Original Article

Relation between the physical demands and success in professional soccer players

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ABSTRACT

Background: The analysis of the efforts performed during a soccer match and its relation with the competitive success still presents numerous questions. Objective: 1) To describe and compare the physical demands (total covered meters and meters covered at high speed ranges), between the teams of the Spanish First and Second Division league. 2) To determine if the distance covered of the teams is related to the sports success (final classification, the points obtained and the goals in favour and against). Method: A total of 712 games (First and Second Division) were analysed using a computerized multi-camera system (Mediacoach, Mediapro and LaLiga ©). In order to quantify the physical performance, the following distances were recorded: total distance (TD), the distance covered between 21-24 km/h (DHI) and distance covered above 24km/h) (DVHI). In order to quantify the sports success, we considered the final classification, the obtained points as well as the goals in favour and against. Results: The total distance covered by the teams of the First and Second Division Leagues was similar, however, the distance covered at high intensity and distance covered at very high intensity was greater in the teams of the First Division ($p<0.05$; *d* of Cohen >1.2). No relations were detected between the meters covered and the recorded success indicators. Conclusion: This data should be taken into account by the coaches and physical trainers when guiding the training process of

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Submitted for publication January 2018
Accepted for publication June 2018
Published *in press* July 2018
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.14198/jhse.2019.141.01

their teams. The distance covered during the competition does not have a direct relationship with success.
Keywords: PERFORMANCE, PHYSICAL, DISTANCE, SOCCER, SUCCESS.

Cite this article as:
Gomez-Piqueras, P., Gonzalez-Villora, S., Castellano, J., & Teoldo, I. (2018). Relation between the physical demands and success in professional soccer players. *Journal of Human Sport and Exercise*, *in press*. doi:https://doi.org/10.14198/jhse.2019.141.01

INTRODUCTION

Soccer is characterized by brief linear and non-linear efforts of high intensity alternated with non-established periods (short or long) of recovery (Anderson et al., 2016). During a soccer match, it is estimated that a professional soccer player covers a total distance of 9-14 Km (Bradley, Carling, et al., 2013). Although most of this distance is covered at a low intensity, approximately 7-12% of this distance is carried out at a high intensity and 1-4% in a sprint (Bush, Barnes, Archer, Hogg, & Bradley, 2015). From the perspective of the intermittent effort profile, this represents a work/rest ratio of 1/8 (Vigne, Gaudino, Rogowski, Alloatti, & Hautier, 2010).

These conditional demands, especially those in reference to high intensity, have increased in professional soccer in recent years (Bradley et al., 2015). Multiple variables of the situation such as the location (Castellano, Blanco-Villaseñor, & Álvarez, 2011), the competitive category (Di Salvo, Pigozzi, Gonzalez-Haro, Laughlin, & De Witt, 2013), the opponent's level (Folgado, Duarte, Fernandes, & Sampaio, 2014), the tactical system (Tierney, Young, Clarke, & Duncan, 2016), the playing style (Morgans, Adams, Mullen, McLellan, & Williams, 2014), the demarcation(Andrezejewski, Chmura, Pluta, & Konarski, 2015), the origin of the players (Casamichana & Castellano, 2014) and the time with and without the ball (Da Mota, Thiengo, Gimenes, & Bradley, 2016), condition the quantity and the intensity of the efforts demanded during the competition.

The connection between the efforts performed during a soccer game and their relation with the competitive success (the final result) have been the focus of attention in several studies (Castellano, 2017; Castellano & Casamichana, 2015) but it is still an inconclusive question (Carling, 2013). There are studies where a positive relation has been estimated between the greater physical demand in a competition and a better classification position (Andersson, Randers, Heiner-Møller, Krustrup, & Mohr, 2010; M. A. Mohr, Krustrup, Andersson, Kirkendal, & Bangsbo, 2008; M. Mohr, Krustrup, & Bangsbo, 2003) but currently, the inclusion of situational variables (Castellano et al., 2011) do not replicate the same results (Bradley, Carling, et al., 2013; Carling, 2013).

In this context it is important pointing that no significant differences have been detected between the total distance covered by the first division teams in relation to the second division teams (Spanish Leagues) (Castellano, 2017). However when each of the above mentioned leagues were divided into two groups (first and second half of the classification table at the end of the season), differences were found between the best classified teams of the First Division (first 10 teams) and the rest of the teams (the worst half of the classified teams from the First Division and the entire Second Division)(Castellano & Casamichana, 2015). Perhaps it would be interesting to carry out an in-depth study in the knowledge regarding the physical variables of high intensity (e.g. >21km/h), due to the weight which it has in the performance in the competition (Iaia, Rampinini, & Bangsbo, 2009), and include other performance indicators such as the goals scored in favour or against.

Based on all the above, the objective of this study will be dual. On the one hand, to describe and compare the physical demands, measured in total covered meters and meters covered at high speed ranges, between the teams of the Spanish First and Second Division league. On the other hand, to determine if the distance covered of the teams is related to the sports success (final classification, the points obtained and the goals in favour and against). Based on the results of this study and assessing the relation which may be detected between the distance covered and the sports success, the coaches and physical trainers should emphasize the importance which corresponds to the conditional dimension in the training process of their teams.

METHOD

Participants

A total of 378 matches in the First Division (L1) (99.4%) and 334 matches in the Second Division (L2) (72.3%), which were disputed in the 2015-16 season, were analysed using the same method which Castellano & Casamichana (2015) used with professional soccer players from the Spanish Soccer League in the 2013-14 season. All players of a team who participated in the same match were analysed (including substitutions). This meant a total of 9968 individual records. All the matches, which did not have a complete record and without mistakes of the same one, were deleted. In order to guarantee the confidentiality of the teams and players, all the data was kept anonymous during the analysis and it was processed according to the ethical standards of the Declaration of Helsinki.

Physical variables

In line with previous studies (Anderson et al., 2016; Castellano et al., 2011), three physical variables were recorded in each game: total distance covered (TD), distance covered at high intensity (21 -24 km/h) (DHI) and distance covered at very high intensity (>24 km/h) (DVHI).

Variables of sports success

The variables of sports success which were recorded include: final position in the classification (ordinal number), quantity of points obtained and the number of goals in favour and against. In order to establish differences between teams based on their classification, the following two options were used. First, the classification order was considered at the end of the season (from 1st to 20th in the L1 league and from 1st to 22nd in the L2 league). Second, the teams were divided in two halves, which means, the teams which finished in the upper half or the lower half of the classification table at the end of the season. This data was derived from the Spanish League's official web page, called "LaLiga" (www.laliga.es ©) after the season had ended.

Procedure

The computerized multi-camera system TRACAB© (managed from the application: Mediacoach) was used to derive the physical performance of the soccer players. This video monitoring tool uses a system with 8 cameras installed in the stadiums, recording the movements of all the players in the field and the ball. This system has already been used in previous studies (Castellano & Blanco-Villaseñor, 2015; Castellano & Casamichana, 2015). The reliability and validity of these types of systems have been successfully assessed in previous studies (Buchheit et al., 2014). Once the reports were generated and obtained for each of the games, the values were selected for the physical variables chosen for this study in a Microsoft Excel database created ad hoc. After checking the data to verify that there were no errors, the statistical analysis was applied.

Data analysis

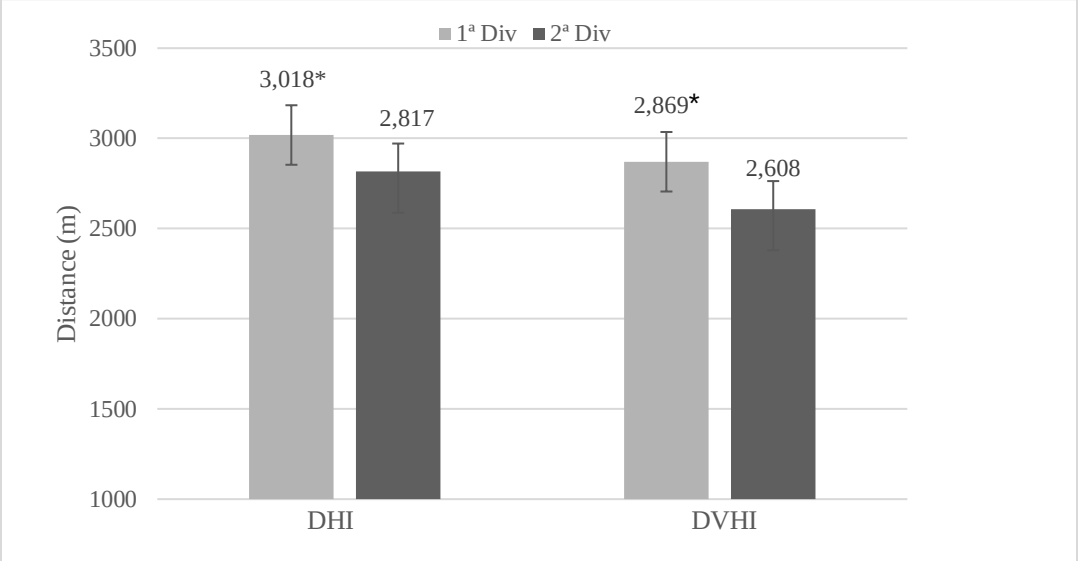
First, we carried out a descriptive and normality analysis (Shapiro-Wilk) of all the recorded variables (TD, DHI, DVHI, classification, points, goals in favour and against) obtaining the average values and the standard deviation.

To estimate the differences between the groups of the First and Second Division and between the teams from the upper and lower halves of the table, contrast tests were applied for the independent samples (Mann Whitney U and T Test). The effect size was calculated by means of the Cohen d test to determine the magnitude of the differences, which considered the following ranges: trivial (<0.2), small (>0.2-0.6), moderate (>0.6-1.2) and large (>1.2-2)(Batterham & Hopkins, 2006).

Finally, in order to establish relations between the physical variables and the variables of the sports success, we applied the Pearson correlation tests in the normal distributions and the Spearman tests in the no normal ones. For the data analysis, we used the IBM SPSS v.22 statistical program with a significance level fixed at $p<0.05$.

RESULTS

The average distance covered by the teams from the First Division during a soccer match was 109,373±2,303 m, while the teams from the Second Division covered 108,224±1,881 m, where there were no significant differences between them. On the other hand, there were differences in the distances covered in the DHI and DVHI values, where the teams from L1 were the ones which covered the most meters in these intensities (Figure 1). The effect size for these contrasts presented a value of 1.2 for DHI and 1.3 for DVHI.



** Significant difference*

Figure 1.Values of physical variables: distance covered at high intensity (DHI) and very high intensity (DVHI) for the 1st and 2nd Spanish Division

When performing the contrast tests between the distance covered by the teams, which concluded the season with the best classification (upper half) and the other teams (lower half), no differences were detected for any of the competitive levels and none of the speed ranges (Table 1).

Table 1. Physical variables values of the teams of the upper and lower half of the classification

Physical variables	Upper half of classification	Lower half of classification	*p*	ES
	First Division			**Cohen D**
TD	108,823±2,653 m	109,924±1,866 m	0.29	0.48
DHI	2,987±199 m	3,049±126 m	0.42	0.00
DVHI	2,853±192 m	2,885±139 m	0.67	0.00
	Second Division			
TD	107,744±1,970 m	108,625±1,788 m	0.28	0.46
DHI	2,839±175 m	2,799±139 m	0.55	0.00
DVHI	2,656±273 m	2,569±187 m	0.38	0.00

TD: Total distance; DHI: Distance to high intensity (21-24 km/h); DVHI: Distance to very high intensity (>24 km/h)

With regard to the correlations between the different physical variables and the success indicators, no significant values were detected in any of teams from either the First or Second Division. None of the physical variables (TD, DHI, DVHI) presented a significant relation with any of the variables of the sports success studied (Table 2).

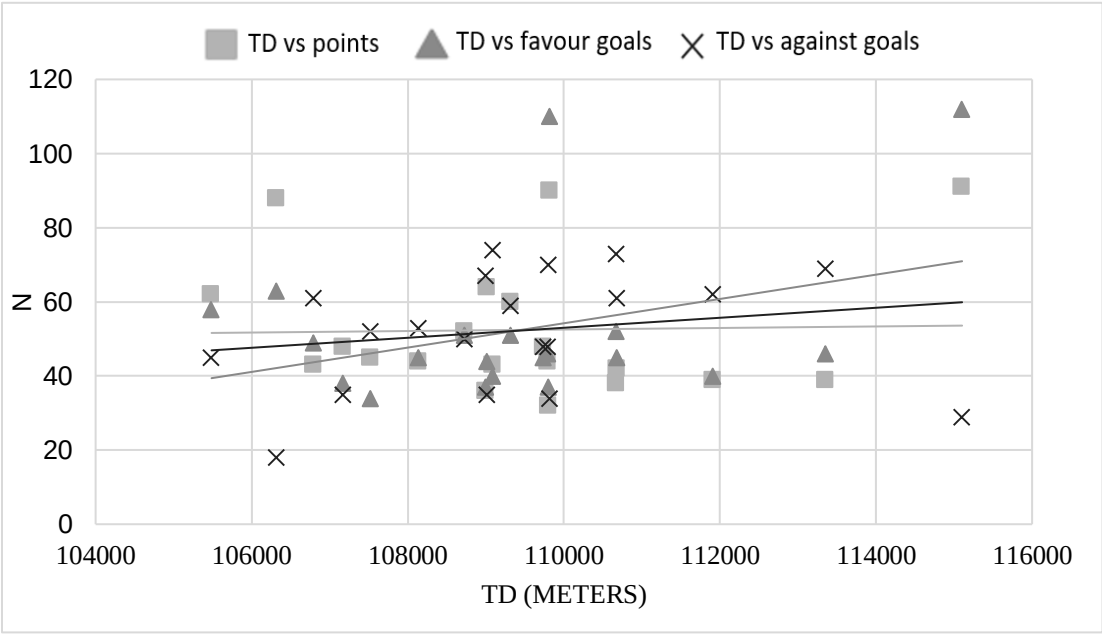
Table 2. Correlation values between success variables and physical variables

Physical variable	Success variable	1ª Division	*p*	2ª Division	*p*
TD	Final classification	0.26	0.49	0.26	0.24
	Points	0.26	0.26	-0.26	0.23
	Favour goals	0.10	0.68	-0.18	0.41
	Against goals	0.28	0.21	0.16	0.47
DHI	Final classification	0.08	0.73	-0.10	0.64
	Points	-0.07	0.75	0.07	0.74
	Favour goals	0.35	0.12	0.19	0.39
	Against goals	0.10	0.67	-0.13	0.54
DVHI	Final classification	-0.03	0.88	-0.15	0.50
	Points	0.04	0.84	0.14	0.52
	Favour goals	0.32	0.16	0.04	0.84
	Against goals	-0.06	0.79	-0.20	0.36

TD: Total distance; DHI: Distance to high intensity (21-24 km/h); DVHI: Distance to very high intensity (>24 km/h)

As can be observed in Figure 2, the TD variable does not show significant relations with the variables of sports success: points, goals in favour and against, neither for the teams from L1 (a) nor from L2 (b). (Figure 2).

(a)



(b)

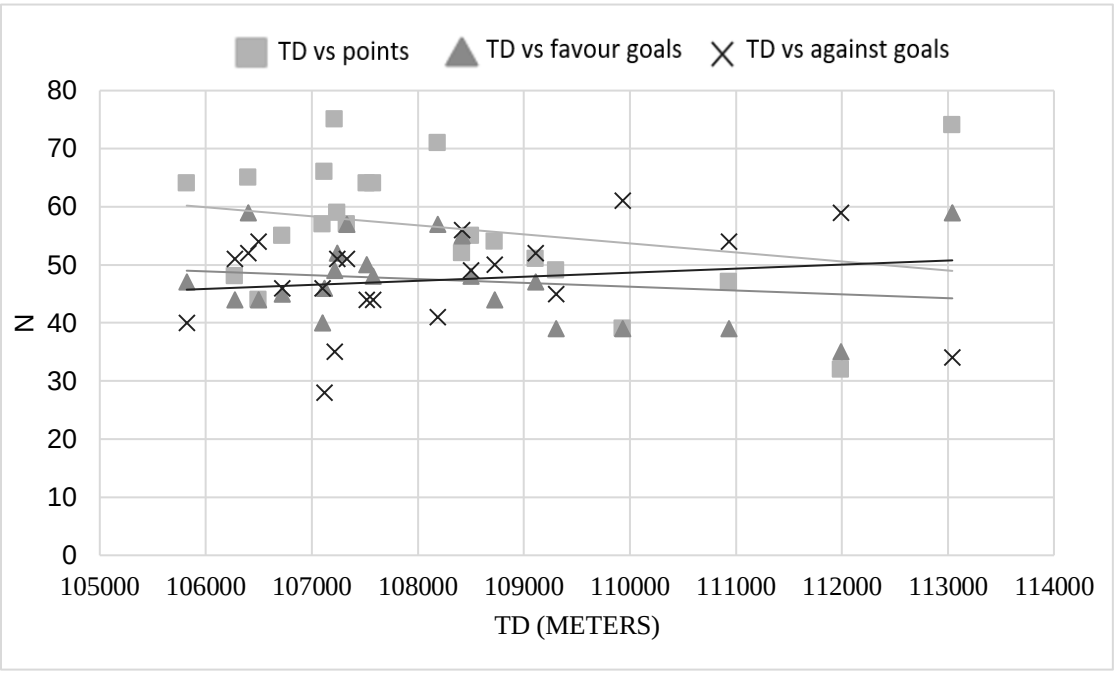


Figure 2. Relationship between total distance (TD) and sport success in the First (a) and Second (b) Spanish Division.

DISCUSSION

The objectives of this study were: 1) to find out if the distance covered during competition by professional soccer teams are similar in the L1 and L2 leagues and 2) if this distance covered determines the sports success at the end of the season in both professional categories. The study's main conclusions were that the TD in L1 was similar to L2, however in the DHI and DVHI values, the L1 was higher than L2 with a large effect size. Likewise, one interesting aspect, which was also detected in this study, is that there was no relation in the physical demands deployed by the teams and their sports success at the end of the season, neither in L1 nor L2.

There are many research projects which have studied the physical demands during the competition in the professional soccer sector (Castellano, Alvarez-Pastor, & Bradley, 2014). Not only the existence of the different measurement methods of the covered distance and/or their speed ranges, but also the different competitive levels and variables of the situation which characterize each competition (Ballesta, García, Fernández, & Alvero, 2015), hinders the comparison of the results at times.

With reference to the potential differences in the covered distance between the teams with a different competitive category, there are several authors who have previously analysed this question (Di Salvo et al., 2013; Morgans et al., 2015). Although this study has not detected significant differences in the total distance (TD) between L1 and L2, it has witnessed that both DHI and DVHI were significantly higher with a large effect size in L1. These results corroborate the results obtained in one study (M. A. Mohr et al., 2008), however they are contrary to others (Bradley, Carling, et al., 2013; Rampinini, Impellizzeri, Castagna, Coutts, & Wisløff, 2009), which found that the teams with a lower competitive level covered greater distances than those from a higher category.

Within the same category and to continue studying this question, the teams were grouped based on their classification obtained at the end of the season. Although several authors had previously verified that the best classified teams had covered more meters during the competition (Andersson et al., 2010; Castellano & Casamichana, 2015; M. A. Mohr et al., 2008; M. Mohr et al., 2003; Vales, Areces, Blanco, & Arce, 2011), in this study no differences were detected in any of the three physical variables studied (TD, DHI, DVHI) among the teams from the upper half and lower half of the classification.

If for years now, it has been considered that high intensity efforts are critical for the outcome of the soccer matches(M. Mohr et al., 2003), these findings, contrary to what was expected, would indicate to us that the distance covered during the competition (above all, at high intensity) is not a decisive factor of the sports performance if it is studied in an isolated way. It is probable that other aspects of the game such as strategy (Bradley, Lago-Peñas, Rey, & Gomez Diaz, 2013) or other situational variables (Castellano & Casamichana, 2016) have had an influence on the obtained results. As indicated by Castellano & Casamichana (2015)(Castellano & Casamichana, 2015), these results could be due to the particular circumstances of each team, which cannot be extrapolated to the rest since it is a dependent team variable.

In the same way that the total distance covered (TD) did not correlate to the final classification of the soccer teams, relations were also not detected with the rest of the different variables of sports success included in this study: points and goals in favour and against. Several papers suggest that this relation occurs in the inverse sense (Hinojosa & Castellano, 2017), which means that the circumstances of the game (the contextual variables such as for example, the result) are what condition the physical demands. This finding should be taken into account within the collective of coaches and physical trainers when establishing relations between the performance of their soccer teams and the performance obtained during the competition.

In recent years, it is known that the distance covered during a soccer game and the sports success are multi-factor phenomenon which depend on many other variables (Barnes, Archer, Hogg, Bush, & Bradley, 2014; Bradley et al., 2015; Castellano & Blanco-Villaseñor, 2015; Tierney et al., 2016). Consequently, the search for relations between both factors should be carried out from holistic approaches which have taken into consideration the interaction between the different variables which intervene in a simultaneous way (Passos, Araújo, & Davids, 2013; Vilar, Araujo, Davids, & Button, 2012). In this sense and from a scientific perspective, the assumption that a greater distance covered will be correlated with a greater sports success is quite simplistic (Carling, 2013).

Accordingly, one of the main limitations of this study was not being able to show the dynamics of distance covered and sports performance which occurred within the same game. It is not new (Castellano et al., 2011) that the momentary context which takes place in a soccer match (momentary scoreboard, weather, expulsions, etc.) or situation variables (location, rivalry level, etc.) condition the physical performance of the team (Folgado et al., 2014; Hinojosa & Castellano, 2017).

Another limitation is related to the fact that the final classification of the season does not 100% reflect how the teams' performances have evolved throughout the season, since the teams have been changing the classification position throughout the competitive season and this can mask the results.

CONCLUSION

The main conclusions of the study are: a) the total distance covered (TD) during the competition by the teams from the L1 and L2 Spanish Soccer Leagues in the 2015/16 season was similar; b) There were differences

when the distance covered was performed at high intensity (DHI) and at very high intensity (DVHI), where both values were higher for the teams from L1, and c) The TD, DHI and DVHI distances covered by the teams in L1 and L2 did not present any relation with the analysed variables of success: classification position, points obtained, goals in favour and against.

PRACTICAL IMPLICATIONS

The application of this study is related to the importance placed on the distance covered by the teams and its relation to the achieved competitive success. Since there is no direct relationship between these two variables, this data should be taken into account by the coaches and physical trainers when guiding the training process of their teams.

CONFLICT OF INTEREST

No conflict.
No fundings.

ACKNOWLEDGEMENTS

Gomez-Piqueras; Design, data collection, writing.
Gonzalez-Villora; Design, review, corrections.
Castellano; Design, data collection, writing.
Teoldo; Design, review, corrections.

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