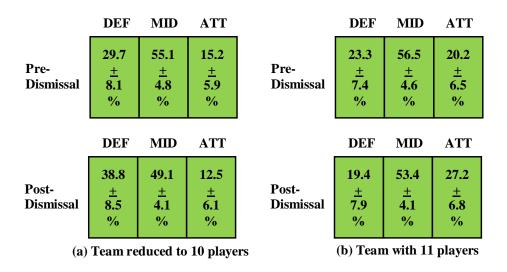|	DEF	MID	ATT
Pre-Dismissal	23.3 ± 7.4 %	56.5 ± 4.6 %	20.2 ± 6.5 %
Post-Dismissal	19.4 ± 7.9 %	53.4 ± 4.1 %	27.2 ± 6.8 %

(b) Team with 11 players

Figure 1. The percentage of time players spent in different thirds of the pitch in 19 matches where the team reduced to 10 players failed to hold onto the match status (mean±SD).
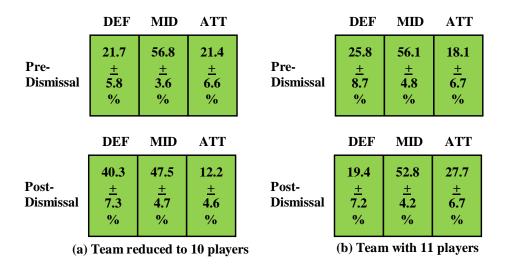
	DEF	MID	ATT
Pre-Dismissal	21.7 ± 5.8 %	56.8 ± 3.6 %	21.4 ± 6.6 %
Post-Dismissal	40.3 ± 7.3 %	47.5 ± 4.7 %	12.2 ± 4.6 %

(a) Team reduced to 10 players

	DEF	MID	ATT
Pre-Dismissal	25.8 ± 8.7 %	56.1 ± 4.8 %	18.1 ± 6.7 %
Post-Dismissal	19.4 ± 7.2 %	52.8 ± 4.2 %	27.7 ± 6.7 %

(b) Team with 11 players

Figure 2. The percentage of time players spent in different thirds of the pitch in 9 matches where the team reduced to 10 players held on to win or draw (mean±SD).

5. Discussion

The team who had a player dismissed maintained (or improved) the match status in only 9 out of the 28 matches that were analysed in the current study. This agrees with the finding of Casamichana et al. (2013) that outnumbered teams are more likely to lose matches than they are to win or draw. A study of in-play betting markets suggested that having a player dismissed would reduce a team's chance of scoring by 33% and increase the opponent's chance of scoring by 25% (Vecer et al., 2008). Bar Eli et al.'s (2006) study of Bundesliga football also found that dismissals reduced teams' chances of scoring while increasing opponents' chances of scoring. Ridder et al. (1994) analysed Dutch League matches and found that teams had an increased chance of scoring when outnumbering their opponents. However, Ridder et al. (1994) did not find a significant reduction in the chance of the outnumbered team scoring. Given the evidence that dismissals can influence the outcomes of matches, players need to maintain discipline in order to avoid being dismissed (Beswick, 2010, p.62).

The results in Table 1 indicate that teams reduced to 10 players do not work significantly harder ($p > 0.05$) than opposing teams that have 11 players on the pitch, especially in matches where the 10 players hold on to win or draw. There were similar differences in performance for both teams after the dismissal compared to before. Distance covered per minute ($p < 0.001$, $\eta^2 = 0.58$) and the high-speed running distance per minute ($p = 0.016$, $\eta^2 = 0.21$) were significantly lower after the dismissal than they were before the dismissal. The number of goals scored in professional soccer matches has been found to increase during successive 15 minute periods (Garganta et al., 1997; Abt et al., 2002; Grehaigne et al., 2002). The number of goals scored in successive 15 minute periods during the 2015-16 English FA Premier League season was 118, 153, 186, 164, 177 and 228 (www.soccerstats.com, accessed 19/9/16). The larger number of goals scored in the last 15 minutes of matches may be due to fatigue in defenders presenting opportunities to opposing attackers (Reilly, 2003). Outnumbered teams may try to ration their effort in order to minimise such risks associated with fatigue during the latter stages of matches.

The current investigation provides evidence that teams respond to dismissals by changing tactical behaviour as shown in Figures 1 and 2. Teams reduced to 10 players spent less time in

the attacking third and more time in the defensive third after the dismissal occurred than they did before. The matches included in the current investigation were matches where the team reduced to 10 players were leading or drawing at the time of the dismissal. Therefore, outnumbered teams could avoid losing by not attacking as much and concentrating on defence after the dismissal. There are risks associated with attacking in soccer. For example, if an attack breaks down when the team's defence is unbalanced, the opponents can counter-attack effectively using a direct penetrative approach (Olsen and Larsen, 1997). Even when playing with equal numbers, a well-executed counter-attack can create a numerical advantage (Luxbacher, 1999, p.63-64). Outnumbered teams may be at increased risk to conceding goals to counter-attacks due to the greater amount of space the opponents will have with the ball. Therefore, outnumbered teams need to prioritise defending. Maintaining a zone-oriented balanced defence reduces the opponent's chances of scoring (Tenga, 2013). A "Catenaccio" style (bolt and lock) defence has been described as particularly effective in preventing the opposition from scoring (Bangsbo and Peitersen, 2002, 205-208). Drills have been proposed to help improve groups of players' ability to defend when outnumbered (Luxbacher, 2005, pp.152-160) and to capitalise in attack when having a numerical advantage (Luxbacher, 2005, pp.173-174). The ability to exploit outnumbered teams may benefit from penetrative attacks being rehearsed in training exercises (Bangsbo and Peitersen, 2004, 169-178).

A further explanation for the team reduced to 10 players avoiding an increased work-rate is the formation they adopt when reduced to 10 players. Given that the score was level or the team was leading at the time of the dismissal, the team may choose to use a single forward with 4 midfielders and 4 defenders. This is a variant of a 4-5-1 formation. Playing with a single forward involves a lower volume of very high speed running when in possession of the ball than if 2 or 3 forwards are used (Bradley et al., 2011).

An alternative explanation for the three-way interaction effect between team, type of match and period of the match on the percentage of time spent in the attacking and defensive thirds of the pitch is the change in match status in the 19 matches where the outnumbered team failed to hold on to winning or level score-line. In matches where a team is level or leading, then has a player dismissed, concedes goal(s) and falls behind, the team will need to attack to avoid losing. This will result in a lower percentage of time spent in the defensive third and a higher percentage of time spent in the attacking third than in matches where they maintain the match status.

The current investigation found that a much greater percentage of sprints were explosive sprints than that reported by Di Salvo et al. (2009); less than 33% for each position. The percentage of explosive sprints observed in the current investigation was greater than 61% for both teams. The matches used in Di Salvo et al.'s study did show an increase in explosive sprints from 28 in the 2003-04 season to 34 in the 2005-06 season. The matches within the current investigation were played in the 2012-13, 2013-14 and 2014-15 seasons. This suggests that the trend for an increasing percentage of explosive sprints, first observed by Di Salvo et al. (2009), has continued steadily in the years since.

6. Conclusions

Teams reduced to 10 players spent less time in the attacking third and more time in the defensive third after the dismissal than before. Teams playing with 11 players spent more time in the attacking third and less time in the defensive third after the dismissal than before. These

differences were amplified in matches where the team reduced to 10 players maintained (or improved) the match status. There was no significant interaction of type of match and match period on any of the 15 dependent variables considered. Teams reduced to 10 players exhibited similar reductions in work-rate variables after the dismissal to teams continuing to play with 11 players.

7. Acknowledgement

8. References

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