

Football officials activities during matches: a comparison of activity of referees and linesmen in European, Premiership and Championship matches

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Summary

We compared the notational activity of 68 referees and 170 referee's assistants or linesmen officiating European matches from UEFA and the Champions League together with matches from the English Premiership and the English Championship competitions during the 2005/2006 football season using a computerised video system. We studied 328 games (14 European matches, UEFA and Champions league, 202 matches from the English Premiership and 112 from the English Championship). Referees covered a mean overall distance of 11.634 km, and assistants 6.508 km per match. Both referees and assistant referees covered significantly shorter distances jogging, running and high speed running in the second half compared to the first. There is a significant negative correlation between the distance covered and activity of officials compared with competition standard. Although we have demonstrated a negative correla-

tion between distance covered and activity and competition standard, the physical activity across all competitions was intense and this reaffirms the high levels of fitness required by officials.

Key words: referee, assistant, activity, injury prevention.

Introduction

The activity of officials covering football matches always provokes much passion in players, managers and supporters. Referees have to be in the right place at the right time, observe play closely, interpret the rules and make critical decisions. The spotting of rule violations may be considered critical for injury prevention (1-3). When 174 matches from the Norwegian Professional league in 2000 were reviewed, only 40% of incidents deemed to pose a high risk for injury led to a free kick being awarded, and only 1 in 10 led to a yellow or red card (2). Although referees make the correct decision in the majority of occasions, it may be considered important to keep close to play to minimise referring errors, which may aid injury prevention (4).

Early research compared the distance covered by officials and compared their heart rates during different activities (5,6). The application of computer software allows notational analysis of player performance and the identification of events leading to injury in professional football (7).

Comparison between studies over the past two decades shows similar activities between different leagues, with that distances covered by referees had increased with time. English football league referees covered 9.44 km per game in 1993 (5). D'Ottavio reviewed the work rate of 18 Italian high level soccer referees officiating their elite division matches, Serie A, during the 1992-1993 season (8,9). The distances covered by the referees had increased to an average of 11.376 km per game. Although there was no overall difference in the distance covered between the two halves, there was less backwards and sideways movement in the second half compared to the first. Forty one per cent of the match distance was covered at speeds less than 13.1 km/h at a heart rate average of 89% of maximum. Sprint bouts never lasted more than a few seconds (8, 9).

More experienced referees probably demonstrate better positioning allowing them to follow the game more closely than the first division officials (10). The observation of an experienced referee over 8 years has shown that distances decrease although there is an increase in intensity of movement (11). Referees actual physical performance has been shown to be influenced by some variables but these are not age or experience (12). Relatively few studies have focused on the activity of assistant referees. As observers would expect, assistants

have been shown to cover shorter distances than referees and perform brief intense bouts of forward running interspaced with long periods of inactivity (13). The ability of the linesman to keep level with the most forward striker is essential to avoid contentious fouls when players are judged to be "off side" (14-17).

We compared the notational activity of referees and assistant referees officiating matches in three different competitions: UEFA and Champions League European games, the English Premiership and the English Championship during the 2005/2006 football season, to determine whether there was a difference in the activity of officials between the different competitions.

Materials and Methods

Notational analysis was undertaken using a computerised video system (Prozone Group Ltd, Leeds, UK). This method allows the tracking of many individuals performing a sporting activity, is technically complicated, but has previously been validated (18, 19). Eight cameras are positioned around the pitch to allow complete vision of all the playing area. Every zone is covered by at least 2 cameras for accuracy, resolution and resilience. The movement of each official is monitored and analysed using the software, determining the overall distances covered, and the distance covered and time spent during different activities (Tab. 1).

High intensity activity included all activity at speeds greater than 19.8 km/h. The time spent performing each activity, the number of episodes of each activity and the number of sprints of different duration was determined. The numbers of accelerations and decelerations were also determined. Officials were also analysed for explosive and leading sprinting. Leading sprinting occurred when an official accelerated into full sprint speed, gradually accelerating through the pace of high speed running. Explosive sprinting occurred when explosive acceleration occurred with the official immediately running at sprint speed (>7.0 m/s) without passing through the pace of high speed running (5.5 m/s-> 7.0 m/s). Descriptive statistical analysis was performed (Analyse It

Software, Leeds, UK). One way Analysis of Variance Analysis (ANOVA) was used to compare each activity between competitions. The distances covered between halves were compared using paired Student t tests. Correlation of the activities between the three different competitions was performed using the Kendall Coefficient. Competition intensity was ordinaly ranked: Championship, Premiership, and then European for increasing match intensity. A significance level of P=0.05 was considered statistically significant for all tests.

Results

Overall, 328 games were analysed, including 14 European matches (UEFA and Champions league), 202 matches from the English Premiership, and 112 from the English Championship from the 2005 and 2006 seasons. The officials consisted of 68 referees and 170 referee's assistants: 10 referees and 23 assistants officiating European games, 20 and 49 from the Premiership, 48 and 128 from Championship matches respectively. No referee or assistant who officiated in Europe also officiated in the Premiership. All statistically significant values (P=0.05) are given in bold.

Referee Results

The distances covered by referees during each competition are shown in Table 2.

Statistically shorter distances were covered in the second half compared to the first half of each game. Significantly less jogging, running and high speed running and more walking was performed in the second half compared to the first half (Tab. 3 and 4). There was no difference in the distance covered by referees whilst sprinting (Tab. 3 and 4).

Championship referees covered significantly greater distances than referees covering the other competitions, in both halves and overall. For individual activities, significantly greater distances were covered by referees jogging and running in the second half of the match du-

Table 1 - The speeds used to define different activities in both units of km/h and m/s:

Walking	0-7.2 km/h	0-2.0m/s
Jogging	7.3-14.4 km/h	2.03-4.0m/s
Running	14.5-19.8 km/h	4.02-5.5m/s
High Speed Running	19.9-25.2 km/h	5.52-7.0m/s
Sprinting	>25.2 km/h	>7.0m/s

Table 2 - Mean distances, for referees, covered during pitch activity:

Distance	European 1 st /2 nd /Total/km	Premiership 1 st /2 nd /Total/km	Championship 1 st /2 nd /Total/km
Walking	1.672/1.724/3.395	1.717/1.740/3.456	1.678/1.732/3.410
Jogging	2.343/2.302/4.645	2.468/2.370/4.838	2.627/2.542/5.170
Running	1.231/1.152/2.384	1.224/1.202/2.426	1.271/1.257/2.528
High Speed	0.388/0.363/0.751	0.364/0.371/0.735	0.367/0.374/0.741
Sprinting	0.059/0.042/0.102	0.057/0.059/0.116	0.056/0.059/0.115
Total	5.708/5.6/11.308	5.843/5.760/11.602	6.012/5.979/11.991

Table 3 - Comparison between the two halves for each activity performed by referees for all competitions (Student t test, significance P=0.05):

Activity	1 st Half/km	2 nd Half/km	Difference/km	2 tailed P
Overall Distance	5.8947	5.8278	0.0669	0.0013
Walking	1.7016	1.7364	0.0349	<0.0001
Jogging	2.5170	2.4261	-0.0908	<0.0001
Running	1.2405	1.2188	-0.0216	0.0306
High Speed Running	1.2405	0.3717	-0.8688	<0.0001
Sprinting	0.0567	0.0581	0.0014	0.5781

Table 4 - One way ANOVA tests and Correlation Analysis on the Referee Data for distance covered between officials covering different competitions, significance P<0.05:

Comparison	Largest Mean/km	Competition	P Value	Tau Statistic	2 tailed P Value
Distance 1st Half	6.0117	Championship	0.0011	-0.16	0.0005
Distance 2nd Half	5.9791	Championship	0.0004	-0.19	<0.0001
Total Distance	11.9908	Championship	0.0002	-0.20	<0.0001
Walking 1 st Half	1.7167	Premiership	0.0548	0.08	0.0584
Walking 2 nd Half	1.7396	Premiership	0.8979	0.04	0.3478
Total Walking	3.4563	Premiership	0.3434	0.07	0.1365
Jogging 1st Half	2.6274	Championship	<0.0001	-0.22	<0.0001
Jogging 2nd Half	2.5421	Championship	<0.0001	-0.22	<0.0001
Total Jogging	5.1695	Championship	<0.0001	-0.24	<0.0001
Running 1 st Half	1.2712	Championship	0.2032	-0.17	0.1333
Running 2nd Half	1.2571	Championship	0.0471	-0.09	0.0435
Total Running	2.5283	Championship	0.0750	-0.09	0.0501
High Speed 1 st Half	0.3882	Europe	0.8117	0.00	0.9891
High Speed 2 nd Half	0.3740	Championship	0.9428	0.01	0.8070
Total High Speed	0.7511	Europe	0.9533	0.00	0.9764
Sprint 1 st Half	0.0592	Europe	0.9751	-0.02	0.7235
Sprint 2 nd Half	0.0589	Premiership	0.3656	0.00	0.9806
Total Sprint	0.1157	Premiership	0.7835	-0.02	0.6534
HI 1 st Half	447.46	Europe	0.8527	0.00	0.9368
HI 2 nd Half	432.70	Championship	0.8235	0.00	0.9368
Total HI	856.27	Championship	0.9875	-0.01	0.8494

ring the Championship games when competitions were compared using one way ANOVA (Tab. 4).

There were no significant differences for the numbers of all the individual actions of walking, jogging, running, high speed running or sprinting between the three classes of competitions. Also there were no differences between the numbers of leading and explosive sprints, the number of accelerations and decelerations and the number of sprints between the 3 competitions for referees when compared using one way ANOVA with significance being P<0.05.

There was a statistically significant negative correlation for the overall distance and the distance spent jogging in both halves, overall and running in the second half.

Assistant Referee/Linesman

Significantly greater distances were covered in the second half and overall and whilst running or moving at faster speeds in Championship matches (Tab. 5 and 6). A significantly greater distance was spent walking in European matches. There was a negative correlation between distance covered and competition (Tab. 6).

There were a significantly higher number of individual activity actions in Championship matches and sprints up to distances of 15 m (Tab. 7). Assistant referees covering European matches covered a significantly greater number of longer sprints.

When the activities performed in each half were compared, the assistant referees covered a shorter distance overall and whilst jogging, running and high speed running together with running in the second half (Tab. 8).

Discussion

This study has confirmed the high levels of activity necessary to officiate at high level. The overall distances in the present investigation are comparable to other studies of both referees and assistants (10, 20, 21).

Championships referees covered the greatest distances overall and in both halves. There was a significant negative correlation between competitions so that, although European competition football may be considered to be more intense, the referees actually cover the least dis-

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Table 5 - Mean distances covered for each activity by Referees Assistant/Linesman:

Distance	Premiership 1 st /2 nd /Total/km	Championship 1 st /2 nd /Total/km	European 1 st /2 nd /Total/km
Walking	1.34/1.329/2.669	1.277/1.282/2.56	1.48/1.477/2.956
Jogging	1.222/1.185/2.407	1.218/1.207/2.425	1.189/1.137/2.326
Running	0.476/0.453/0.929	0.526/0.499/1.025	0.39/0.373/0.763
High Speed	0.173/0.161/0.334	0.226/0.208/0.434	0.124/0.124/0.247
Sprinting	0.031/0.031/0.062	0.044/0.039/0.084	0.02/0.031/0.051
Total	3.282/3.205/6.487	3.335/3.282/6.617	3.227/3.182/6.419

Table 6 - One way ANOVA and Kendall Correlation data for distance covered performing different activities by the Assistant Referee:

Category/Distance	Competition	Mean Distance/km	P	Tau Statistic	P Value
Distance 1st Half	Championship	3.3352	0.1265	-0.06	0.0389
Distance 2nd Half	Championship	3.2823	0.0325	-0.07	0.017
Overall Distance	Championship	6.6174	0.0262	0.31	<0.0001
Walking 1st Half	Europe	1.4797	<0.0001	0.28	<0.0001
Walking 2nd Half	Europe	1.4766	<0.0001	0.22	<0.0001
Total Walking	Europe	2.9562	<0.0001	-0.09	0.0029
Jogging 1 st Half	Premiership	1.2216	0.5915	0.00	0.8901
Jogging 2 nd Half	Championship	1.2069	0.0858	-0.06	0.0513
Total Jogging	Championship	2.4250	0.1980	-0.04	0.2263
Running 1st Half	Championship	0.5261	<0.0001	-0.22	<0.0001
Running 2nd Half	Championship	0.4987	<0.0001	-0.21	<0.0001
Total Running	Championship	1.0248	<0.0001	-0.26	<0.0001
High Speed 1st Half	Championship	0.2260	<0.0001	-0.27	<0.0001
High Speed 2nd Half	Championship	0.2081	<0.0001	-0.26	<0.0001
Total High Speed	Championship	0.4341	<0.0001	-0.33	<0.0001
Sprinting 1st Half	Championship	0.0443	<0.0001	-0.17	<0.0001
Sprinting 2nd Half	Championship	0.0393	0.0032	-0.13	<0.0001
Total Sprinting	Championship	0.0835	<0.0001	-0.19	<0.0001
HI 1st Half	Championship	270.24	<0.0001	-0.26	<0.0001
HI 2nd Half	Championship	247.31	<0.0001	-0.24	<0.0001
Total HI	Championship	517.55	<0.0001	-0.31	<0.0001

Table 7 - One way ANOVA comparing the number of actions, leading and explosive sprint, the number of accelerations and decelerations and the number of sprints undertaken by Assistant Referees in the 3 competitions:

Number of actions for each activity	Greatest Competition	Largest Number of Actions	P Value
Walking	Championship	1110.862	0.0974
Jogging	Championship	689.424	0.7389
Running	Championship	242.603	<0.0001
High Speed Running	Championship	83.402	<0.0001
Sprinting	Championship	17.085	<0.0001
Explosive Sprint %	Europe	50.526%	0.0681
Leading Sprint %	Championship	56.104%	0.0682
Number of Accelerations			
Low	Championship	561.929	0.7894
Medium	Championship	100.415	0.0005
High	Championship	13.589	0.0003
Number of Decelerations			
Low	Championship	544.964	0.4223
Medium	Championship	84.554	0.0002
High	Championship	6.406	0.1130
Number of Sprints			
0-5 m	Championship	12.772	<0.0001
5.1-10 m	Championship	3.330	<0.0001
10.1-15 m	Championship	0.545	0.0340
15.1-20 m	Championship	0.125	0.1938
>20 m	Europe	0.107	0.0139

Table 8 - Comparison between the two halves for each activity performed on the pitch (Student t test) for referee's assistants:

Distance for each activity	1 st Half/km	2 nd Half/km	Difference	2 tailed P Value
Total Distance	3.2983	3.2301	-0.0682	<0.0001
Walking	1.3247	1.3195	-0.0052	0.3750
Jogging	1.2190	1.1907	-0.0283	0.0002
Running	0.4892	0.4651	-0.0241	<0.0001
High speed running	0.1889	0.1756	-0.0133	0.0002
Sprinting	0.0353	0.0338	-0.0014	0.2901

tance. This negative correlation was also shown for jogging and second half running.

Higher level of competition requires higher technical and tactical capabilities. In European competition, the players ran less than during Premiership games because of the tactical aspects, so naturally the referee ran less. The referees' activity has been suggested to be correlated to players' activity, and not the opposite (22).

International level referees during international competitions are less active than national level officials in home matches (20). Our study has correlated distance covered with competition level over three different levels of competition, and further confirms a negative correlation across three competitions.

There are conflicting results on differences in activity between the first and second halves. Krustup, Mohr and Bangsbo found no significant difference in the total distance covered, but there was a significant second half decrement in the high intensity running category (13). In contrast, D'Ottavio & Castagna found a 4% second half decrement in the total distance covered, without a significant decrease in high intense activity, but with an increase in the time spent standing still in the second half (8, 9). In the present study, referees covered significantly greater distances jogging, running and high speed running in the first half than the second half, and walked more in the second than in the first half. Also the overall distance covered was less in the second half compared to the first. These variations are consistent with previous studies, and may be accounted for by fatigue as the matches progressed. During late stages of games, the players frequently alter the technique of play with a shift to long passes for distance (21). It has been commented that this increases the workload for referees whilst sparing players (21). There was no significant difference in the distance sprinted by referees in both halves: referees will sprint whenever they need to, but will vary slower speeds over the course of the game.

High intensity activity may be the most reliable variable for monitoring the tactical strategy of elite level referees. With higher match intensity, the overall distance covered resulted from elite officials performing more sub-maximal activity rather than increasing the amount of high intensity activity (20). In this study, there was a significant negative correlation for high intensity activity for the distance covered. This could suggest that referees covering European matches are more tactically aware. The Prozone data categorises high intensity activity as being greater than 19.8 km/h. Other studies use speeds faster than 18.1 km/h to determine high intensity activity (8, 9). This means that the studies are not directly comparable, although D'Ottavio's work showed that 17.2 % of the

match was covered with high intensity activity. Our study showed a mean of 7.3 % activity greater than 19.8 km/h. The number of sprints and distance covered could reflect the differing speeds of play between the three competitions as the official attempts to keep up with the game. Championship officials cover a greater distance per sprint, a possible consequence of the increased number of attacks and counter attacks in that competition.

When examining the activity of assistant referees, there were comparable distances covered in total, with an overall mean of 6.508 km in our study and 7.28 km in the Danish study (13). European assistants performed significantly more walking in both halves, and overall and Championship assistants performed significantly more running and greater speed activity. Referees and their assistants progress through the various leagues as they become more experienced and skilled. Championship assistants may be relatively inexperienced, and will be keen to follow the game closely: thus they may spend a greater amount of time running faster. Assistants in European competitions will be experienced referees in their own right, and so could be better able to follow the game: this could be the reason why they may walk more. Alternatively, this could be due to the differing style of play between competitions. The fact that Championship assistants also had a significantly higher number of individual actions at running speed and faster and made a significantly higher number of short sprints (0-5 m and 5.1-10 m) may support this hypothesis, as they will perform a greater number of shorter, faster actions to keep up with the game. Championship assistants also spent a significantly greater amount of time standing.

Similarly to the referee data, when Assistant Referee activity was compared between the two halves, a significantly shorter distance was covered overall, jogging, running and high speed running in the second half compared to the first half. Even though referee's assistants cover less ground, they either tire or follow the players who are covering less ground in the second half (23). When assistant referee activity was correlated between competitions, there was significant negative correlation between the competitions for all activities performed running or at a faster pace. There were also a significantly higher number of individual walking activities performed and activities at speeds faster than running pace.

Although there are differing patterns of activity between both referees and their assistants, the activities for both these officials negatively correlate between the competitions studied.

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