Contextual Variables and Time-Motion Analysis in Soccer

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Key words
- soccer
- work-rate
- performance analysis
- multivariate model
- situational variables

Abstract

Using a multi-camera computerised tracking system the present study aimed to provide a detailed analysis of the work-rate profile of a team of elite soccer players during official matches of the Spanish Premier League. Observation-based performance measures were obtained from 434 individual samples. 6 physical parameters involving the distance covered by players were analysed: standing intensity (0–11 $km \cdot h^{-1}$), low-intensity running (11.1–14 $km \cdot h^{-1}$), moderate-intensity running (14.1–17 $km \cdot h^{-1}$), high-intensity running (17.1–21 $km \cdot h^{-1}$), very high-intensity running (21.1–24 $km \cdot h^{-1}$) and sprinting (> 24 $km \cdot h^{-1}$). These intensity thresholds were considered with respect to 4 contextual variables: *match status, match location, opponent level* and *match half*, which were analysed in relation to the *effective playing time*. A descriptive analysis and a multivariate mixed model were employed for the analysis of change processes in soccer. The distance total covered (m) by players at different work intensities during the *effective playing time* was greater when playing at *home* (3931 vs. 3887 *away*), when the reference team was *losing* (3975 vs. 3837 *drawing* and 3921 *winning*) and when the level of the opposing team was *higher* (4032 vs. 3938 *medium* and 3736 *bottom*). By contrast, their physical performance decreased during the *2nd half* of matches (3822 vs. 3985 *1st half*).

Introduction

Analysis of movement patterns during match-play has been used to evaluate physical demands in soccer for more than 30 years [33]. However, the work-rate profile can be altered as a result of many factors, including the method used by different systems of time motion analysis [29]. In this regard, a recent review suggests that both different techniques used to analyse work rate and 'situational' variables (such as match location or status and the quality of the opposition, among others) have an important influence on measures of soccer performance [6,17,39]. As such, the effective assessment of players or teams requires knowledge of the contextual factors [20,21,28,39] that can potentially affect performance [31].

One of these variables is the *halves of the game*. Previous studies [2,27,34] have reported that a longer distance is covered during the first half of the match compared to the second half, although the results are not entirely consistent [4,11,41]. These inconsistent findings are probably to do with the interaction of other variables such as research designs, instruments or analytic techniques [6,29].

Match status is another factor that has attracted increasing attention in the scientific literature on soccer performance [39]. This factor is defined as "winning", "drawing" or "losing" in relation to the number of goals scored and conceded by the sampled team at the time of data entry [17,21]. Some studies have considered this situational variable (score) when analysing the physical activity of players [6,24].

There has also been considerable research into *home advantage* [25], the results suggesting that teams gain a higher percentage of overall points when playing at home [23,26,37,38]. However, few studies have considered how playing at home influences the work-rate profiles in combination with other variables, although it seems that home teams cover a greater distance than do away teams during low-intensity activity [20,41].

Finally, the *opponent level* has been investigated with regards to differences in physical ability between players of the best and worst teams in the same league [40], or as a function of their opponent level [27]. It is likely that differences in

accepted after revision
January 20, 2011

Bibliography
DOI http://dx.doi.org/10.1055/s-0031-1271771
Published online: 2011
Int J Sports Med

ISSN 0172-4622

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players' physical activities are due to the tactics and style of play adopted, although this variable must be studied independently.

In the context of the above, the present research takes a novel approach in 2 respects. Firstly, it uses multivariate analysis to study the interaction between distances covered at different work intensities and contextual variables. Secondly, it makes use of the *effective playing time*, i.e., the time when the ball is in play, in order to study the workload of professional soccer players. On the one hand, it is likely that the variability of results reported for the physical workload [20,22,27] of players in different matches is due to variability in the *total playing time*. However, previous methods have not addressed the *effective playing time*, even though this tends to be longer during the first half; this is in contrast to the total playing time, which is usually greater in the second half [9]. The distinction between effective and total playing time would therefore seem to be relevant in terms of elucidating the differential effects on players' physical profile.

In summary, the aim of the study was to determine physical performance profiles in soccer by observing a professional team in competitive matches, analysed from the perspective of *effective playing time* (E_t). Specifically, the study sought to identify the interactive effects of *match location* (home vs. away), *score* (win, draw and lose), *opponent level* (top, medium and bottom) and *match half* (first vs. second) on work-rates.

Material and Methods

Participants

A multi-camera computerised tracking system (*AMISCO Pro*®, version 1.0.2., Nice, France) was used to gather data from Spanish Premier League players completing an entire match half (434) during the 2005–06 season. Data were collected for the duration of each match half, including injury time. The reliability and validity of this semi-automatic tracking system has been evaluated in other studies [11,12,41]. The club in question gave permission for this information to be used. However, to ensure team and player confidentiality, all data were desensitised before analysis and were processed in accordance with the Declaration of Helsinki [15]. Institutional approval for the study was given by the ethics committee of the University of the Basque Country.

Total and effective playing time

Total playing time (T_t) was defined as the duration of the match as a whole, including stoppage time. *Effective playing time* (E_t) refers to the duration of play after subtracting the time taken up by stoppages, substitutions, goals and injuries, etc., in other words, subtracting the amount of time in which the ball is out of play.

Movement categories and intensity thresholds

In line with other studies [2,10,12,27,41] matches were analysed by distinguishing a set of activity categories. Specifically, the following 6 match performance parameters were analysed with respect to the distance covered: *standing intensity* (standing, walking, jogging) (SD, 0–11 $km \cdot h^{-1}$); *low-intensity running* (LD, 11.1–14 $km \cdot h^{-1}$); *moderate-intensity running* (MD, 14.1–17 $km \cdot h^{-1}$); *high-intensity running* (HD, 17.1–21 $km \cdot h^{-1}$); *very high-intensity running* (VHD, 21.1–24 $km \cdot h^{-1}$); and *sprinting* (SpD, >24 $km \cdot h^{-1}$).

Contextual variables

4 independent variables were included in the research. With respect to the contextual variable *match location*, and in line with previous studies [2], we distinguished between matches played at home and away. As regards the *match halves* these were also divided into 2 levels: first and second half. With respect to the *opponent level* we examined differences in physical performance when the reference team played against successful teams (ranked in the top 6 league positions), moderately successful teams (ranked 7th to 13th in the league) and the least successful teams (ranked in the bottom 7 of the league). These categories are similar to those reported previously [28,39]. With respect to the partial and final result or *match status* [21], this was divided into 3 levels, i.e., whether a team wins, loses or draws in each half.

Statistical analyses

Data are presented as the mean ± standard deviation (±*SD*), along with the 95% confidence interval (95% CI). Initial statistical analyses were performed using *SPSS* for Windows version 17.0 (*SPSS* Inc., Chicago, IL, USA). Differences in *match time* (*total* and *effective*) with respect to the 4 independent variables were determined using the Student's *t*-test (*halves* and *match location*) and a one-way analysis of variance (*opponent level* and *score*). When a significant F-value was found, Bonferroni's post-hoc tests were applied. The level of statistical significance was set at $p < 0.05$.

A multivariate mixed model using SAS for Windows 9.1 [35] was also applied to analyse the change processes in soccer. A linear mixed model is a parametric linear model for clustered, longitudinal or repeated-measures data that quantifies the relationships between a continuous dependent variable and various predictor variables. Longitudinal data differs from traditional multivariate data, in which a number of measurements are collected for each subject before analysing the multiple measurements as a single multivariate outcome. Here, Mauchly's test of sphericity was used to determine, firstly, that the data could be treated as multivariate (transformed variables, $\chi^2 = 21\,675.6$; Pr > ChiSq < 0.0001) and, secondly, that they fulfilled the criterion of orthogonality ($\chi^2 = 8\,340.2$; Pr > ChiSq < 0.0001). Both tests were significant, thus confirming the suitability of a multivariate procedure.

Results

Total and effective playing time

The average total duration (T_t) of each half was 46 min 32 s (±44 s) for first halves and 48 min 35 s (±1 min 4 s) for second halves, while the mean *effective playing time* (E_t) in each half was 26 min 19 s (±2 min 39 s) and 26 min 4 s (±2 min 25 s), respectively (**Table 1**). The time during which the ball was in play did not reach 55% (E_t/T_t%) of the total match duration, independently of the contextual variables. There were significant differences in the T_t with respect to the variables *halves, match location* and *score*, as well as in the E_t with respect to the variable *opponent level*.

Distance covered

When considering the whole match, the total distance covered by players in each half ranged between 3 871 m and 3 958 m during the effective playing time, which corresponds to 69% of the

distance covered in the *total playing time* (5667±450 m). The mean total distance (±*SD*) covered under different running intensities for each half is shown in **Table 2**. The time motion analyses revealed that during 45 min the players performed 117 m of sprinting (SpD) and 145 m of very high-intensity activity (VHD). In the E_t the 'relative weight' (%) of the distance covered at 5 of the 6 intensities (SpD, VHD, HD, MD and LD) was greater than the corresponding figure for the T_t. The opposite occurred for the variable SD, whose value was lower in the E_t.

Distances covered and contextual variables

The initial descriptive analysis (**Table 3**) shows the mean distances covered in metres (m), standard deviations (±*SD*) and confidence intervals (95% CI) according to the different movement categories and for the effective playing time (E_t) with respect to the situational variables.

Mauchly's test was used to determine whether or not the within-subjects variance-covariance matrix had a Type H covariance structure [16]. The results for the type III general linear model (GLM) procedure for within-subjects effects showed a similar trend. Except for *match location* the remaining contextual variables were shown to be significant when analysing workload during the E_t (**Table 4**). This indicates that players of the observed team cover different distances at different intensities depending on the situational variables.

As regards the multivariate model used, the results of the type III (fixed effects) analysis showed significant differences between the distances covered at different intensities during the E_t for the variables *halves, opponent level* and *score* (see **Fig. 1**).

Discussion

The purpose of this study was to determine any qualitative and quantitative differences in the demands placed on elite soccer players during match-play according to effective playing time

Table 1 Objective measures of match duration in minutes and seconds (± SD s) and 95% confidence interval in minutes and seconds [95%CI] for total or 'real' (T_t) and effective (E_t) playing time according to the situational variables.

Variable	Level	n	Total time (T_t)	Effective time (E_t)	E_t/T_t%
halves [I]	1st half	248	46 min 32 s (±44 s)	26 min 19 s (±159 s)	55.2
			[46 min 27 s–46 min 38 s]	[25 min 59 s–26 min 39 s]	
	2nd half	186	48 min 35 s (±64 s)	26 min 04 s (±145 s)	52.6
			[48 min 26 s–48 min 44 s]	[25 min 43 s–26 min 25 s]	
opponent level [II]	top (1)	154	47 min 23 s (±106 s)	26 min 59 s (±156 s)	55.8
			[47 min 06 s–47 min 40 s]	[26 min 34 s–27 min 24 s]	
	medium (2)	159	47 min 32 s (±68 s)	26 min 24 s (±178 s)	54.0
			[47 min 21 s–47 min 42 s]	[25 min 56 s–26 min 52 s]	
	bottom (3)	121	47 min 18 s (±56 s)	25 min 00 s (±58 s)	51.9
			[47 min 08 s–47 min 28 s]	[24 min 50 s–25 min 10 s]	
match location [III]	home	277	47 min 37 s (±87 s)	26 min 19 s (±159 s)	54.9
			[47 min 26 s–47 min 47 s]	[26 min 00 s–26 min 38 s]	
	away	157	47 min 04 s (±65 s)	26 min 02 s (±141 s)	54.0
			[46 min 54 s–47 min 15 s]	[25 min 39 s–26 min 24 s]	
score [IV]	draw	141	47 min 12 s (±64 s)	26 min 05 s (±179 s)	53.8
			[47 min 01 s–47 min 22 s]	[25 min 35 s–26 min 34 s]	
	win	122	47 min 13 s (±91 s)	26 min 01 s (±103 s)	54.0
			[46 min 57 s–47 min 29 s]	[25 min 43 s–26 min 20 s]	
	lose	171	47 min 44 s (±82 s)	26 min 28 s (±158 s)	54.9
			[47 min 32 s–47 min 57 s]	[26 min 04 s–26 min 52 s]	
	total	434	47 min 25 s (±81 s)	26 min 13 s (±153 s)	54.1
			[47 min 17 s–47 min 33 s]	[25 min 58 s–26 min 27 s]	

n is the number of entire match halves. [I] Significant differences were found in the T_t ($p<0.05$) for the first and second *halves*; *Bonferroni's* post-hoc test: second>first. However, no significant differences were found for the E_t ($p=0.310$). [II] No significant differences were found in the T_t ($p=0.274$) for *opponent level*. However, significant differences were found for the E_t ($p<0.05$); *Bonferroni's* post-hoc test: 1>2, 1>3, 2>3. [III] Significant differences were found in the T_t ($p<0.05$) for *home and away; Bonferroni's* post-hoc test: home>away. However, no significant differences were found for the E_t ($p=0.238$). [IV] Significant differences were found in the T_t ($p<0.05$) for *score*; *Bonferroni's* post-hoc test: lose>draw and lose>win. However, no significant differences were found for the E_t ($p=0.253$)

Table 2 Mean distances covered in metres (m), percentages (%), standard deviations (±SD) and confidence intervals (95% CI) with respect to the different movement categories and to the total (T_t) and effective (E_t) playing time achieved by elite soccer players in each match half.

Intensity category	Total time (T_t) [m]					Effective time (E_t) [m]					E_t/T_t%
	Mean	%	±SD	95% CI		Mean	%	±SD	95% CI		
SpD	117	2.1	76	110	124	112	2.9	73	105	119	95.7
VHD	145	2.6	61	139	151	137	3.5	59	131	142	94.4
HD	445	7.9	139	432	459	406	10.4	136	393	419	91.2
MD	584	10.3	166	568	560	507	13.0	156	493	522	86.8
LD	881	15.5	168	866	897	723	18.5	159	708	738	82.0
SD	3495	61.7	155	3480	3510	2030	51.8	250	2006	2053	58.0
total	5667	100	450	5624	5709	3915	100	463	3871	3959	69.0

Running intensities are: SD (0–11 Km · h^{-1}); LD (11.1–14 Km · h^{-1}); MD (14.1–17 Km · h^{-1}); HD (17.1–21 Km · h^{-1}); VHD (21.1–24 Km · h^{-1}); and SpD (>24 Km · h^{-1}). 'E_t/T_t%' is the mean distance covered (in metres) by the player during the effective playing time divided by the mean distance covered by that player during the total playing time multiplied by 100

Table 3 Mean distances covered in metres (m), standard deviations (±SD) and confidence intervals (95% CI) with respect to the different movement categories and to the *effective playing time* (E_t) achieved by elite soccer players for each match half in relation to the 4 contextual variables.

			Intensity category					
			SpD	VHD	HD	MD	LD	SD
halves	1st half	mean (m)	116.3	140.3	417.9	524.5	745.8	2039.7
		±SD	75.2	60.7	131.8	162.1	162.4	264.3
		95% CI	106.9	132.7	401.4	504.2	725.5	2006.6
			125.7	147.9	434.4	544.7	766.1	2072.8
	2nd half	mean (m)	107.0	131.9	390.5	484.2	692.2	2016.4
		±SD	70.4	56.8	139.1	145.0	150.3	228.4
		95% CI	96.8	123.7	370.4	463.2	670.5	1983.3
			117.2	140.2	410.6	505.2	714.0	2049.4
opponent level	top (1)	mean (m)	114.8	143.5	416.6	525.0	746.5	2086.0
		±SD	71.8	59.3	143.4	169.5	168.1	255.5
		95% CI	103.4	134.0	393.8	498.0	719.7	2045.3
			126.3	152.9	439.4	551.9	773.3	2126.7
	medium (2)	mean (m)	117.2	136.7	411.2	508.1	722.7	2042.0
		±SD	75.3	57.4	135.2	151.9	165.9	290.5
		95% CI	105.4	127.8	390.0	484.3	696.8	1996.5
			129.0	145.7	432.3	531.9	748.7	2087.5
	bottom (3)	mean (m)	102.7	128.1	386.4	483.4	692.9	1942.0
		±SD	71.9	60.8	124.0	141.2	133.3	135.4
		95% CI	89.8	117.1	364.1	458.0	668.9	1917.6
			115.7	139.0	408.7	508.8	716.9	1966.4
match location	home	mean (m)	118.9	136.3	403.0	508.6	728.4	2035.6
		±SD	75.1	59.0	139.8	157.4	162.1	258.6
		95% CI	110.0	129.4	386.5	489.9	709.2	2005.0
			127.8	143.3	419.5	527.2	747.6	2066.2
	away	mean (m)	100.7	137.3	411.8	504.8	713.1	2019.4
		±SD	68.4	59.6	127.7	154.4	154.4	233.1
		95% CI	89.9	127.9	391.7	480.5	688.7	1982.6
			111.5	146.7	431.9	529.1	737.4	2056.1
match status	lose (1)	mean (m)	117.1	146.3	430.0	525.5	729.4	2026.5
		±SD	67.7	53.7	133.6	153.7	158.9	251.4
		95% CI	106.9	138.2	409.8	502.3	705.4	1988.5
			127.3	154.4	450.2	548.7	753.4	2064.4
	draw (2)	mean (m)	111.3	131.2	372.4	475.2	700.3	2046.9
		±SD	73.3	58.6	132.4	152.5	166.4	290.2
		95% CI	99.1	121.4	350.3	449.8	672.6	1998.6
			123.5	140.9	394.4	500.6	728.0	2095.2
	win (3)	mean (m)	106.9	129.7	411.9	518.5	739.7	2014.3
		±SD	80.4	65.6	134.8	159.2	149.8	189.7
		95% CI	92.5	117.9	387.7	490.0	712.9	1980.3
			121.3	141.5	436.0	547.0	766.6	2048.3

Running intensities are: SD (0–11 Km · h^{-1}); LD (11.1–14 Km · h^{-1}); MD (14.1–17 Km · h^{-1}); HD (17.1–21 Km · h^{-1}); VHD (21.1–24 Km · h^{-1}); and SpD (>24 Km · h^{-1})

and with respect to 4 situational variables (***halves, score, opponent level*** and ***match location***) that were analysed simultaneously.

Our results are consistent with recent investigations using sophisticated measurement technologies [10,20] and which demonstrate that the mean distance covered by male elite outfield players for each half is ~5600 m in T_t, but only ~3900 m in E_t (**Table 2**), equivalent to 69%. In the T_t, our data show a work-rate profile similar to that reported in other studies of Spanish Premier League players [10,12,20,41]. Mean values for physical demands are also close to the mean values obtained in studies of players in the Italian *Serie A* [10,22], the English Premier League [4,10], the German Championship [10] and the Swedish professional league [1]. However, they contrast with those reported by Rienzi et al. [34], who found that international South American players covered less total distance during a game.

The present paper is the first to report external workload distances for intense movement when taking into account the *effective playing time* (E_t). The E_t accounts for a little over 50% of the *total match time* (T_t), it being the only time during which teams have the opportunity to alter the score. In support of this notion a time-motion analysis based on E_t (~70% of workload corresponds to this period) can provide more precise information about a player's physical activity, which may have direct repercussions on the match outcome. In this regard we found significant differences with respect to the duration of the T_t but not for the E_t. This suggests that it would be useful to evaluate players' activity on the basis of the E_t, since this measure remains more stable across matches (**Table 1**); this would eliminate the possible variability between matches that is associated with the T_t, such as in matches where the home team is losing and the referees prolong the T_t [36].

The second noteworthy aspect of the present study is that we applied a multivariate analysis including contextual variables, those hypothesised to affect the physical performance of players. The players' work-rates showed some significant differences in relation to the situational variables (**Table 4**, *within-subjects effects*). In soccer, the evidence for a difference in the total dis-

Table 4 General linear model (GLM) procedure and repeated-measures analysis of variance for the contextual variables.

Hypothesis tests for **between-subjects** effects					
Facet	**DF**	**Type III SS**	**Mean square**	**F-Value**	**Pr>F**
match location	1	107444.8	107444.80	3.4	0.0661
opponent level	2	4875664.7	2437832.37	76.7	<0.0001
half	1	2809417.0	2809417.02	88.4	<0.0001
match status	2	1270662.9	635331.49	19.9	<0.0001
error	2597	82567969.6	31793.60		
Hypothesis tests for within-subjects effects					
Facet	**DF**	**Type III SS**	**Mean square**	**F-Value**	**Pr>F**
workload (WL)	5	5805498772	1161099754	58233.8	<0.0001
WL**match location*	5	243321	48664	2.4	0.0322
WL**opponent level*	10	6134952	613495	30.8	<0.0001
WL**half*	5	1070249	214050	10.7	<0.0001
WL**match status*	10	3916993	391699	19.7	<0.0001
error (workload)	12985	258902615	19939		

Facet	**SpD**	**VHD**	**HD**	**MD**	**LD**	**SD**
match location†	1>2	2>1	2>1	1>2	1>2	1>2
opponent level	2>1>3	1>2>3	1>2>3	1>2>3	1>2>3	1>2>3
half	1>2	1>2	1>2	1>2	1>2	1>2
match status	1>2>3	1>2>3	1>3>2	1>3>2	3>1>2	2>1>3

DF: degrees of freedom; Type III SS: the sum of squares for type III data; Pr>F: level of significance. Running intensities are: SD (0–11 Km · h^{-1}); LD (11.1–14 Km · h^{-1}); MD (14.1–17 Km · h^{-1}); HD (17.1–21 Km · h^{-1}); VHD (21.1–24 Km · h^{-1}); and SpD (>24 Km · h^{-1}). *Match location* was Home (1) and Away (2). *Opponent level* was Top (1), Medium (2) and Bottom (3). *Halves* were First (1) and Second (2). *Match status* was Lose (1), Draw (2) and Win (3). †No significant differences ($p = 0.06$)

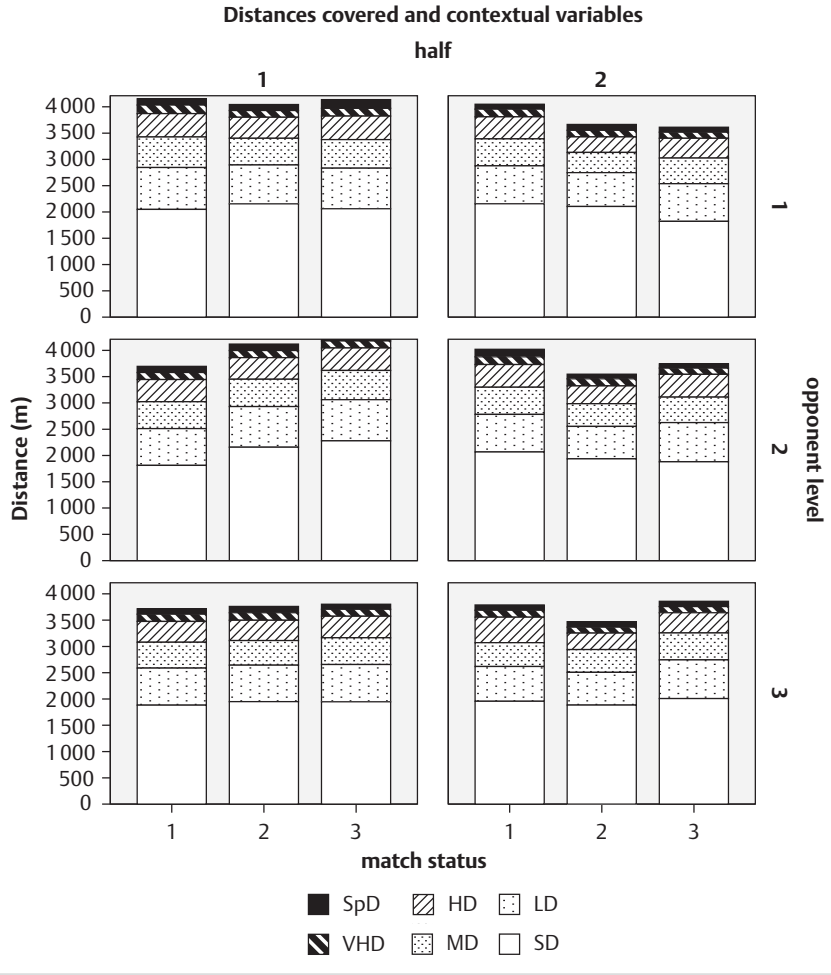

Fig. 1 Distances covered and contextual variables. Running intensities are: SD (0–11 Km · h^{-1}); LD (11.1–14 Km · h^{-1}); MD (14.1–17 Km · h^{-1}); HD (17.1–21 Km · h^{-1}); VHD (21.1–24 Km · h^{-1}); and SpD (>24 Km · h^{-1}). *Opponent level* was Top (1), Medium (2) and Bottom (3). *Halves* were First (1) and Second (2). *Match status* was Lose (1), Draw (2) and Win (3).

tance covered between halves is inconsistent, and a significant decrement does not necessarily occur in all players [6]. Some studies [2,5,11,22,34,30] have reported that the distance run decreases during the second half, suggesting a form of fatigue [32]. Indeed, recent studies have shown that the amount of both high-intensity running and sprinting declines as a soccer match progresses [14,18]. However, Di Salvo et al. and Zubillaga [11,41] reported just the opposite, while Bradley et al. [4] found no differences for high-intensity running and sprinting. In the present study, significant differences were found between the first- and second-half movement patterns for players' workload in the E_t. These differences in workload occur despite the fact that the duration of the E_t is similar in the 2 match halves (**Table 1**).

With respect to *match location* (home vs. away), no significant differences were found for distances covered at different intensities. Contrary to the findings of Lago et al. [20] the concept of *home advantage* does not seem to have repercussions for physical performance ($p = 0.06$). The absence of any differences could be due to the influence of the interaction with the other contextual variables. It should also be noted that for *match location*, no significant differences were found in the duration of the E_t between the games analysed (**Table 1**).

With respect to the *opponent level*, and in line with the findings of other studies [22,28], the poorer the quality of the opponent, the shorter the distance covered by the reference team. However, in contrast to Lago et al. [20], who found that teams playing against better quality teams ran less distance at low intensities (0–11 and 11.1–14 $km \cdot h^{-1}$), the present results show that when playing against more successful teams the reference team covered greater distances in all intensity range categories (Top > Medium > Bottom) except for the SpD category (Medium > Top > Bottom), although significant differences were found for the E_t (**Table 1**).

Finally, the physical profile was also influenced by *match status*. Contrary to Zubillaga [41] but similar to Lago et al. [19,20] it seems that the distances covered (Spd, VHD, HD and MD) by the reference team were greater when the result was adverse (**Table 4**). This suggests that when losing, players try to reach their maximal physical capacity in order to draw or win the match. Accordingly, players clearly performed less low-intensity activity. Furthermore, this occurred when no significant differences were found for the E_t (**Table 1**).

A limitation of the present study is that the players' position was not taken into account, in contrast to the approach taken in some previous reports [3,4,12,13]. It is likely that the workload of players according to their position is affected differently depending on the contextual variables involved.

It has already been noted that research findings and conclusions often vary across independent studies. Certainly, no one study can measure and control for all extraneous influences, particularly when results may be influenced by different contextual variables [19] that affect players' performance, for example, the type of competition [41], the players' level [22], the playing style of different leagues [34], the match status or the quality of the opponent [20]. The present study only provides a simple overview of the work-rate profiles of elite soccer players by analysing longitudinal data, although it is the first to report a MANOVA analysis. The particular applications of this analysis are useful for identifying contextual dynamics, and it offers empirical clues to the influence of multivariate factors that should not be considered in isolation. If performance is adversely influenced by specific situational variables, possible causes can be examined and match preparation focused on reducing such effects [20].

Identifying physical qualities is a *sine qua non* among the other attributes needed by athletes to be competitive in the team-sports arena. The present findings suggest that a failure to consider the E_t when quantifying the physical workload of players may also affect this. Furthermore, consideration of the *effective playing time* provides more precise information about competitive physical demands, and this can then be applied to the training context in order to develop drills, etc. that are more closely tailored to actual match requirements [8]. Our results highlight a number of variables that could explain physical workload in soccer players, and combinations of these variables could be used to develop a model for predicting (from a probabilistic viewpoint) the physical activity profile in competition. Indeed, the findings of this study, together with those of other authors [19,21,39], suggest that effective assessment of soccer performance at a behavioural level needs to account for the potential interactions between situational variables.

It is hoped that the present findings will serve to broaden the body of research on physical demands in elite soccer match-play, as well as improving knowledge of specific situational variables and their possible influence as regards tactical preparation for matches. As such, the results could be used to reduce undesirable effects [7] (for example, by preventing a decline in players' performance or avoiding an increased likelihood of injury) or to develop recovery strategies that help players to maintain their performance in soccer.

Acknowledgements

This study is part of the project entitled Avances tecnológicos y metodológicos en la automatización de estudios observacionales en deporte, funded by Spain's Dirección General de Investigación, Ministerio de Ciencia e Innovación (PSI2008-01179) over the period 2008-2011.

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