Universidad Camilo José Cela

FACULTAD DE SALUD

ESCUELA INTERNACIONAL DE DOCTORADO

HOW TO BE SUCCESSFUL IN PROFESSIONAL FOOTBALL: ANALYSIS OF PHYSICAL DEMANDS AND MATCH STATISTICS OF PROFESSIONAL FOOTBALL TEAMS COMPETING IN *LALIGA*.

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Dedico a minha esposa Helo.
Que sonhou comigo e deu o seu melhor como esposa e mãe.
Aos meus pais, Ivonete e Carlinhos e ao meu irmão Rick.
Sem eles, nada disso seria possível.
A Deus, por colocá-los em minha vida.

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ABBREVIATIONS

1st: First place

2nd: Second place

4th: Fourth place

5th: Fifth place

7th: Seventh place

17th: Seventeenth place

18th: Eighteenth place

20th: Twentieth place

ANOVA: Analysis of Variance

CI: Confidence Interval

CONMEBOL: The South American Football Confederation

COVID-19: Corona Virus Disease 2019

***d*:** Cohen's Effect Size

DBS: Diego Brito de Souza

DS: Deviation Standard

ES: Effect Size

GPS: Global Position System

IFFHS: International Federation of Football History and Statistics

JCR: Journal Citation Reports

km/h: Kilometre per hour

***LaLiga*:** First division of Spanish football league

min: Minutes

RLDC: Roberto López Del Campo

P: Probability

r: Pearson's coefficient of correlation

®: Registered brand

SABR: Society for American Baseball Research

SPSS: Statistical Package for the Social Sciences

UEFA: Union of European Football Associations

USA: United States of America

WA: Washington

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ABSTRACT

The football performance depends on the combination of in-game technical, physical, and tactical actions in a context in which players' psychology and motivation are also key for performance. The main objective of this Doctoral Thesis was to investigate the physical demands and game statistics of best-ranked and worse-ranked teams of the professional football first division league in Spain (*LaLiga*). Furthermore, a second objective was to analyse how the suspension of *LaLiga* due to the COVID-19 pandemic affected teams' physical performance. To fulfil these objectives, we conducted 8 studies with descriptive, comparative, and relational experimental designs to analyse match data generated during ten seasons of *LaLiga*. In Study 1, accumulated teams' attack and defensive match statistics were analysed along with the points earned at the end of each season in *LaLiga* for eight seasons (2010–2011 to 2017–2018). The analysis included a total of 3040 football matches. A multiple regression analysis was able to explain 84.1% of the total variance in the number of points earned at the end of the season with attacking statistics. Defensive statistics explained 73.5% of the variance in the end-season points. Overall, shooting accuracy while attacking along with avoiding clear positions for shooting from the opposing team were the indicators best associated with the points obtained at the end of the *LaLiga* championship.

The aim of Study 2 was to analyse in-game match statistics of the top-3 and bottom- 3 teams ranked in *LaLiga* for eight seasons (2010–2011 to 2017–2018). Accumulated offensive and defensive match statistics when playing at home and away were obtained. The match statistics that best discriminated successfully from unsuccessful football teams were shooting accuracy while attacking and the number of shots conceded while

defending. In addition, the game statistics related to passing were not related to success in football.

The aim of Study 3 was to identify match statistics that best explained the differences between the first- and the second-placed teams in *LaLiga.* For this aim, the number of wins draws, losses, distribution of scored/ received goals, and accumulated attack, and defensive match statistics were obtained of the 1st and 2nd place teams for eight seasons (from 2010–2011 to 2017–2018). A higher number of wins when playing away was the best indicator of performance to differentiate between the winner and the second-place team in *LaLiga*. Increased shooting accuracy and conceding fewer shots from corners might also aid in obtaining victory in *LaLiga*.

The aim of Study 5 was to determine the relationship between match running patterns with and without ball possession and the number of points earned at the end of the *LaLiga*. Running distance covered with and without ball possession at speeds ≥21 and <21 km/h were analysed for four seasons (2015–2016 to 2018–2019). Best football teams covered a greater distance with the ball than the less successful teams. Afterward, the aim of Study 6 was to determine the influence of a player's peak/maximum running speed on the team's ranking position at the end of a national league. Peak/maximum running speeds of 475 male professional football players were recorded for 38 fixtures in *LaLiga* for the 2017–2018 season. Successful and less successful football teams have squads with players able to obtain similar maximum running speeds during match play throughout the season. Hence, players' maximum running speeds have a poor association with the team's ranking position at the end of the *LaLiga*.

Study 7 and Study 8 were associated with the suspension of *LaLiga* in the 2019-2020 season due to the first wave of the COVID-19 pandemic. This season was suspended for 12 weeks, and it was resumed to finish the remaining 11 fixtures. The aim of Study 7 was to perform a descriptive and comparative analysis of the running performance of teams competing in *LaLiga* across 4 seasons (2015-2016 to 2018-2019). We carried out this analysis to anticipate teams' physical performance after the resumption of the competition as the suspension mimicked the duration of the transition period and preseason of prior seasons. The analysis included the average running distance per game for each of the 38 matchdays that compose *LaLiga*. This analysis revealed that teams habitually need 8-10 matchdays to reach a steady state of running performance. These data suggested that football players would progressively increase their performance across the 11 matchdays that were left to complete *LaLiga* in the 2019-2020 season.

The aim of Study 8, was to analyse running patterns before suspension and after the resumption of *LaLiga* in the 2019-2020 season to determine how the lockdown affected players' physical performance. A pairwise comparison was performed of running patterns of 2019–2020 vs. 2018–2019 season (*i.e.*, control season). The analysis indicated that the high-intensity running performance of professional football teams was maintained after the resumption of the competition while the above-mentioned alterations likely aided in the in-game regulations that facilitated the maintenance of physical performance.

As main conclusion, success in professional football in *LaLiga* was associated with shooting accuracy and the ability of teams to prevent the opposing team from shooting from a comfortable position. Interestingly, physical performance variables as running distance with and without the ball, peak running velocity, and the time when a goal is

scored are poorly associated with success in *LaLiga*. In addition, although it was initially speculated that the physical performance of the teams would be notably reduced after home confinement during COVID-19 first wave, the introduction of new regulations allowed the team's physical performance to be maintained in the 11 rounds that were played to conclude the 2019-2020 season.

Keywords: soccer, data analysis, physical performance, technical performance, goals scored.

RESUMEN

El rendimiento en el fútbol depende de una infinidad de acciones técnicas, físicas y tácticas realizadas durante en el partido. El principal objetivo de la presente Tesis Doctoral fue investigar el rendimiento físico, y estadística de juego de los equipos mejor y peor clasificados en la Primera División de fútbol profesional de España (LaLiga). Además, el objetivo secundario fué analizar cómo la suspensión de LaLiga, debido a la pandemia de COVID-19, afectó al rendimiento físico de los equipos. Para cumplir con estos objetivos, realizamos 8 estudios con diseños descriptivos, comparativos y relacionales para analizar los datos generados durante los partidos de diez temporadas. En el Estudio 1 se analizaron las estadísticas acumuladas de ataque y defensa junto con los puntos obtenidos al final de cada temporada durante ocho temporadas (de 2010-2011 a 2017-2018). El análisis incluyó un total de 3040 partidos de fútbol. Un análisis de regresión múltiple pudo explicar el 84,1% de la varianza total en el número de puntos con estadísticas de ataque y el 73,5% con estadísticas defensivas. Los indicadores con más revelancia para los puntos obtenidos fueron la precisión de tiro en ataque y evitar posiciones claras de tiros del equipo contrario durante las jugadas defensivas.

El objetivo del Estudio 2 fue analizar las estadísticas de juego de los tres primeros y tres últimos clasificados de LaLiga durante 8 temporadas consecutivas (desde 2010-2011 hasta 2017-2018). Fueron analizadas las estadísticas acumuladas de partidos ofensivos y defensivos cuando el equipo jugaba en casa como cuando jugaba como visitante. Las estadísticas relacionadas con la precisión de los tiros al atacar y el número de tiros concedidos al defender fueron las estadísticas de juego que mejor discriminaron a los equipos de fútbol ganadores. Además, las estadísticas de juego relacionadas a los pases no presentaron relación con el éxito en el fútbol.

El objetivo del Estudio 3 fue identificar las estadísticas de juego que mejor explicaban las diferencias entre el equipo que ganó LaLiga y el que quedó como segundo clasificado. Para ello, el número de victorias, empates, derrotas, distribución de goles marcados / recibidos y acumulados se analizaron durante 8 temporadas (desde 2010-2011 hasta 2017-2018). Un mayor número de victorias fuera de casa fue el mejor indicador de rendimiento que diferenció al ganador del campeonato frente al equipo que ocupó el segundo lugar.

El objetivo del Estudio 5 fue determinar la relación entre la distancia recorrida con y sin posesión de balón y la cantidad de puntos obtenidos al final de LaLiga. Se analizó la distancia recorrida con y sin posesión de balón a velocidades ≥21 y <21 km / h de 4 temporadas consecutivas (2015-2016 a 2018-2019). Los equipos con una mejor clasificación al final de LaLiga tuvieron una mayor distancia recorrida con el balón que los equipos con una peor clasificación. Posteriormente, en el Estudio 6 el objetivo fue determinar la influencia de la velocidad de carrera máxima de un jugador en la clasificación del equipo al final de LaLiga. Se registraron las velocidades pico / máximas de 475 futbolistas profesionales masculinos en los 38 partidos de LaLiga en la temporada 2017-2018. Los equipos de fútbol con más éxito y los menos exitosos tuvieron equipos con jugadores capaces de obtener velocidades máximas de carrera similares. Las velocidades máximas de los jugadores tuvieron una baja asociación con la posición en el ranking del equipo al final LaLiga.

Los Estudios 7 y 8 estuvieron asociados con la suspensión de LaLiga en la temporada 2019-2020 debido al confinamiento impuesto por las autoridades sanitarias durante la

primera ola del COVID-19. Esa temporada, la competición se suspendió durante 12 semanas y fue reanudada para completar las 11 jornadas restantes para su finalización. El objetivo del Estudio 7 fue realizar un análisis descriptivo y comparativo del rendimiento en carrera de los equipos que compiten en LaLiga a lo largo de 4 temporadas (2015-2016 hasta 2018-2019). Realizamos este análisis para anticipar el rendimiento de los equipos en carrera de los equipos tras la reanudación de la competición ya que la suspensión fue similar en duración al descanso veraniego y pretemporada de años anteriores. El análisis incluyó la distancia media recorrida por partido en 38 jornadas de LaLiga. El análisis reveló que los equipos necesitan de 8 a 10 jornadas para alcanzar un rendimiento de carrera estable. Estos datos apuntan que los futbolistas aumentan progresivamente su rendimiento a lo largo de las 11 jornadas que ocurren antes de acabar LaLiga 2019-2020.

El objetivo del Estudio 8 fue presentar un análisis de los patrones de movimiento antes de la suspensión y después de la reanudación de LaLiga para determinar cómo el confinamiento afectó el rendimiento físico de los jugadores. Se realizó una comparación por pares de los patrones de carrera de la temporada 2019-2020 frente a la de la temporada 2018-2019 (*i.e.,* temporada de control). El rendimiento de las acciones de alta intensidad de los equipos de fútbol profesional se mantuvo después de la reanudación de la competición. Este hecho estuvo probablemente facilitado por las nuevas reglas introducidas.

Como conclusiones principales, podemos determinar con la presente Tesis Doctoral que el éxito en fútbol profesional estuvo asociado con la puntería a la hora de disparar a gol y con la capacidad de los equipos para evitar que el equipo contrario dispare desde una

posición cómoda. El rendimiento físico con y sin balón y el tiempo en el que se marca gol estuvieron menos asociado con el éxito en LaLiga. Además, aunque inicialmente se especuló que el rendimiento físico de los equipos estaría notablemente reducido tras el confinamiento, la introducción de nuevas regulaciones permitió que el rendimiento físico de los equipos se mantuviera en las 11 jornadas que se disputaron tras el confinamiento para finalizar la temporada 2019-2020.

Palabras claves: Fútbol, análisis de datos, desempeño físico, desempeño técnico, goles marcados.

INTRODUCTION

A brief history of data analysis in sports and *LaLiga*.

Originally, the first sport to use data analysis aiming to improve sports performance was baseball. In 1971, a group of data scientists that included historians, statisticians, and researchers, created the *Society for American Baseball Research* (SABR; (Davenport, 2014)). In the late 1970s, one of these scientists began publishing annual abstracts with simple statistics of baseball as batting average, although, the data analysis gained more complexity over the years (Millington & Millington, 2015). Today, the SABR has more than 6000 members, including broadcasters, writers, and players. In the 2000s, it was created the first edition of several specialized scientific journals (*e.g., International Journal of Performance Analysis in Sport; Journal of Quantitative Analysis in Sports*). Previously, traditional scientific journals in sports area *(e.g., Journal of Sports Sciences; Journal of Sports Medicine and Physical Fitness; Medicine and Science in Sports and Exercise)* already published important papers in the sports analytics area. To our knowledge, the first paper published with sports notational analysis was in the ’70s (Lefebvre & Passer, 1974). In that seminal paper, the authors analyzed the effects of match location on the number of player’s aggressive events, assessed as yellow cards and penalty kicks, and concluded that players were more aggressive when losing or when playing away (Lefebvre & Passer, 1974). Obviously, players’ aggressivity is not the main theme in today’s football performance but this study used a relevant contextual variable-match location which constitutes one of the most used variables used today to contextualize football performance (Collet, 2013; Lago-Peñas et al., 2016; Lepschy et al., 2018).

In the old days, important methods of match analysis and calculations were handmade. The first paper using computer video analysis and study of time-motion variables was in

1991 (Ali & Farrally, 1991). In this experimental study, the authors developed a suitable method to analyze the time spent by players during standing, walking, jogging, cruising and sprinting. Today, we have potent resources as video-based systems (TRACAB®; Vicon ®) global positions system (GPS) (Castellano et al., 2019; Pons et al., 2019), artificial intelligence, machine learning, deep learning and neural network, to track, identify and quantify players' and ball movements in a match (Baboota & Kaur, 2019; Merhej et al., 2021; Rein & Memmert, 2016). In addition, other resources transform the information into accessible and comprehensible data.

Currently, the teams of many sports and competitive leagues, invest in data science to improve their success (Castellano et al., 2014; Pons et al., 2019). Nowadays, the *LaLiga* counts with a modern and complex system managed by the Mediacoach® that generates, processes, and transforms match data to inform professional football clubs of their physical, technical and tactical performance. Interestingly, according to the ranking of the International Federation of Football History & Statistics (IFFHS), *LaLiga* is the strongest league in the world in this century, earning 13 annual IFFHS awards in the last 20 years ((IFFHS, 2021); Table 1). In the same way, a recent investigation developed an evaluation index to categorize the best football league in Europe, and *LaLiga* obtained the top place (Vales-Vázquez et al., 2018).

Table 1 *Ranking the world's strongest national leagues between 2001 – 2020. Adapted from IFFHS (2021).*

Place	League	Points	Confederation
1	Spain (*LaLiga*)	23108	UEFA
2	England	22014	UEFA
3	Italy	20427,5	UEFA
4	Brazil	19218	CONMEBOL
5	Germany	18353	UEFA
6	Argentina	17392	CONMEBOL
7	France	17356,5	UEFA
8	Portugal	14034,5	UEFA
9	Netherlands	13730	UEFA
10	Colombia	13683,5	CONMEBOL
11	Belgium	12646,5	UEFA
12	Mexico	12473,5	CONCACAF
13	Greece	12277,5	UEFA
14	Turkey	12122,5	UEFA
15	Paraguay	11939,5	CONMEBOL
16	Russia	11884	UEFA
17	Scotland	11760	UEFA
18	Ukraine	11678,5	UEFA
19	Czech Republic	11107,5	UEFA
20	Ecuador	10640	CONMEBOL

In Spanish football, the use of the data to analyze the physical and technical performance provided by these technologies is relatively new. The first article published using a multiple-camera match analysis system in Spanish football was in 2007. The authors carried out a physical performance analysis using the data of 2002-2004 of Spanish teams and they concluded that the players covered more distance in 1st half than in the 2nd half, and that midfielder players covered more distance than any other position (Di Salvo et al., 2007).

In a quick review in the database *Web of Science* until 2020, and after excluding papers not associated with football performance, we found 62 articles with the following these search terms: (Spanish football OR *LaLiga*) AND ("match analysis" OR "data analysis"). This search reflects that there has been an important increase in the number of articles published from the year 2016 onwards (Figure 1) which indicates an increasing interest to use match data generated by *LaLiga*. This increase may be explained by the strong interest of the MediaCoach® department within *LaLiga* providing and disclosing matches data and encouraging the scientific publication of peer sports scientists. In addition, to close the "scientific cycle", the articles are intelligible and they are habitually referenced in popular mass media (López, 2019; Martín, 2019).

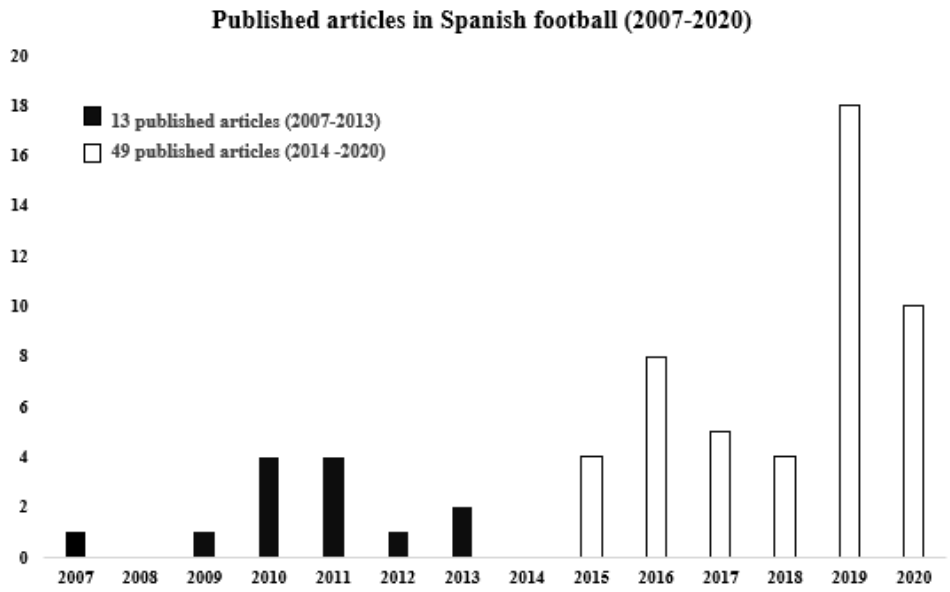


Figure 1. Evolution of the number of published articles about match/data analysis in *LaLiga*.

In conclusion, we are close to experiencing the peak of data science in sport, meanwhile, there is a visible increase in the number of studies using data science in football. Nevertheless, most of the studies analyzed match data with the intention of categorizing

and explain the events and physical demands of football but few studies were able to use match data to answer important practical questions. Therefore, it is still important to create methodologies of analysis capable of answering important questions relevant for coaches and strength and conditioning teams.

Media Coach® as a research instrument.

LaLiga owns software for video match analysis (Mediacoach ®) based on the OPTA ® (Spain) track analysis tool. The validation of this complex system is divided into two aspects, the first in respect of the tracking of match statistics variables, and the second in respect of the tracking the players running patterns. During official matches of *LaLiga*, every in-game action is categorized by a mixed software tool that included an automatized categorization of some actions by a computerized system (*e.g.*, passes) and categorization by a trained analyst who uses a rigid set of definitions (*e.g.*, yellow and red cards; (Liu et al., 2013)). The reliability of this current tracking system was tested with an intra-class correlation coefficient that ranges from 0.88 to 1.00 (Liu et al., 2013). In addition, the multicamera tracking system can accurately assess player's running distances at different speeds while discriminating when the players are in possession of the ball. The system measures players' running distance in total and at different speeds (*i.e.*, below 14.0 km/h, between 14.0 and 20.9 km/h, between and 21.0 and 23.9 km/h, and above 24.0 km/h). in addition to peak/maximum running speeds at 25 frames per second. Briefly, Mediacoach® obtains information to calculate players' running performance through a stereo camera system which is based on two multi-camera units placed at either side of the midfield line. Each multicamera is composed of three cameras with a resolution of 1920 × 1080 pixels and they are synchronised to provide a stitched panoramic picture, which is then used to create the stereoscopic view for triangulating the players and ball.

It should be noted that optical tracking data might introduce errors in the analysis by occlusions, which is why one human operator is required to correct these errors during measurement. The validity of this semi-automatic software to assess movement demands during match play has been obtained through high agreement of the multicamera tracking analysis with the data obtained with GPS (García-Unanue et al., 2018; Pons et al., 2019) and with data obtained from a reference camera system (*i.e.* VICON motion capture system (Linke et al., 2020)).

The new paradigm in football: match statistics analysis.

Football is a multidisciplinary and very popular sport, with more than 270 million registered players in more than 1.7 million football teams (FIFA, 2007). Although the number of professional football players only represents 0.3% of the total number of football players around the world, the impact of professional football is high due to the attraction of mass media and the economic revenues associated with several domestic leagues and international championships. Success in football, as in other team-oriented sports, is a complex construct in where a myriad of intrinsic and extrinsic factors contributes to the overall performance of the match or tournament. Particularly, players' physical conditioning, football-specific technical aptitudes, and team tactics are some of the main contributors to football performance (Sarmento, Clemente, et al., 2018) although different contextual factors have also been recently reported as key elements for football performance (García-Unanue et al., 2018; Gómez et al., 2019; Sarmento, Clemente, et al., 2018).

Unlike other team sports, football is a low-scoring game where match wins are often obtained through small score differences between football teams. Although scoring a goal is traditionally perceived as the most obvious representation of football success, most

player and team actions do not result in a goal scored, and thus, the final match score does not always represent an objective categorization of a team's football performance (Lepschy et al., 2018) For this reason, previous research has analysed variables that result in higher tournament rankings (Sarmento, Clemente, et al., 2018). Overall, the quality of the opposing team, match location, and match result are strongly related to evolution and the final result of the match (Lago, 2009; Liu et al., 2015; Sarmento et al., 2014; Taylor et al., 2008). These variables might affect football performance and success because they may influence game development, as measured by different match statistics (Lago-Peñas et al., 2010). Several game actions have been proposed as key football performance indicators which indicate that a higher number of these actions may increase the likelihood of winning. The association of these variables with football performance has been reviewed and summarized only recently (Lepschy et al., 2018; Mackenzie & Cushion, 2013; Sarmento et al., 2014). Overall, the number of shots, number of goals obtained by a given number of shots (*e.g.* shot accuracy/efficiency), ball possession, number of passes, and passing accuracy are the match statistics most frequently used to differentiate between winners and losers (Castellano et al., 2012; Lago-Peñas et al., 2011; Liu, Hopkins, et al., 2016; Szwarc, 2007) and/or better-ranked and least-ranked teams (Lago-Ballesteros & Lago-Peñas, 2010; Rampinini et al., 2009). Interestingly enough, the importance of these variables for football performance appears in investigations of professional national leagues (Harrop & Nevill, 2014; Rampinini et al., 2009), continental leagues (Lago-Peñas et al., 2011), and World Cup championships (Castellano et al., 2012; Liu et al., 2015).

The low amount of players and games included in most of the aforementioned investigations along with defensive match statistic underrepresentation are common limitations in investigations that analyse football performance (Mackenzie & Cushion,

2013). In addition, these previous investigations suggest that almost all match statistics are statistically associated with football performance (Lepschy et al., 2018; Sarmento, Clemente, et al., 2018), which complicates the efforts of coaches and performance analysts. Upon the findings of previous investigations, it becomes difficult to distinguish between what game actions should be prioritized through football playing styles and training routines to improve the likelihood of competitive match wins. Last, previous investigations have been unable to compare the magnitude that each match statistic contributes to success in elite football. These investigations have always analysed short periods, and thus, they might be partially biased by the effect produced by extraordinary players' performance, injuries, or even the leadership styles imposed by the team's coaches (Kattuman et al., 2019). Although the difficulty of analyzing several seasons is comprehensible, the use of results obtained from one season, or one tournament, might produce partially biased outcomes. For this reason, it is important that successive investigation includes the analysis of several seasons to increase the statistical power of the analysis and to reduce the bias introduced by some events associated with one season.

Comparison of successful and unsuccessful teams.

In this highly technological world, video analysis systems applied to sports performance have become an indispensable tool for coaches and technical assistants to collect information about individual's and team's activities during training and competitions (den Hollander et al., 2018). Specifically, video analysis in football has helped to investigate several aspects of football performance such as technical, tactical, and physiological factors during the competition (Sarmento et al., 2014). The speed and accuracy of current computerized video analysis have made it possible to scrutinize the in-game actions of elite football teams in real-time. Furthermore, the data obtained with

this tool have improved the planning and structuring of the match and the training programs of high-performance teams (Sarmento, Anguera, et al., 2018). Video analysis also constitutes an essential tool for research in team sports and several studies have been published in recent years with this technology to aid in understanding football performance, allowing an enhanced application of science to modern football (Lepschy et al., 2018; Sarmento, Figueiredo, et al., 2018). In this regard, a solid body of research has been carried out to determine what aspects of football match-play increase the likelihood of scoring more goals, while avoiding rivals scoring. (Casal et al., 2019; Castellano et al., 2012; Liu et al., 2015; Oberstone, 2009; Ermanno Rampinini et al., 2009). Although extrinsic factors, such as home advantage (Almeida et al., 2014; Seçkin & Pollard, 2008), have been associated with football performance, comparative (Lago-Peñas et al., 2010; Ermanno Rampinini et al., 2009), and predictive analysis of the statistics during play (Lago-Peñas et al., 2016) have reflected that several in-game actions are the strongest contributors to overall football success.

In a recent review by Lepschy et al. (2018), shooting accuracy was identified as the in-game action that best explained football performance, followed by other offensive variables such as the number of shots on goal, the percentage of ball possession, and the rate of passing accuracy. During an elite football match, the success of an offensive sequence is higher when it starts with a counterattack/fast attack in comparison with a positional attack (Sarmento, Figueiredo, et al., 2018). In addition, the number of passes performed in an offensive sequence decreases the probability of its success (Sarmento, Figueiredo, et al., 2018) coinciding with the low contribution of the number of passes to the points obtained at the end of the season (Brito Souza et al., 2019). A high proportion of the studies included in the review by Lepschy et al. (2018) did not consider the match location although this variable might greatly influence the players' technical actions that

lead to victory (Liu et al., 2015). Furthermore, in a critical review by Mackenzie & Cushion (2013), these authors have suggested that the analysis of in-game actions to predict football performance should be contextualized by match location and thus, a clear identification of the in-game actions that might increase the likelihood of victory is necessary when playing at home vs when playing away. As might be expected, previous investigations have found a clear discrepancy between successful and unsuccessful football teams in highly competitive championships around the world (Lago-Peñas et al., 2011; Liu, Gómez, et al., 2016; Ermanno Rampinini et al., 2009). In addition, the comparison made in these investigations rarely assesses the importance of each match statistic for overall football performance.

How to win the league? 1st versus 2nd teams' comparison.

The understanding of successful key indicators in elite football is now clearer than ever. Although the outcome of a football match is not always free of chance, the knowledge of football performance indicators that can regulate success is critical for coaches and performance analysts (Lepschy et al., 2020). While some aforementioned investigations are useful in broadly defining success in elite football, they failed to address the subtle differences within top-ranked teams that compete in a national football league for the championship. This may confuse the work of coaches and performance analysts, especially those that work for highly ranked teams because there is no clear scientific background to prioritise game actions over others. Specifically, previous literature shows a very similar number of offensive and defensive match statistics within highly ranked teams In contrast, research that compares 1st and 2nd-ranked teams in a football championship is scarce. Szwarc (2007) analysed match statistics between the teams that won/lost the final game of the Champions League from 1997 to 2003. This author found

that the number of shots on goal and an effective goalkeeper were the main factors in obtaining a victory in the final match. However, unlike the Champions League, where victory is obtained through KO-rounds, triumph in a national football league is obtained by the sum of the points scored throughout the season. Thus, the factors that explain success in weekly competitions of a national football league might differ from the Champions League.

To the authors' opinion, the explanation of key performance indicators that aid to obtain victory in a football league should be made by comparing match-play variables among high-performance teams, instead of interpolating the information of previous investigations that compared high vs low-performance teams (Lago-Peñas et al., 2010).

The influence of match running and ball possession on success in football

To ensure that elite players are optimally prepared for the high-intensity demands imposed during competitive match play, it is imperative that players are exposed to comparable demands under controlled training conditions (Harper et al., 2019). However, despite the importance conceded to developing optimal physical conditioning in elite football players, information about the influence of match running performance on football success is scarce and contradictory. In the Italian Serie A League, the worse-ranked teams (15th-20th of the ranking) ran a greater total distance per match than the more successful teams (1st-5th of the ranking) (Rampinini et al., 2009). Interestingly, completing > 8% of the total running distance at >16 km/h might increase the likelihood of attaining one of the first positions in the Serie A League (Longo et al., 2019) while the running activities at lower speeds might be unrelated to ranking. Furthermore, the distance covered with the ball was greater in the more successful teams in the Serie A League, particularly when running with the ball at > 14 km/h (Ermanno Rampinini et al., 2009). When analysing the German Bundesliga, the total distance covered during

matches, as well the number of running activities <18 km/h, were unrelated to the final points accumulated at the end of the season (Hoppe et al., 2015). Again, the running distance and the number of activities performed with ball possession were positively associated with ranking points and the running distance covered with the ball explained 60% of the variance in the final number of points accumulated. In contrast, in the Spanish *LaLiga*, both successful and unsuccessful teams presented the same running requirements at > 21 km/h and the running distance with ball possession was similar in teams classified for the Champions League and teams that were relegated to an inferior category (Clemente et al., 2019). While these investigations infer the importance of running with ball possession, the true influence of this action on overall football success is still unknown. All previous investigations on this topic (Clemente et al., 2019; Hoppe et al., 2015; Longo et al., 2019; Rampinini et al., 2009) have always analysed match running performance and its association with ranking points during one season. Thus, the outcomes of these investigations might be influenced by the effect produced by the running performance of extraordinary football players, in-season players' injuries, the signing of new players, or even by the physical conditioning training by the teams' staff (Kattuman et al., 2019).

Is it players' maximum speed running determinant for the success in *LaLiga*?

Modern professional football is a highly demanding team sport characterized by a succession of high intensity actions performed intermittently. These actions, particularly the ones performed in close proximity to the ball, require high values of speed, strength, power, and agility (Ade et al., 2016). In the last few years, research has shifted the focus of the physical determinants in football, conceding more relevance to anaerobic-based actions instead of the traditional view of football as an aerobic-based team sport. In this regard, high intensity running and sprinting account for only ~10% of the total distance

covered during a match (Mohr et al., 2003; Suarez-Arrones et al., 2015), but high-intensity running is a key element to discriminate between elite football players and players of a lower competitive level (E. Rampinini et al., 2007). Professional football players have become faster over time (Haugen et al., 2014), with a greater capacity to cover a large volume of running at high intensity during matches (Bush et al., 2015). On the other hand, players' aerobic capacity has slightly decreased over the time (Tønnessen et al., 2013). Additionally, through the use of principal component analysis (PCA), a technique to discriminate the physical performance variables which are more relevant for football performance, it has been demonstrated that high speed running is within the variables that best describe the profile of the physical demands during an official match (Casamichana et al., 2019; Oliva-Lozano et al., 2021). Overall, this information suggests that a player's capacity to cover a high volume of running at high intensity is a crucial determinant of modern football success. During a competitive match, football players perform a high intensity action every 30 to 90 s, and each high-intensity action lasts, on average, from 2 to 4 s (Vigne et al., 2010). Hence, from a physical perspective, players perform short-term but continuous high intensity actions interspersed with recovery periods that may vary depending on the evolution of the game. In elite football, players can perform more

than 150 intense actions during a match (Mohr et al., 2003), but most of them are not performed at maximum speed. The number of these actions increases with the level of play (Haugen et al., 2014), varies with the playing position on the field (Rampinini, Coutts, et al., 2007) with a higher number of sprints and distance at sprint velocity in wide midfielders than in other positions (Oliva-Lozano et al., 2020), and rises over the course of a season (Chmura et al., 2019). Interestingly, straight sprinting is the most frequent action before scoring a goal (Faude et al., 2012) and the possession of a high value of

maximum running speed is key for overtaking opponents and winning disputed balls. Furthermore, high values of maximum running speed may also reduce the relative neuromuscular load during a match (Mendez-Villanueva et al., 2013) as any action at a given running speed will represent a lower fraction of a player's maximum speed. Still, it is important to note that the distance covered at high intensity during the competition is not a unique factor associated with football success. In fact, some researchers have suggested that the contribution of the distance covered at high intensity to overall performance is very limited (Gomez-Piqueras et al., 2019). Last, the relevance of high intensity running for performance may vary from match to match due to contextual variables such as match location, match outcome, or the level of the opponent (Oliva-Lozano et al., 2021).

Match-play situations requiring maximum or near-to-maximum running speeds are rarely produced during the game, although they are performed at critical moments. For this reason, the maximum running speed that a football player can attain during match play has become one of the most popular variables to assess a player's physical performance. Overall, the mean of maximum sprinting velocity of professional football players is normally between 31 and 32 km/h (Rampinini, Coutts, et al., 2007), but there are professional players with running speeds ranging from 29 to 33 km/h (Ermanno. Rampinini et al., 2007). However, the majority of high intensity runs in football are shorter than 20 m, which precludes reaching maximum running speeds. Hence, the value of maximum running speed and the distance that a player could cover at high intensity are sometimes unrelated. For example, wide midfielders and external defenders perform more high-intensity running and sprinting (Vigne et al., 2010), but the fastest players are usually the forwards (Haugen et al., 2020). To date, the influence of players' maximum running speed on the overall team's football performance has not yet been properly

investigated. As mentioned above, it is clear that the possession of a high running speed and the capacity to repeat sprints over the time during a competitive match are both potentially beneficial factors for football performance. Nevertheless, to date, it is unknown if it is better to direct players' physical conditioning to obtain formidable high maximum speeds or to direct training to obtain players able to produce sprints of lower/submaximal velocity but with a higher capacity of repeating them over time..

Insights for the return to play after suspension of sports competition due to COVID-19.

In the last two seasons, the pandemic of coronavirus disease-19 (COVID-19), an acute respiratory syndrome caused by the coronavirus SARS-CoV2, entailed several changes that have affected football. During the first wave of COVID-19, the pandemic entailed the suspension of sports competition worldwide and, in most territories, home confinement and quarantine. These exceptional measures were adopted by the majority of health authorities in European countries, especially after the World Health Organization characterized COVID-19 as a pandemic on 11 March, 2020 (WHO, 2020). Home confinement was decided within a battery of limitations that governments set to diminish the spread of the virus, while the restrictions were particularly restraining with professional sports competitions due to the high risk of virus infection when bringing together thousands of people in a sport arena. Although the length of home isolation due to the COVID-19 outbreak varied substantially among European countries, in the case of Spain, it entailed a strict quarantine that prohibited all individuals from practicing any form of exercise outside of their own residence from 14 March, 2020 till 10 May, 2020. During quarantine, professional athletes and sportspeople used several forms of home training, attempting to maintain their physical conditioning and lifestyles, ultimately reducing the harmful physiological and psychological effects of home isolation. In this regard, the staffs of Spanish professional football teams provided to their players

personalized training programs to reduce the detraining effects of home isolation, by using video-based activities that primarily included strength exercise with body loads, and intermittent exercise routines performed within a low range of displacement. However, the critical movements and actions of football, including accelerations/decelerations, sprints with and without changes of direction, and kicking the ball were difficult to replicate in the conditions for most players (Moreno-Pérez et al., 2020) and it was speculated that players would need several weeks of football-specific retraining to recover their physical and technical performance (Herrero-Gonzalez et al., 2020). The COVID-19 outbreak occurred when most of the European professional football leagues were unfinished, disrupting the competition. The great economic incomes associated with professional football in Europe increased the pressure to resume football competition as soon as possible once the pandemic was under control (Corsini et al., 2020). The German Bundesliga was the first major European football league to successfully return to play, resuming its football competition on 16 May 2020. The English Premier League returned on 17 June 2020 while the Italian Serie A resumed competition on 20 June 2020. In contrast, the organizers of other leagues, as the French Ligue 1, decided to bring a premature close to avoid football matches until the next season.

Due to the uneven evolution of the COVID-19 in each country, the return to football training and competition were tailored taking into account the characteristics of the pandemic in each country (Eirale et al., 2020). In Spain, on 11 May 2020, the home isolation measures were alleviated, and professional football players competing in *LaLiga*, the top Spanish football league, were allowed to attend the club's facilities. From that date, players were allowed to train first by using football-specific training routines with a 1–2 m "social" distance (for 1 week) and by using training groups of an increasing

number of players afterward. Due to the positive evolution of the pandemic in Spain, and after adopting a strict protocol to minimize infection during football matches, football and medical authorities authorized resuming *LaLiga* on 8 June 2020 (Kirkland., 2020) to complete the 11 matchdays remaining to finish the competition. Hence, in the case of Spain, professional football players competing in *LaLiga* were confined at home for ~8 weeks and they were allowed to train to prepare the first competitive match for 4 complete weeks, for a total suspension of the competition lasting ~12 weeks. Although much has been hypothesized about the potential effect of home isolation on players' physical performance when the competition was resumed after COVID-19 (Bisciotti et al., 2020; Carmody et al., 2020; Eirale et al., 2020; Primorac et al., 2020), a potential answer may be obtained by analyzing the data of previous seasons in *LaLiga*. The end of *LaLiga* normally occurs in the third week of May, and the start of the following season normally occurs in the third week of August. This means that the first division of professional football in Spain is suspended by ~12 weeks every year for the summer break. During this period, professional football players perform a transition period which may have different characteristics for those players competing in international football events (*i.e.*, international football players competing with their national teams), while for most players it entails active recovery. During the transition period, there have been found several detraining effects such as changes in body composition, declines in sprint running performance, and reduction in muscle power (Silva et al., 2016). Afterward, professional football teams perform a preseason period lasting ~4–6 weeks (Campos-Vazquez et al., 2017) to offset the detraining effects of the transition period and to start football competition with the best possible level of fitness. Although the main objective of the preseason period is to adapt players to the efforts, movements, and physical challenges of competition and it usually entails high volumes of training and friendly matches (Rago

et al., 2018), players usually need several weeks of official football competition to achieve a steady-state of physical performance, as it has been previously found in the Bundesliga (Chmura et al., 2019). Furthermore, the analysis of the data of the previous season may be very useful in the case of future lockdowns that entail sports competition suspension and posterior resumption. The analysis of running performance after the competition resumption may be useful to understand the outcomes of the 2019–2020 season of *LaLiga*, as running activities during the matches are related to end-season ranking in a national league (Longo et al., 2019). In addition, the analysis of running performance after the competition resumption in the 2019–2020 season may be helpful to set specific guidelines, based on precedents, that aid the return to play after lockdowns.

OBJECTIVES

Considering the theme of the present Doctoral Thesis, the main objective was to investigate the physical demands and technical performance through match statistics of best-ranked and worst-ranked teams of the *LaLiga* to determine performance parameters more associated with success. Our main question is, how to be successful in professional football? To answer this question, we analysed ten seasons (2010-2011 to 2020-2021) of the accumulated data of the *LaLiga*. Furthermore, a second objective was to analyse how the suspension of *LaLiga* due to the COVID-19 pandemic affected teams' physical performance. To fulfil these objectives, we conducted 8 studies with descriptive, comparative, and relational experimental designs to analyse matches data generated during ten seasons of *LaLiga* supported by hypotheses and questions from the current literature and wondering practical applications, we outline the following derivative objectives:

- Identify match statistics that best explain the number of points obtained in *LaLiga* and the differences between better- and worst-ranked teams.
- Perform a descriptive analysis of the running performance of teams competing in *LaLiga* across the season and determine the association between match running performance variables, with and without ball possession, and the number of points earned in *LaLiga*.
- Investigate the relevance of players' maximum speed on football performance in *LaLiga* and investigate differences in maximum running speed among playing positions.
- Providing a comparative analysis of match running performance in teams competing in *LaLiga* before and after the lockdown due to COVID-19.

HYPOTHESIS

Based on the introduction considerations, to comply with the objectives above-mentioned, we have proposed the following hypothesis:

1. Successful teams (*i.e.*, the ones in the first ranking positions at the end of the season) will have more passing accuracy, the number of shots, and shooting accuracy and they will score more goals in the 2nd half than unsuccessful teams.
2. Successful teams will have higher values for all running performance variables performed when in possession of the ball than less successful teams
3. Successful football teams will have squads with the fastest players in all field positions, in comparison to worse-ranked teams.
4. After the resumption of competition in the 2019-2020 season, the running distance covered at high intensity may be smaller than before the suspension due to the home confinement decreed to avoid the spread of COVID-19.

INVESTIGATIONS

The present Doctoral Thesis was structured as a compendium of investigations. This Thesis is composed of eight investigations carried out by the doctoral student, with the research group of the Exercise Physiology Laboratory of the Camilo José Cela University (Madrid) and with the group of researchers from the Mediacoach department at *LaLiga*. All investigations were based on match data of games from *LaLiga* obtained for ten seasons (from 2010-2011 to 2020-2021). All data were obtained from *LaLiga*, which authorized the use of the variables included in these investigations. In accordance with *La Liga's* ethical guidelines, these investigations did not include information that identified football players. The Institutional Review Board of the Camilo José Cela University approved this project, which is following the latest version of the Declaration of Helsinki (Attachment 1).

The eight studies proposed in this Doctoral Thesis have been designed based on hypothesis from investigations previously published in the literature. As a result, 7 scientific articles have been published in journals with an impact factor in the Journal Citation Reports (JCR). One of the articles is, at the moment of writing this document, under review. A summary of the above-mentioned studies is presented below, along with the publication information and the JCR impact factor (Table 2). Table 3 shows the summary of the methodological characteristics, as well the information about the sample, the variables measured, and the main findings found of each investigation. A complete copy of each article can be consulted in the annexes of this Doctoral Thesis.

Table 2. Journal of publication of the Doctoral Thesis articles and impact index at the time of preparation of the Doctoral Thesis.

Study	Tittle	Impact factor (JCR)	Quartile	Area
Study 1	Diego Brito Souza, Roberto López-Del Campo, Hugo Blanco-Pita, Ricardo Resta & Juan Del Coso**. A new paradigm to understand success in professional football: analysis of match statistics in *LaLiga* for 8 complete seasons.** International Journal of Performance Analysis in Sport, 2019.	1.950	Q2	Orthopedics and Sports Medicine
Study 2	Diego Brito de Souza, Roberto López-Del Campo, Hugo Blanco-Pita, Ricardo Resta and Juan Del Coso. **An Extensive Comparative Analysis of Successful and Unsuccessful Football Teams in *LaLiga*.** Frontiers in Psychology, 2019.	2.990	Q2	Psychology
Study 3	Juan Del Coso , Diego Brito de Souza , Roberto López-Del Campo , Hugo Blanco-Pita & Ricardo Resta. **The football championship is won when playing away: difference in match statistics between the winner and the second-place team in *LaLiga***. International Journal of Performance Analysis in Sport, 2020.	1.950	Q2	Orthopedics and Sports Medicine
Study 4	Diego Brito de Souza, Victor Moreno-Perez, Roberto López-Del Campo and Juan Del Coso. **Relationship between time of goal scoring and classification in *LaLiga*: an analysis of 8 complete seasons**. **(NOT PRESENTED IN THIS THESIS VERSION)**	Under Review	-	-
Study 5	Diego Brito Souza, Roberto López-Del Campo, Hugo Blanco-Pita, Ricardo Resta & Juan Del Coso. **Association of match running performance with and without ball possession to football performance.** International Journal of Performance Analysis in Sport, 2020	1.950	Q2	Orthopedics and Sports Medicine
Study 6	Juan Del Coso, Diego Brito de Souza, Víctor Moreno-Perez, Javier M. Buldú, Fabio Nevado, Ricardo Resta and Roberto López-Del Campo. **Influence of Players' Maximum Running Speed on the Team's Ranking Position at the End of the Spanish *LaLiga*.** International journal of environmental research and public health, 2020.	3.390	Q1	Social Sciences
Study 7	Diego Brito de Souza, Jaime González-García1, Roberto López-Del Campo, Ricardo Resta, Javier Martínez Buldú, Michal Wilk, Juan Del Coso. **Players' physical performance in *LaLiga* across the season: insights for competition continuation after COVID-19**. Biology of Sport, 2021.	2.806	Q1	Orthopedics and Sports Medicine
Study 8	Diego Brito de Souza, Roberto López-Del Campo, Ricardo Resta, Victor Moreno-Perez and Juan Del Coso. **Running Patterns in *LaLiga* Before and After Suspension of the Competition Due to COVID-19**. Frontiers in Physiology, 2021.	4.566	Q2	Physiology
		TOTAL 19,602		

Table 3.The main methodological characteristics and main results of the Studies that make up this Doctoral Thesis.

	Study 1	**Study 2**	**Study 3**	**Study 4**	**Study 5**	**Study 6**	**Study 7**	**Study 8**
Design	Quantitative research, descriptive and correlational analysis.	Quantitative and qualitative research, descriptive and comparative analysis. Top 3 vs Bottom 3.	Quantitative Research, descriptive and comparative analysis. 1st vs 2nd.	Quantitative Research, descriptive, comparative, and correlational analysis.	Quantitative Research, descriptive, comparative, and correlational analysis.	Quantitative Research, descriptive, comparative, and correlational analysis.	Quantitative Research, descriptive and comparative analysis.	Quantitative Research, descriptive and comparative analysis.
Sample (teams/players/goals)	32 different teams	24 teams in top 3 and 24 teams in bottom 3.	16 teams, 2 per season, 3 different teams.	20 teams per season, 8353 goals.	20 teams per season.	20 teams and 475 players.	20 teams per season.	20 teams per season, 530 and 555 players respectively and 342 players in both seasons.
Number of matches	3040 matches	3040 matches	3040 matches	3040 matches	1520 matches	380 matches	1520 matches	760 matches
Number of seasons	8 seasons	8 seasons	8 seasons	8 seasons	4 seasons	1 season	4 seasons	2 seasons
Main dependent variables	Pass, passing accuracy, shot, shooting accuracy, effectiveness against conceded shooting. corners, goals, free kicks.	Pass, passing accuracy, shot, shooting accuracy, effectiveness against conceded shooting. corners, goals, free kicks.	Pass, passing accuracy, shot, shooting accuracy, effectiveness against conceded shooting. corners, goals, free kicks.	Total goals scored, goals scored in each half, goals scored in each 15 min interval.	Total running distance with and without ball possession, running distances <21 km/h and >21 km/h with and without ball possession	Maximum speed running.	Total running distance covered, running distances covered: <14 km/h, 14 to 20,9 km/h, 21 to 23,9 km/h, >24 km/h, number of actions >24 km/h.	Total running distance covered, running distances covered: <14 km/h, 14 to 20,9 km/h, 21 to 23,9 km/h, >24 km/h, number of actions >24 km/h. Game duration, number of substitutions.
Contextual variables	Points accumulated at end of the season	Attack and defensive variables	Win, draws, losses. Home and away games	Ranking categories, ranking points, 1st and 2nd half.	Ranking categories.	Ranking position, player position in the pitch.	None	Lockdown
Main statistical analysis	Pearson correlation, multiple regression analysis	Student's t-test, effect size and qualitative analysis of likelihood of differences.	Student's t-test, effect size Cohen's d	Mann-Whitney test, Kruskal-Wallis for independent samples, multiple regression analysis.	One-way ANOVA, Tukey's post-hoc, Pearson correlation, multiple regression analysis.	One-way ANOVA, two-way ANOVA, Pearson correlation, multiple regression analysis.	One-way ANOVA, LSD post-hoc.	Student t-tests, two-way ANOVA, LSD post-hoc, Cohen's d units.
Main results	The analysis was able to explain 84.1% of the total variance in the number of points in relation to offensive statistics and 73.5% with defensive statistics	The match statistic with the greatest difference between the top 3 and bottom 3 football teams was shooting accuracy.	The championship winner obtained more victories while playing away, a higher number of scored goals and lower number of received goals while playing away.	Scoring in the 2nd half, especially between minute 61 and 75 of the match, were most associated with the number of ranking points obtained in *LaLiga*.	More successful teams covered a high proportion of the total distance performed when they are in possession of the ball.	Players' maximum running speeds had a poor association with the team's ranking position at the end of *LaLiga*.	Players' physical performance was lower at the beginning of the season and the teams needed approximately 8-10 matchdays to reach a steady state running performance.	High intensity running performance of professional football teams was maintained after the resumption of the competition.

Study 1: A new paradigm to understand success in professional football: analysis of match statistics in *LaLiga* for 8 complete seasons.

Objectives

This study aimed to identify match statistics that best explain football success in a professional football league. We have used the number of points obtained at the end of a competitive season as the (dependent) variable of success and the accumulated match statistics at the end of the season as the predictive (independent) variables.

Methods

Sample

The design of this descriptive, correlational investigation is based on suggestions made by Mackenzie & Cushion, (2013) in order to have a rigorous approach in analyzing football performance. The design of this investigation has taken multiple factors into consideration, including the sample (*i.e*. elite football teams across 8 complete seasons), competitive nature of football (*i.e*. a professional football league), and the operational definitions of the investigated variables (*i.e*. match statistics and ranking points). For this investigation, the term "ranking points" depicts the number of points earned during the season once the championship has been finished. Data were obtained from the Spanish Professional Football League (*LaLiga*) for the seasons between 2010–2011 and 2017–2018. *LaLiga* authorized the use of these data for the purpose of this investigation (Attachment 2). In accordance with *LaLiga*'s ethical guidelines, this investigation does not include information that identifies football players. Table 4 contains information about the average number of ranking points obtained at the end of each season in the 1st division league. It also highlights points obtained by the champion team, teams classified

for the Champions League and Europa League, the relegated teams, and the last-classified team. The end-season match statistics of football teams that competed in the championship were also obtained, for an analysis of 3040 football matches and 32 different teams that competed during the eight years analysed (38 matches per season and football team). Because we used the accumulated match statistics and ranking points, we were required to use 160 comparative data points (20 teams per season and 8 seasons). Because the objective of this investigation was to determine the match statistics that best correlated with overall football performance in a professional league, we used the number of points obtained at the end of the seasons as the variable that best represented football performance (dependent variable). The remaining match statistics selected for this investigation and their operational definitions are presented in Table 5.

Table 4. Points obtained by the teams competing in the seasons 2010-2011 to 2017-2018 in *LaLiga*.

Season	Average ± SD	Champion	Champions League	Europa League	Relegation	Last
2010-2011	53 ± 17	96	≥ 62	≥ 58	≤ 43	30
2011-2012	52 ± 17	100	≥ 58	≥ 55	≤ 41	27
2012-2013	53 ± 18	100	≥ 66	≥ 57	≤ 36	34
2013-2014	53 ± 18	90	≥ 70	≥ 59	≤ 39	25
2014-2015	52 ± 21	94	≥ 77	≥ 60	≤ 35	20
2015-2016	52 ± 18	91	≥ 64	≥ 60	≤ 38	32
2016-2017	53 ± 21	93	≥ 72	≥ 64	≤ 31	20
2017-2018	53 ± 18	93	≥ 73	≥ 60	≤ 29	20

Table 5. Operational definitions of match statistics and events used for the investigation.

Attacking variables	**Specifications**
Goal	The score obtained by the attacking team when the ball completely passes over a goal line
Shot	Attempt to score a goal of the attacking team, made with any legal part of the body, either on or off target
Shooting accuracy	Goals/shots
Pass	Attempted exchange of the ball between two players of the attacking team
Successful pass	Successful exchange of the ball between two players of the attacking team
Passing accuracy	Successful passes/passes
Cross	The action made by a player to introduce the ball within the opposition team
Penalty kick	Single shot on the goal while it is defended only by the opposing team's goalkeeper
Turnover	Loss of ball possession to the opposing team due to mistake or poor control
Foul received	Infringement committed by the opposing team and sanctioned by the referee
Corner	The ball crosses the end line of the opponent's side and the last person in contact with the ball was an opponent
Free kick goal	Goal scored for the attacking team as the result of a direct or indirect free kick
Offside	Infringement committed by the attacking team as a result of a player being offside.
Defensive variables	

Goal received	The score obtained by the opposing team when the ball passes completely over a goal line
Shot conceded	Attempt to score a goal made by the opposing team
Effectiveness against conceded shooting	Goals received/shots conceded
Foul committed	Infringement committed by the defending team and sanctioned by the referee
Penalty kick conceded	Single shot on the goal while it is defended only by the defending team's goalkeeper
Corner against	The ball crosses the end line of defending team’s side and the last person in contact with the ball was an opponent
Yellow cards	Sanction by the referee to one of the players of the defending team
Red cards	Sanction by the referee to one of the players of the defending team that ends in player expulsion
Free kick goals received	Goal received as the result of a direct or indirect free kick
Recovery	Obtaining the ball possession due to a defensive action

These variables were selected based on previous studies regarding this topic (Lago-Peñas et al., 2010; Liu et al., 2015; Ermanno Rampinini et al., 2009). In order to improve the applicability of this study's results to professional football, the accumulated match statistics were distributed in attacking/offensive actions and defensive actions.

Statistical analysis.

We used Pearson's correlation coefficient (r) to assess the association between each team's match statistics and the points obtained at the end of the season. Afterward, we performed a multiple regression analysis in a stepwise interactive mode in order to assess the influence that each match statistic had on the points obtained at the end of the league. This analysis was inspired by a similar investigation in a professional basketball league (Puente et al., 2015). In the regression analysis, all match statistics were introduced based on their correlation with the residual ($p < 0.1$) and their intercorrelation with variables that already included in the equation. Of note, we excluded the number of goals (attacking variable) and the number of goals received (defence variable) from the multiple regression analysis because the number of ranking points is primarily based on the number of goals obtained/received by the teams in each game. By using a threshold of 5 points in the variance inflation factor (VIF), redundant variables were excluded to avoid multicollinearity. The produced regression equation was accepted at a significance level of $P < 0.01$. The r2 values were adjusted for the number of cases and parameters in the analysis. Using the standardized regression coefficients, the relative contribution of each different variable in relation to the explained variances was calculated as follows: Partial contribution r2 adjusted = ([Standardized regression coefficient for parameter]/ Σ [of all standardized regression coefficients in equation]).

The significance level for the statistical analysis was set at $P < 0.05$ and all analysis and calculations were performed using the SPSS v.20 software package (SPSS Inc., USA).

Results

Table 6 contains Pearson's correlation coefficients that are based on data from the specified eight seasons. Table 6 also contains information about the attacking match statistics according to the ranking obtained in the *LaLiga* championship. As expected, the number of goals was the attacking variable with the highest association to the points obtained at the end of the seasons, although the number of shots, the number of corners, the shooting accuracy, the number of passes, and the number of successful passes also presented high correlations to the ranking points (all $p < 0.05$). Table 7 shows Pearson's correlation coefficients between the points obtained at the end of the season and defensive match statistics of the football teams. In this case, the number of goals received was the variable with the highest association to the ranking points, followed by the defence's effectiveness against rival' shooting and the number of recoveries (all $P < 0.05$).

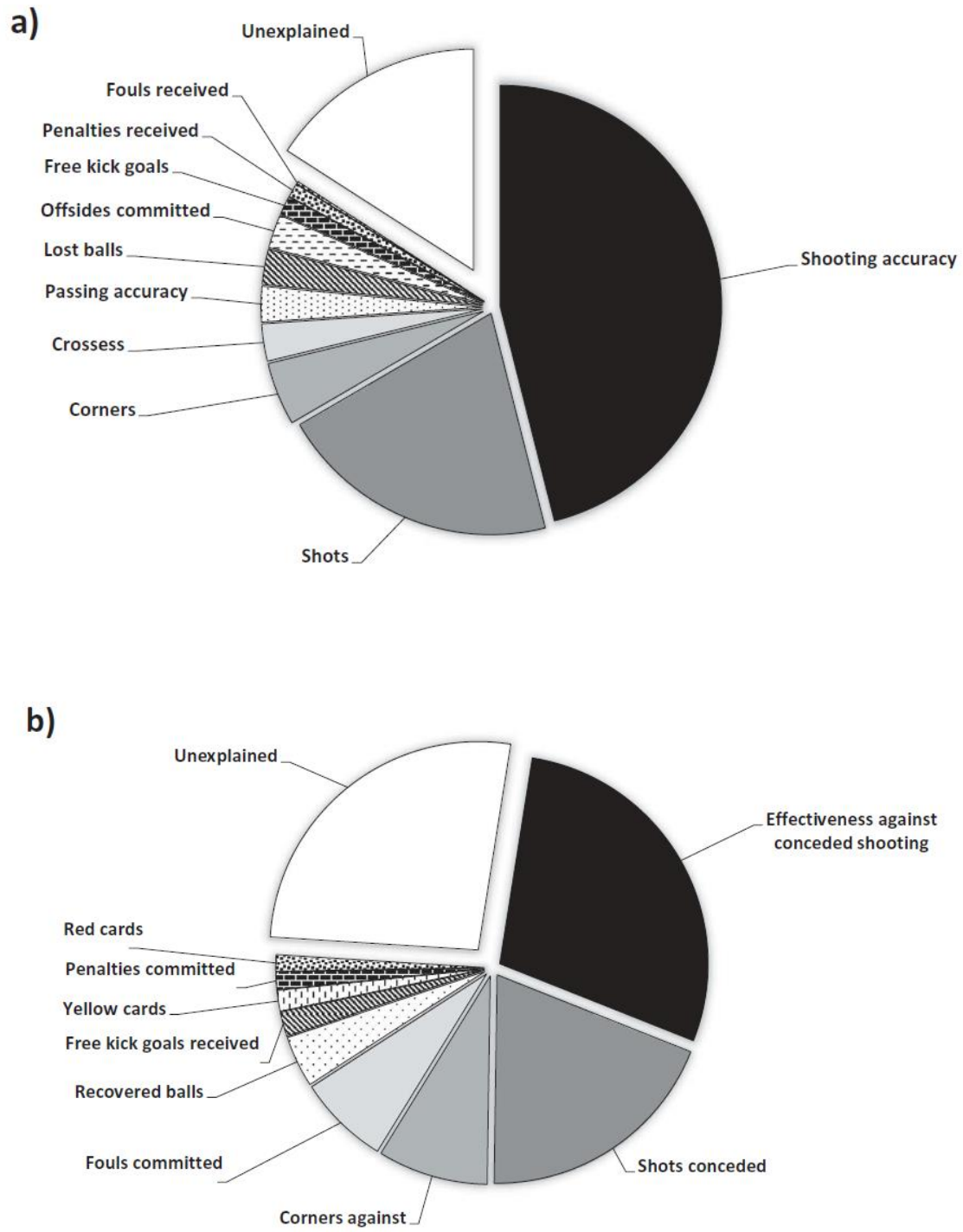
Table 6. Pearson correlation coefficients (r) for the association between the points obtained at the end of the season and attacking match statistics. (*) denotes that the correlation was statistically significant at $p < 0.05$.

Attacking variables	r	All	Champion	Champions League	Europa League	Relegation	Last
Goals (number)	0.49*	53 ± 21	104 ± 14	79 ± 23	59 ± 6	38 ± 7	31 ± 6
Shots (number)	0.42*	470 ± 82	598 ± 75	556 ± 113	475 ± 53	429 ± 49	422 ± 47
Shooting accuracy (%)	0.31*	11 ± 3	18 ± 2	14 ± 2	12 ± 2	9 ± 1	7 ± 1
Passes (number)	0.34*	17912 ± 3111	25113 ± 4367	20607 ± 3124	18213 ± 1784	16446 ± 1813	15687 ± 715
Successful passes (number)	0.34*	13554 ± 3351	21396 ± 4590	16516 ± 3400	13937 ± 1976	12008 ±1897	11284 ± 807
Passing accuracy (%)	0.27*	75 ± 5	85 ± 4	80 ± 4	76 ± 4	73 ± 4	72 ± 2
Crosses (number)	0.16*	764 ± 141	690 ± 185	798 ±175	735 ± 170	774 ± 128	755 ± 101
Penalty kicks(number)	0.26*	5 ± 3	9 ± 5	7 ± 3	7 ± 3	5 ± 3	4 ± 2
Turnovers (number)	0.09	4962 ± 360	4757 ± 248	4899 ± 333	4890 ± 352	4970 ± 318	4956 ± 198
Fouls received (number)	0.17*	538 ± 51	560 ± 21	558 ± 59	534 ± 40	515 ± 69	524 ± 45
Corners(number)	0.42*	199 ± 33	235 ± 17	228 ± 36	205 ± 29	189 ± 25	175 ± 26
Free kick goals (number)	0.35*	11 ± 4	15 ± 4	15 ± 6	11 ± 5	10 ± 3	8 ± 2
Offsides (number)	0.29*	97 ± 20	131 ± 10	110 ± 22	100 ± 20	91 ± 21	85 ± 19

Table 7. Pearson correlation coefficients (R) for the association between the points obtained at the end of the season and defensive match statistics. (*) denotes that the correlation was statistically significant at $P < 0.05$.

Defensive variables	**r**	**All**	**Champion**	**Champions League**	**Europa League**	**Relegation**	**Last**
Goals received (number)	-0.49*	53 ± 13	30 ± 8	37 ± 9	50 ± 8	67 ± 11	69 ± 8
Shots conceded (number)	-0.22*	470 ± 70	354 ± 45	414 ± 56	465 ± 44	524 ± 30	522 ± 75
Effectiveness against shooting conceded (%)	-0.36*	89 ± 2	92 ± 2	91 ± 2	89 ± 2	87 ± 2	87 ± 2
Fouls committed (number)	-0.02	538 ± 66	427 ± 63	498 ± 69	549 ± 59	537 ± 49	567 ± 43
Penalty kicks conceded (number)	-0.18*	5 ± 2	3 ± 2	4 ± 2	6 ± 2	6 ± 3	6 ± 2
Corners against (number)	-0.18*	199 ± 33	144 ± 14	172 ± 33	203 ± 24	217 ± 26	223 ±32
Yellow cards (number)	-0.08	57 ± 11	44 ± 11	54 ± 11	60 ± 10	55 ± 8	62 ± 8
Red cards (number)	-0.08	1 ± 1	1 ± 1	2 ± 2	2 ± 1	1 ± 1	1 ± 1
Free kick goals received (number)	-0.24*	11 ± 4	5 ± 2	9 ± 3	11 ± 3	14 ± 3	13 ± 4
Recoveries (number)	0.27*	1882 ± 176	2016 ± 108	1972 ± 143	1896 ± 119	1814 ± 175	1772 ± 166

Figure 2 depicts the variance in the points obtained as explained by each match statistic related to (a) attacking and (b) defensive team actions. Overall, the multiple regression analysis explained 84.1% of the total variance in the number of points at the end of the seasons regarding offensive statistics. For the defensive statistics, the multiple regression analysis explained 73.5% of the variance. Shooting accuracy, followed by the number of shots, was the attacking variable that best explained the variance of the ranking points. The defence's effectiveness against rival shots and the number of conceded shots were the variables that explained the highest amount of variance in the number of points.



Percentage of variance in the number of points obtained at the end of the season as explained by match statistics from 8 complete seasons in LaLiga. a) match statistics related to teams' attack actions; b) match statistics related to teams' defense actions

Figure 2. Percentage of variance in the number of points obtained at the end of the season as explained by match statistics from 8 complete seasons in *LaLiga*.

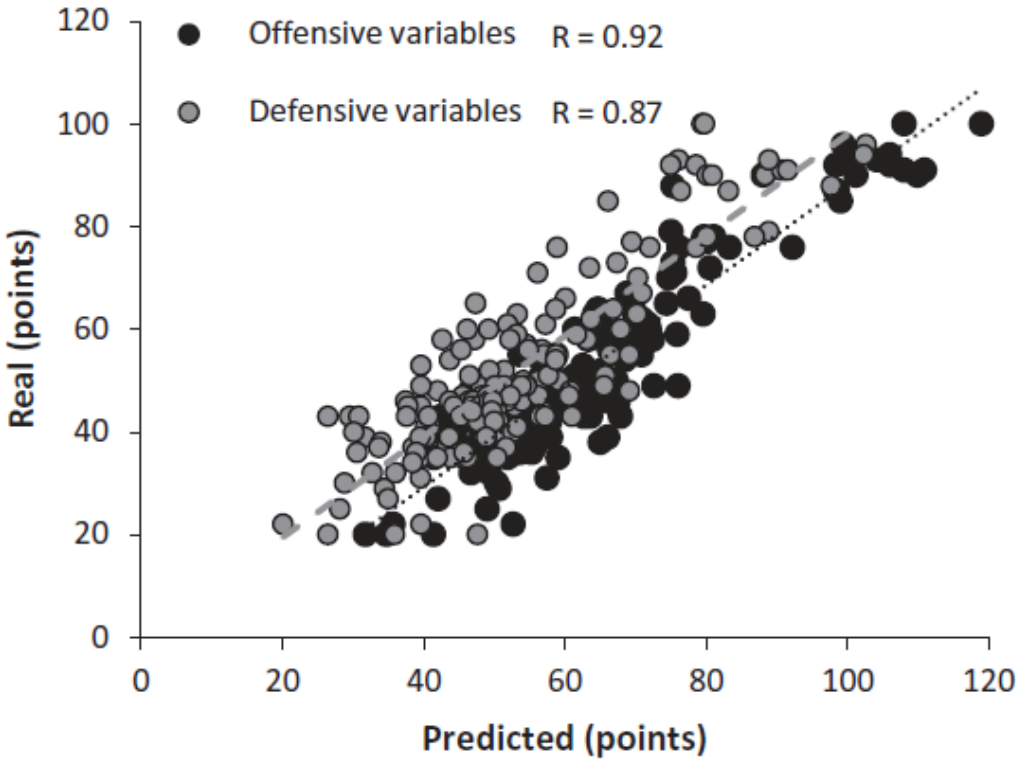
Figure 3 includes a comparison between the predicted and actual number of points obtained at the end of the season with the two models of prediction. The predicted model with offensive variables correlated with actual ranking points at $r = 0.92$ ($p < 0.05$) and the predicted model with defensive variables correlated with ranking points at $r = 0.87$ ($p < 0.05$).

Predictive model of ranking points based on offensive match statistics

Predicted number of points = −33.409+(Shots×0.070)+(Shooting accuracy×4.476) +(Passing accuracy×-0.143)+(Total crosses×-0.005)+(Penalty kicks×-0.097) +(Turnovers×0.002)+(Fouls received×-0.001)+(Corners×0.039)+(Free kick goals×-0.049)+(Offsides×0.034).

Predictive model of ranking points based on defensive match statistics

Predicted number of points = 173.987+(Opponent shot accuracy×-4.138)+(Shots conceded-0.097)+(Recoveries×0.008)+(Fouls committed×-0.038)+(Penalty kick conceded×0.197)+(Corners against×-0.093)+(Yellow cards×-0.031)+(Red cards×-0.267) +(Free kick goals received×-0.113).



The prediction was based on a multiple regression analysis performed with offensive or defensive match statistics. Each dot represents one team at the end of the season.

Figure 3. Correlation between the actual and predicted number of points at the end of 8 seasons in *LaLiga*

Study 2: An Extensive Comparative Analysis of Successful and Unsuccessful Football Teams in *LaLiga*.

Objectives

This investigation aimed to perform a comprehensive comparative analysis of successful and unsuccessful football teams in the Spanish professional football championship (*LaLiga*) by including accumulated match statistics obtained during 8 competitive seasons.

Methods

Design and procedures.

Study 2 represents a descriptive, comparative analysis of the end of season accumulated match statistics of professional football teams competing in *LaLiga* (20 teams per season). This research was inspired by a previous investigation carried out by (Liu, Gómez, et al., 2016) using match statistics from *LaLiga* 2012-2013 but the power of the analysis has been increased with the inclusion of 8 consecutive seasons (from 2010-2011 to 2017-2018). To comply with *LaLiga* ethical guidelines, the information included in this investigation does not allow the recognition of football players' identities. Although 20 professional teams compete in *LaLiga* every season, we have selected the top 3 and bottom 3 ranked teams at the end of each season in order to perform a comparative analysis of successful and unsuccessful teams. Thus, this study contains information about 24 successful football teams (the top 3 ranked teams for the seasons: 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016, 2016-2017 and 2017-2018) and 24 unsuccessful football teams (the bottom 3 ranked teams for the seasons: 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016, 2016-2017 and 2017-2018). The match statistics included in this study were based on previous studies

with similar aims (Lago-Peñas et al., 2010; Liu et al., 2015; Oberstone, 2009; Ermanno Rampinini et al., 2009) and they were categorized as offensive and defensive variables to improve the applicability of these results to professional football. A more detailed definition of the match statistics included in this investigation has aforementioned, while the operational definitions for each variable were as follow: Shot: an attempt to score a goal; shooting accuracy: number of goals divided by the number of shots; pass: an attempt to exchange the ball between two players of the team; passing accuracy: number of successful passes divided by the total number of passes; cross: an action made by a player with the objective of introducing the ball within the opposition team; penalty kick: a single shot on the goal while it is defended only by the opposing team's goalkeeper; turnover: a loss of ball possession as the result of an imprecision; foul received: an infringement committed by the opposing the team and sanctioned by the referee; corner: an action when the ball crosses the end line of opponent's side and the last person in contact with the ball was an opponent; free kick goal: a goal scored for the attacking team as the result of a direct or indirect free kick; offside: an infringement committed by the attacking team as a result of a player being offside. Shot conceded: an attempt to score a goal made by the opposing team; effectiveness against conceded shooting: the number of goals received divided by the number of shots conceded; foul committed: an infringement committed by the defending team and sanctioned by the referee; penalty kick conceded: a single shot on the goal while it is defended only by the defending team's goalkeeper; corner against; an action ball crosses the end line of defending team's side and the last person in contact with the ball was an opponent; yellow card: a sanction by the referee to one of the players of the defending team; red card: a sanction by the referee to one of the players of the defending team that ends in player expulsion; free kick goals received: a goal received as the result of a direct or indirect free kick; recovery: an action where the

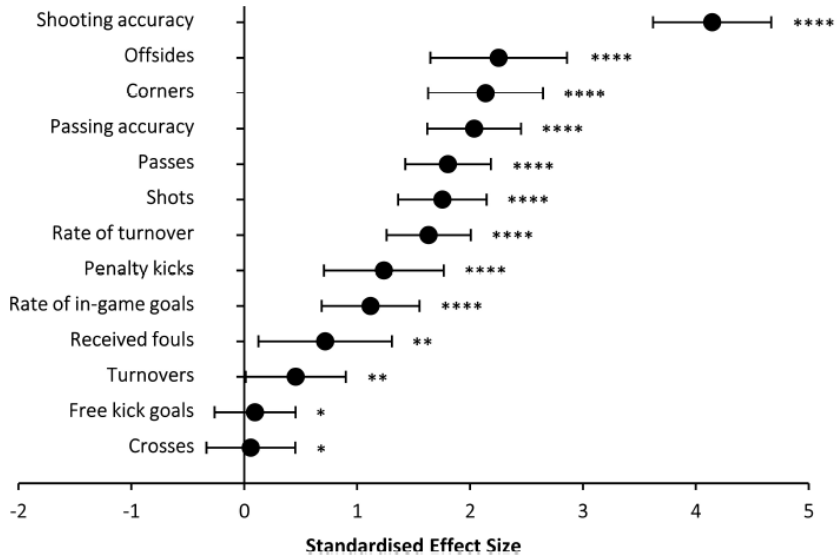
team obtains or regains the ball possession due to a defensive action. To complete the information of this analysis, the end of season accumulated statistics were obtained and subsequently divided into matches played at home and away to allow a sub-analysis for match location.

Statistical Analysis

The data were electronically extracted from the Mediacoach® reports and entered into a database designed for this research. The data were extracted by one author (RLDC) using a spreadsheet (Excel 2016, Microsoft Office, WA, United States) and then they were checked for accuracy by another author (DBS). Then, data on the top 3 and bottom 3 football teams in each season were clustered and mean and standard deviation (SD) were obtained. The comparison between the top 3 and bottom 3 teams was performed with independent Student's t-test and the differences were considered as statistically relevant at $P < 0.05$. To complete the null-hypothesis statistical approach, the effect size (ES) was also calculated in all pairwise comparisons to assess the magnitude of the differences between the top 3 and bottom 3 ranked teams. Specifically, the ES 90% confidence intervals (CI) were calculated on log transformed data to reduce bias due to non-uniformity of error. A qualitative descriptor was included to represent the likelihood of differences among teams (< 1% no chances of change; 1 to 5%, very unlikely; 5 to 25%, unlikely; 25 to 75%, possible; 75 to 95%, likely; 95 to 99%, very likely; >99%, most likely). ES were interpreted according to the following ranges:<0.2, trivial; 0.2–0.6, small; 0.6–1.2, moderate; 1.2–2.0, large; 2.0–4.0, very large; and >4.0, extremely large (Hopkins et al., 2009). This same analysis was performed for the overall accumulated statistics and the games played at home and away.

Results

Figure 4 and Table 8 contain data on the comparisons between top 3 and bottom 3 teams for the offensive in-game actions. In all offensive actions, a statistically significant between-group difference was identified at the level of $P < 0.01$. However, the ES have been included to improve the categorization of the magnitude of the successful vs. unsuccessful teams' differences: overall, shooting accuracy was the offensive variable with the highest effect size for the top 3 - bottom 3 comparison (Figure 4) while the importance of shooting accuracy to differentiate top 3 vs. bottom 3 teams was maintained when playing at home and when playing away (Table 8). When attacking, the number of offsides and corners, passing accuracy and the total number of passes presented large effect sizes for the top 3- bottom 3 comparison, with a most-likely difference among teams (Figure 4). At home, shooting accuracy, the number of offsides, passing accuracy, and the number of corners also presented large effect sizes for the top 3 - bottom 3 comparison, while the number of free kick goals and the number of crosses were the variables with the lowest effect sizes. When playing away, the total number of shots was the variable with the greatest effect size, followed by shooting accuracy and the number of passes and passing accuracy (Table 8).



possible; **likely;**most likely.*

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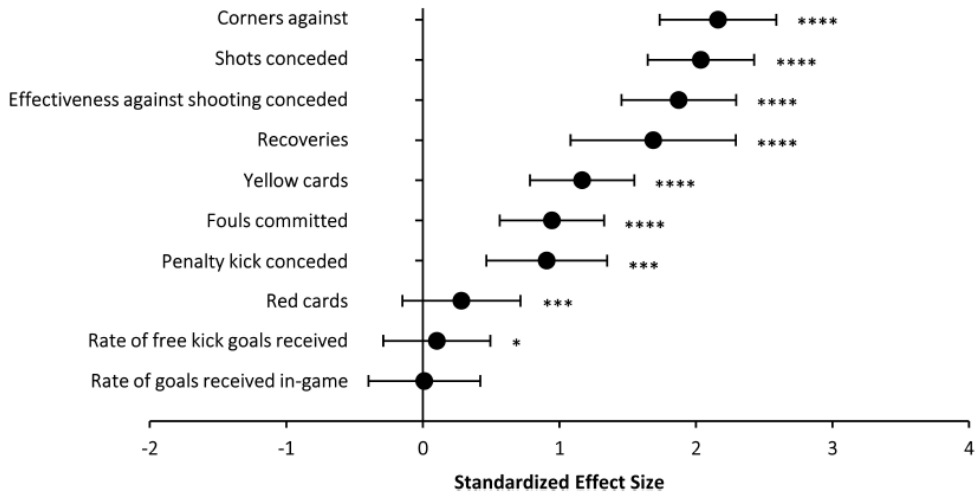
Figure 4. Standardized effect size in offensive variables for the comparison between the top 3 – bottom 3 teams in *LaLiga* from 2010 to 2018.

Table 8. Attacking variables for the top 3 and bottom 3 teams ranked in *LaLiga* from 2010 to 2018.

	Home			Away			Total		
Offensive variables	**Top 3**	**Bottom 3**	**ES (90%CI)**	**Top 3**	**Bottom 3**	**ES (90%CI)**	**Top 3**	**Bottom 3**	**ES (90%CI)**
Shooting accuracy (%)	16±2	8±1	4.15(0.52)	15±3	8±2	2.76(0.49)	16±2	8±1	4.15(0.52)
Offsides (number)	64±8	47±12	2.46(0.75)	59±14	42±10	1.48(0.49)	123±17	89±20	2.25(0.60)
Corners (number)	136±15	106±15	2.23(0.53)	103±18	78±17	1.40(0.48)	239±27	184±26	2.14(0.61)
Passing accuracy (%)	83±5	73±3	2.33(0.44)	81±5	72±3	1.70(0.41)	82±5	72±3	2.04(0.42)
Passes (number)	11712±1998	8379±795	1.88(0.38)	10986±2065	7814±837	1.72(0.38)	22698±4036	16193±1560	1.81(0.38)
Shots (number)	328±54	243±25	1.65(0.39)	328±54	183±28	3.30(0.44)	594±102	427±47	1.76(0.39)
Rate of turnover (%)	21±4	31±3	1.86(0.38)	23±5	31±3	1.36(0.37)	22±5	31±3	1.63(0.37)
Penalty kicks (number)	5±3	3±2	0.68(0.47)	3±2	2±1	1.08(0.50)	8±4	4±3	1.24(0.53)
Rate of in-game goals (%)	83±7	74±6	1.12(0.43)	83±7	74±12	1.13(0.63)	83±7	74±6	1.12(0.43)
Received fouls (number)	260±24	259±30	0.07(0.53)	287±31	260±36	0.91(0.52)	547±42	518±61	0.72(0.59)
Turnovers (number)	2402±172	2583±141	0.99(0.42)	2420±152	2382±177	0.25(0.51)	4822±301	4965±279	0.46(0.44)
Free kick goals (number)	17±7	26±6	1.12(0.42)	26±12	26±6	0.06(0.63)	17±7	16±2	0.10(0.36)
Crosses (number)	426±107	445±63	0.24(0.37)	342±72	322±64	0.22(0.43)	768±168	767±118	0.06(0.39)

Figure 5 and Table 9 depict data on the comparison of the top 3 vs. bottom 3 teams for all defensive game actions. Again, all defensive match statistics presented between-group differences at the level of $P < 0.01$. However, the match statistics with the highest effect size for the comparison of successful and unsuccessful teams were the number of corners, the number of shots conceded and the effectiveness against shooting conceded (Figure 5). On the contrary, the number of red cards, and the distribution of in-game/free kick goals received were the variables with the lowest effect sizes for the comparison between top 3 vs. bottom 3 teams. At home, the number of shots conceded was the variable with the greatest effect size (Table 9). When playing away, the number of corners conceded was the variable with the highest effect size (Table 9). Other variables such as recoveries, yellow cards and fouls committed also presented large and most-likely differences between successful and unsuccessful teams (Figure 5) and the effect sizes of these variables slightly changed for the comparisons made at home and away.



*Standardized effect size in defensive variables for the comparison between the top 3 – bottom 3 teams in LaLiga from 2010 to 2018. *possible; ***very likely; ****most likely*

Figure 5. Standardized effect size in defensive variables for the comparison between the top 3 – bottom 3 teams in *LaLiga* from 2010 to 2018.

Table 9.Defensive variables for the top 3 and bottom 3 teams ranked in *LaLiga* from 2010 to 2018.

	Home			Away			Total		
Defence variables	**Top 3**	**Bottom 3**	**ES (90%CI)**	**Top 3**	**Bottom 3**	**ES (90%CI)**	**Top 3**	**Bottom 3**	**ES (90%CI)**
Corners against (number)	69±14	95±17	1.55(0.43)	87±15	124±16	2.11(0.42)	156±24	219±28	2.16(0.43)
Shots conceded (number)	167±30	231±23	1.79(0.38)	216±32	292±29	2.03(0.40)	383±57	523±48	2.04(0.39)
Effectiveness against shooting conceded (%)	9±2	12±3	1.21(0.42)	8±2	14±3	1.92(0.44)	9±2	13±2	1.87(0.42)
Recoveries (number)	1015±60	929±91	1.49(0.64)	985±73	871±87	1.61(0.55)	2000±122	1800±169	1.69(0.61)
Yellow cards (number)	37±10	55±8	1.36(0.38)	51±12	57±8	0.61(0.37)	88±20	113±14	1.17(0.38)
Fouls committed (number)	236±38	274±29	0.98(0.40)	236±44	273±24	0.84(0.37)	472±78	547±48	0.95(0.38)
Penalty kick conceded (number)	1±1	2±1	0.99(0.54)	2±2	4±2	0.71(0.52)	3±2	6±2	0.91(0.44)
Red cards (number)	1±1	2±1	0.08(0.56)	1±2	1±1	0.02(0.50)	2±2	3±1	0.28(0.43)
Free kick goals received (%)	21±10	20±8	0.14(0.44)	20±8	21±7	0.07(0.49)	20±7	20±5	0.10(0.39)
Goals received in game (%)	79±10	80±8	0.12(0.42)	80±8	79±7	0.17(0.45)	80±7	80±5	0.01(0.41)

Study 3: The football championship is won when playing away: difference in match statistics between the winner and the second-place team in *LaLiga*.

Objective

This analysis intends to define what characteristics differentiate a high-performance team between other teams with comparable performance in order to obtain a championship win.

Methods

Design and procedures

Study 3 presents a descriptive and comparative analysis for main end season match statistics obtained by the first-two ranked teams in the Spanish Professional Football League (*LaLiga*; from 2010/11 to 2017/18 seasons). The investigation does not included information that allows the identification of football players to keep *LaLiga* ethical guidelines. The investigation was approved by the University Institutional Review Board (Camilo José Cela University).

Measures

This analysis has been based on the suggestions made by (Mackenzie & Cushion, 2013) and includes a sample of three different elite football teams – across eight complete seasons teams are included in the 1st/2nd place cluster according to their end-season ranking – that won the championship or ended in second place; teams competing in the same championship and against the same rivals; and operational definitions of the investigated variables. Table 10 contains information about the end-season ranking points of the teams included in the analysis.

Table 10. Ranking points and names of the elite football teams included in the analysis.

Season	**1st place (points)**	**2nd place (points)**
2010-2011	F.C. Barcelona (96)	Real Madrid C.F. (92)
2011-2012	Real Madrid C.F. (100)	F.C. Barcelona (91)
2012-2013	F.C. Barcelona (100)	Real Madrid C.F. (91)
2013-2014	Atlético de Madrid (90)	F.C. Barcelona (87)
2014-2015	F.C. Barcelona (94)	Real Madrid C.F. (92)
2015-2016	F.C. Barcelona (91)	Real Madrid C.F. (90)
2016-2017	Real Madrid C.F. (93)	F.C. Barcelona (90)
2017-2018	F.C. Barcelona (93)	Atlético de Madrid (79)

The end-season accumulated match statistics of the 1st and 2rd-ranked teams were obtained from *LaLiga* during the 8 years. In the analysis, we included the number of home and away wins, the number of home and away draws and the number of home and away losses for each team, and information about the obtained/received goals during each season. In addition, we selected standard match statistics measured by Media Coach® with their operational definitions which are defined in Table 5. The selection of these variables has been based on previous studies (Lago-Peñas et al., 2010; Liu, Hopkins, et al., 2016; Ermanno Rampinini et al., 2009). The accumulated match statistics were divided by offensive and defensive actions to improve the applicability of this study's results to professional football.

Statistical Analysis

All variables are presented as average ± standard deviation for the 1st and 2nd ranked teams. To determine the magnitude of the differences in match statistics, the effect size was calculated through pairwise comparisons (Hopkins et al., 2009). The Cohen's d statistic ± 90% confidence intervals (CI) were used on log-transformed data to reduce bias due to any non-uniformities of error. The smallest significant standardized effect threshold was set as 0.2. Effect sizes were interpreted according to the following ranges: <0.2, trivial; 0.2–0.6, small; 0.6–1.2, moderate; 1.2–2.0, large; 2.0–4.0, very large and; >4.0, extremely large. All of these calculations were made in spreadsheets to compare the means of the two groups provided by Hopkins, (2020).

Results

Figure 6 depicts the distribution of wins, draws, and losses – both at home and away – for 1st- and 2nd-placed teams in the last eight seasons of *LaLiga*. In comparison to the championship winner, the second-place team obtained a similar number of victories at home but a lower number of away wins (ES = large). As a result, the total number of wins at the end of the season was inferior in the 2nd place vs the 1st place team (ES = large). On the contrary, the 2nd place team obtained a higher number of away draws (ES = moderate) and away loses (ES = moderate), resulting in a higher total number of draws (ES = small) and losses (ES = moderate) at the end of the season. Interestingly, the number of draws and losses at home was not different between the 1st and 2nd place teams.

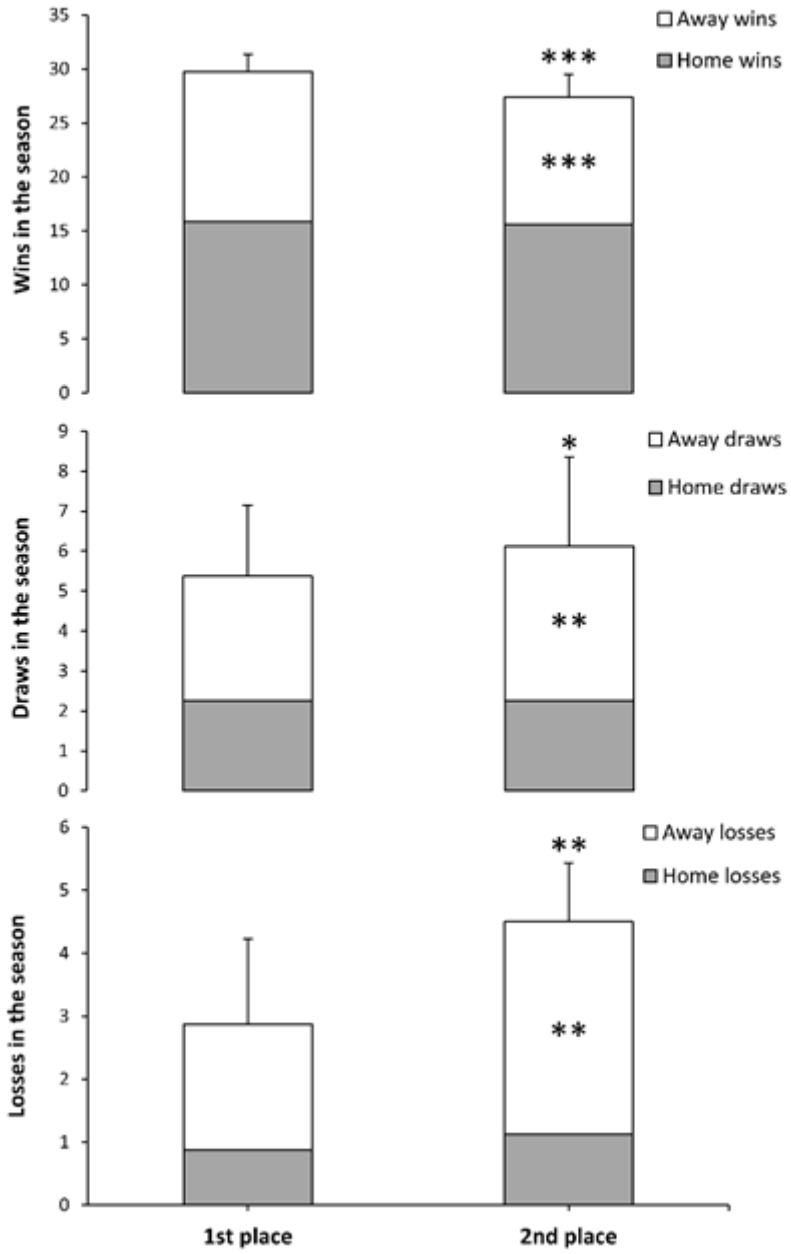


Figure 6. Distribution of wins, draws, and losses in the first and second place teams during the last 8 seasons of *LaLiga*.

Table 12 includes information about the differences in the distribution of goals between 1st and 2nd place teams. A higher number of goals scored while playing away, a lower number of goals received while away, and a lower number of received free-kick goals

were the variables with the highest effect size on the 1st vs. 2nd place teams' comparison (ES ≥ 0.6 and moderate). A higher number of goals scored in the second half and a lower number of goals received in the second half were other variables that differentiated between the 1st and 2nd place teams (ES = small). Table 13 depicts data about differences in match statistics between the champion and the second-place team at the end of the season. A higher shooting accuracy differentiated the championship winner from the second-place team (ES = moderate), even when the winner shot less (ES = small). The winner also performed a higher number of passes and successful passes with a lower proportion of crosses (ES = small). In the defensive variables, a lower number of conceded shots, penalty kicks, corners, and yellow cards likely differentiated between the teams (ES ≥ 0.5 and from small-to-moderate).

Figures 7 and 8 depict an overview of the magnitude of effect size identified for each variable analysed in this investigation. Away wins, the total number of wins and shooting accuracy were variables with the largest effect in the comparison of 1st vs 2 place teams. On the contrary, losses and draws away, the total number of losses and the number of conceded corners were variables in which the 2nd place team obtained higher numbers than the championship winner.

Table 11. Distribution of goals in the first and second place teams during the seasons from 2010-2011 to 2017-2018 of *LaLiga*.

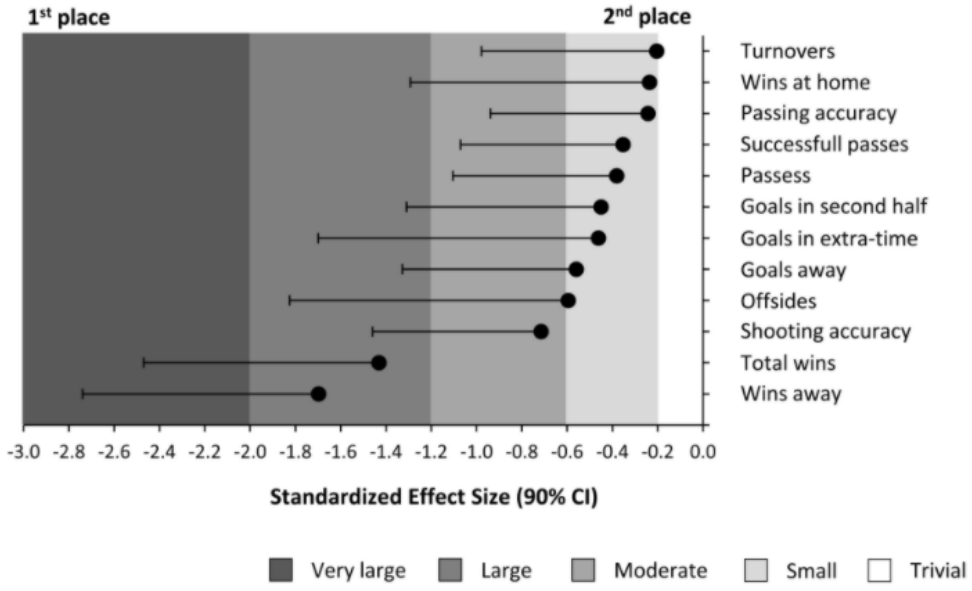
Variable	1st place	2nd place	ES±CI	+/Trivial/-	Likelihood
Goals	103±14	102±20	-0.2±1.1	28/24/47	unclear
Goals at home	58±10	62±13	0.3±1.1	55/22/23	possible
Goals away	46±9	40±8	-0.6±1.1	5/16/79	likely
Goals first half	44±9	47±12	0.2±1.1	50/23/27	unclear
Goals second half	59±10	54±12	-0.5±0.9	10/21/69	possible
Goals in extra-time	5±2	5±2	-0.5±1.2	18/18/65	possible
Free kick goals	15±4	16±6	0.1±1.1	32/25/44	unclear
In-game goals	88±15	85±15	-0.1±0.8	25/31/44	unclear
Goals received	30±8	33±7	0.4±0.7	69/22/8	possible
Goals received at home	14±4	14±4	0.1±0.8	45/32/24	possible
Goals received away	16±5	19±3	0.6±0.6	85/13/2	likely
Goals received first half	13±4	14±6	0.2±1.1	47/25/27	unclear
Goals received second half	17±4	19±3	0.5±0.7	78/18/5	likely
Goals received in extra-time	1±1	2±2	0.4±0.9	61/23/16	possible
Free kick goals received	5±2	8±3	0.8±0.7	92/6/1	likely
In-game goals received	25±7	25±5	0.1±0.7	38/37/25	possible

ES: Effect size. CI= Confidence Interval

Table 12. Distribution of match statistics in the first and second place teams in the seasons from 2010-2011 to 2017-2018 of *LaLiga*.

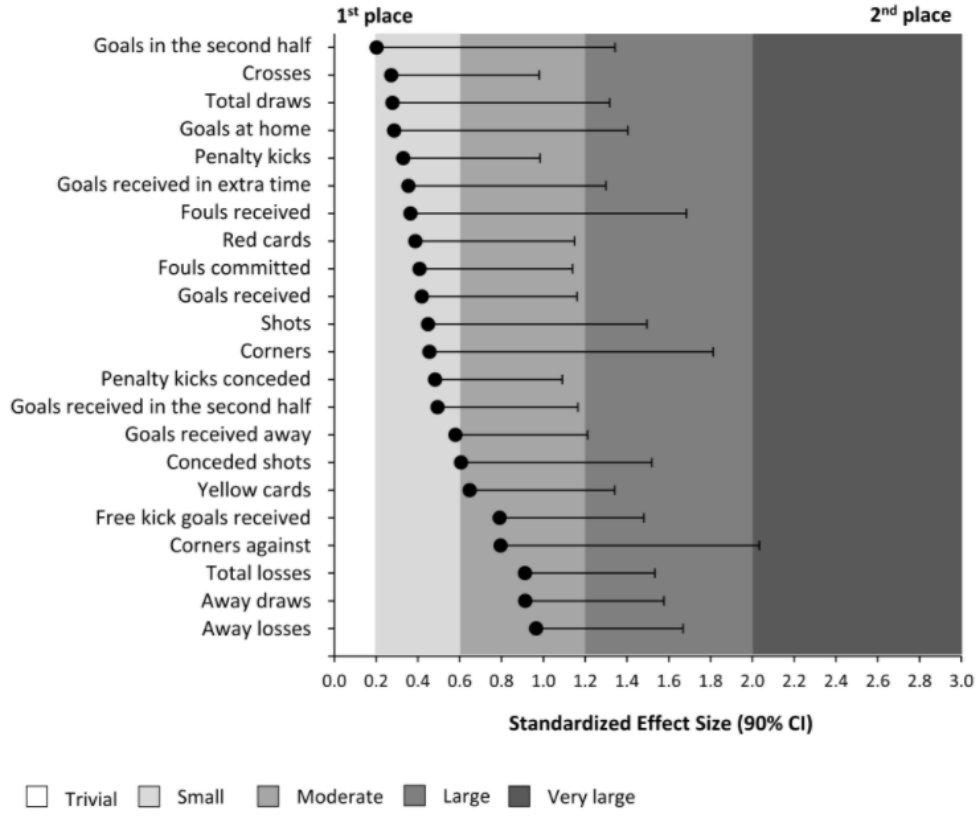
Variable	1st place	2nd place	ES±CI	Chance % +/Trivial/-	Likelihood
Shots	598±75	642±105	0.4±1.0	66/19/15	possible
Shooting accuracy (%)	17.5±2.1	16.0±1.6	-0.7±0.7	2/10/88	likely
Passes	25113±4367	23115±3565	-0.4±0.7	9/24/67	possible
Successful passes	21396±4590	19347±3704	-0.4±0.7	10/26/64	possible
Passing accuracy (%)	84.6±4.4	83.3±3.3	-0.2±0.7	14/32/54	possible
Crosses	690±185	745±165	0.3±0.7	57/30/13	possible
Penalty kicks	9±5	10±3	0.3±0.7	64/28/9	possible
Turnovers	4757±248	4701±233	-0.2±0.8	19/31/50	unclear
Fouls received	560±21	570±44	0.4±1.3	59/18/23	possible
Corners	235±17	246±33	0.5±1.4	63/17/20	possible
Offsides	131±10	126±18	0.3±1.1	55/22/23	possible
Shots conceded	354±45	389±62	0.6±0.9	78/15/7	likely
Effectiveness against conceded shooting (%)	8.4±1.7	8.8±1.7	0.2±0.9	49/28/23	possible
Fouls committed	427±63	454±56	0.4±0.7	69/23/8	possible
Penalty kicks conceded	3±2	2±2	0.5±0.6	79/17/4	likely
Corners against	144±14	158±28	0.8±1.2	80/11/9	likely
Yellow cards	76±15	87±12	0.6±0.7	86/11/3	likely
Red cards	2±2	2±2	0.4±0.8	67/24/10	possible
Recoveries	2016±108	2005±138	-0.1±0.9	28/30/42	possible

ES: Effect size. CI = Confidence Interval



Only game statistics with ≥ small effect size have been included.

Figure 7. Standardized effect size (−90% CI) of game statistics where the first-place team obtained higher numbers than the second place team in the seasons from 2010-2011 to 2017-2018 of *LaLiga*.



Only game statistics with ≥ small effect size has been included

Figure 8. Standardised effect size (+90% CI) of game statistics where the first place team obtained lower numbers than the second place team in the seasons from 2010-2011 to 2017-2018 of *LaLiga*.

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Study 4: Relationship between the time of goal scoring and classification in *LaLiga*: an analysis of 8 complete seasons.

Study 5: Association of the match running performance with and without ball possession to football performance.

Objectives

The aim of this study was to determine the association between match running performance variables, with and without ball possession, and the number of points earned at the end of a professional football league by using data on 4 complete seasons.

Methods

Design and procedures

This investigation is a descriptive correlational analysis to determine the importance of running with and without the ball in overall football performance. It includes a sample of 20 high-performance teams across 4 seasons (2015–2016 and 2018–2019) for a total of 1,520 matches. Overall football performance during the season was defined as the number of points earned during the season once the championship had finished (*i.e.* ranking points), a variable that has been previously used for this purpose (Brito Souza et al., 2019).

Table 14 contains information about the average ranking points obtained at the end of each season. It also highlights points obtained by the league champion (1st), teams classified for the Champions League (2nd – 4th) and Europa League (5th and 6th), and the relegated teams (18th – 20th). Teams that did not fulfil these criteria were categorised as middle teams because their points classified them in the middle of the ranking (7th – 17th). Seeking high applicability of the research outcomes to the real context in a professional football league, the variables used for this analysis were running distances

covered with and without ball possession. For both situations, running distance covered at ≥ 21 km/h and at < 21 km/h were analysed.

Table 13. Points obtained by the teams competing in 4 seasons in *La Liga*.

Season	Champion	Champions League	Europa League	Middle	Relegation
2015-2016	91	≥ 64	≥ 60	≥ 39	≤ 38
2016-2017	93	≥ 72	≥ 64	≥ 35	≤ 31
2017-2018	93	≥ 73	≥ 60	≥ 43	≤ 29
2018-2019	87	≥ 61	≥ 59	≥ 41	≤ 37

Data on each variable was normalized as the team's running distance per match to obtain easier-to-use information for coaches and physical conditioning staff. Because we used the accumulated match statistics and ranking points, we were required to use 80 comparative data points (20 teams per season and 4 seasons).

Statistical Analysis

We set the significance level for the statistical analysis at $P < 0.05$ and all analysis and calculations were performed using the SPSS v.20 software package (SPSS Inc., USA). Initially, we used the Levene test to verify sample homogeneity, and the Shapiro-Wilk test to verify normality in each variable (*i.e.* total running distance and running distance covered at ≥ 21 km/h and at < 21 km/h with and without ball possession). Descriptive means and standard deviations were calculated for all these variables within each group (Table 15). We used a one-way ANOVA to compare the means between groups (Champion vs. teams classified for the Champions League vs. teams classified for the Euro League vs. Middle teams vs. Relegation teams). After a significant F value was obtained in the ANOVA, the differences between groups were identified by performing pairwise comparisons and using Tukey post-hoc test. Afterward, we used Pearson's correlation coefficient (r) to assess the association between all running variables of each team and the points obtained at the end of the season. Then, we performed a multiple

regression analysis in a stepwise interactive mode to assess the influence that each running variable had on the points obtained at the end of the league. In the regression analysis, all match statistics were introduced based on their correlation with the residual ($p < 0.1$) and their intercorrelation with variables that already existed in the equation. By using a threshold of 3.5 points in the variance inflation factor (VIF), redundant variables were excluded to avoid multicollinearity. The produced regression equation was accepted at a significance level of $P < 0.01$. The r2 values were adjusted for the number of cases and parameters in the analysis. Using the standardised regression coefficients, the relative contribution of each of the different variables concerning the explained variances was calculated as follows (Puente et al., 2015). Partial contribution r2 adjusted = ([Standardised regression coefficient for parameter]/ Σ [of all standardised regression coefficients in equation]).

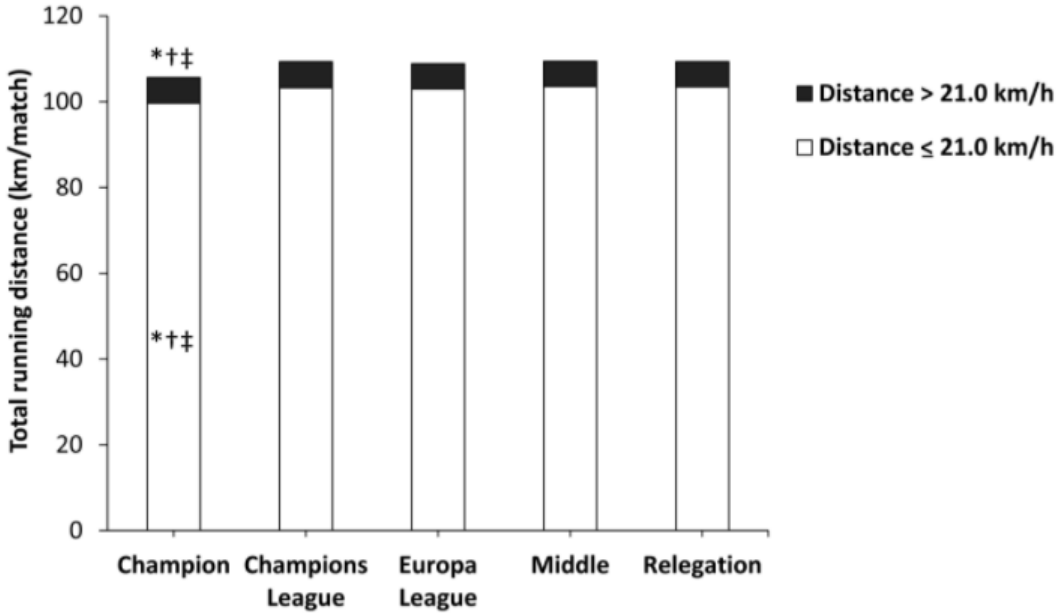
Results

Figure 12 depicts teams' total running distances per match according to their ranking position at the end of the competitive season. The ANOVA analysis revealed a main effect of the ranking position on total running distance ($P = 0.040$). On average, the league champion (105.6 ± 1.7 km/match) ran a shorter distance than the teams that classified for the Champions League (109.3 ± 2.5 km/match, $P = 0.05$), than the teams ranked in the middle of the classification (109.4 ± 2.3 km/match, $P = 0.02$), and the teams that were relegated to the second division (109.3 ± 2.3 km/match, $P = 0.04$). The differences in running distance between the league champion and the teams that classified for the Europa League (108.9 ± 1.7 km/match, $P = 0.15$) did not reach statistical significance. A similar main effect of ranking position was found on running distance at speeds <21 km/h ($P = 0.03$), where the league champion ran less distance than the Champions League

teams (P = 0.05), Middle teams (P = 0.01) and Relegation teams (P = 0.03). However, all teams ran a similar distance at speeds >21 km/km (P = 0.65: Figure 12).

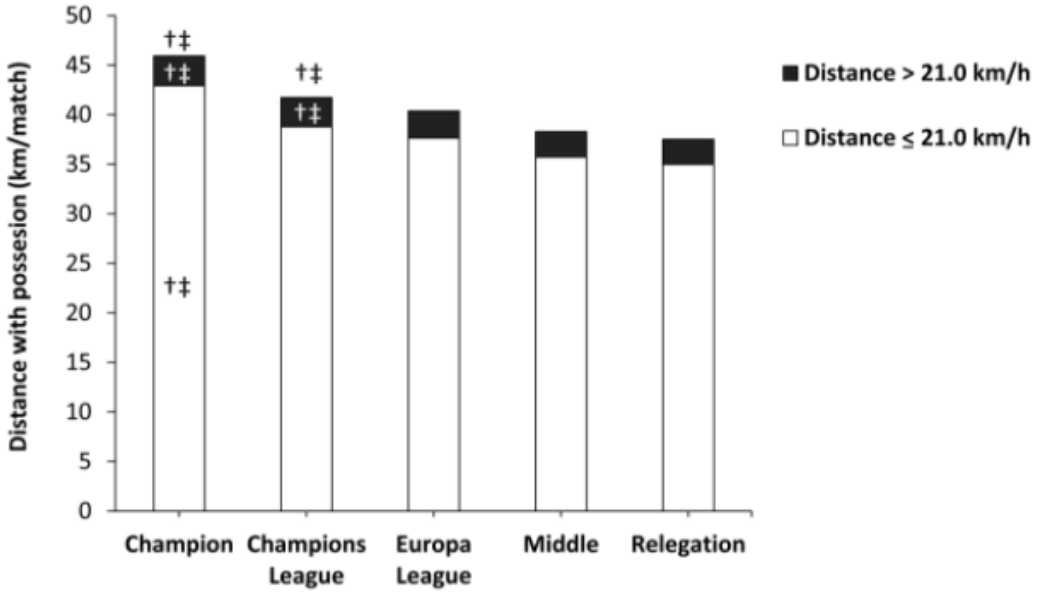
Figure 13 depicts teams' running distances per match with ball possession. The ANOVA analysis revealed a main effect of the ranking position on teams' total running distances with ball possession (P < 0.01). On average, the league champion and the teams classified for the Champions League ran a greater distance with possession than Middle teams (P < 0.01) and Relegation teams (P < 0.01). Regarding the running distance with ball possession at ≥ 21 km/h (ANOVA; P < 0.01), again the league champion and the teams classified for the Champions League ran a greater distance than Middle teams (P < 0.01) and Relegation teams (P < 0.01) but only the league champion also ran a greater distance with the ball at < 21 km/h than Middle teams (P < 0.01) and Relegation teams (P < 0.01).

Figure 14 depicts teams' running distances per match without ball possession. The ANOVA analysis revealed a main effect of the ranking position on the running distance without ball possession (P < 0.01). Specifically, the league champion ran less distance than all the remaining teams (P < 0.01). This difference was due to a lower running distance at < 21 km/h in the league champion when compared to Champions League (P = 0.04), Middle (P < 0.01). and Relegation (P < 0.01) teams. In contrast, there was not any between-group difference in the distance covered without the ball at ≥ 21 km/h (P = 0.06).



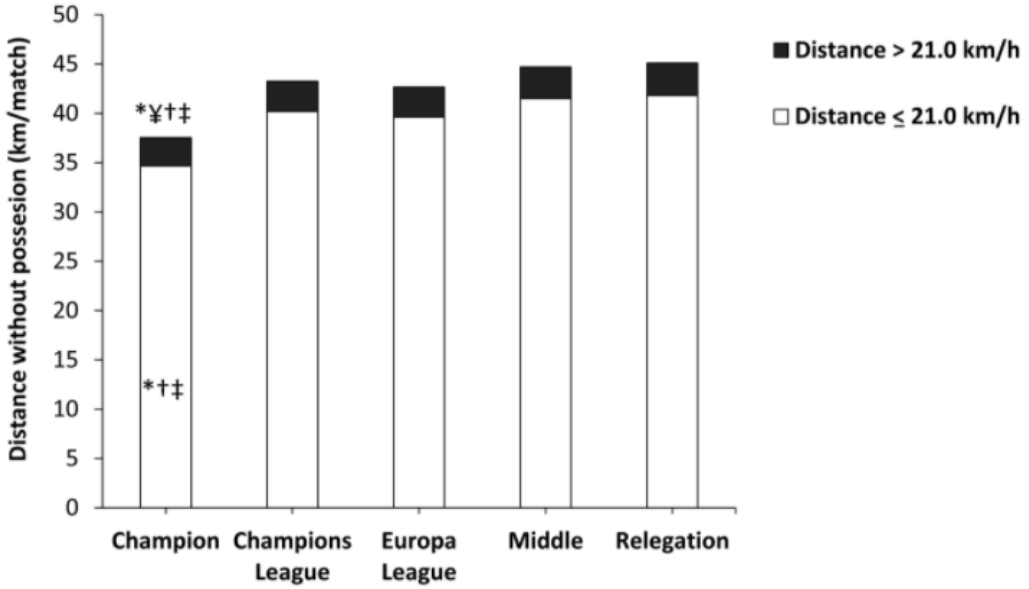
(*) Different from champions league teams at P < 0.05; (†) Different from middle teams at P < 0.05; (‡) Different from relegation teams at P < 0.05.

Figure 9. Total running distance per match in teams with different ranking categories in *LaLiga.*



(†) Different from middle teams at P < 0.05; (‡) Different from relegation teams at P < 0.05.

Figure 10. Running distance per match with ball possession in teams with different ranking categories in La Liga.



(*) Different from champions league teams at P < 0.05; (¥) Different from Europa league teams at P < 0.05; (†) Different from middle teams at P <0.05. *(‡) Different from relegation teams at P < 0.05.*

Figure 11. Running distance per match without ball possession in teams with different ranking categories in La Liga.

Table 15 contains Pearson's correlation coefficients of the analysed variables with the ranking points at the end of the season. Neither total running distance nor distances above and below 21 km/h correlated to the points obtained at the end of the season. However, the distances covered with possession positively correlated with ranking points while the distances covered without possession negatively correlated to ranking points. Figure 15 depicts the variance in the points obtained as explained by the variable analysed. Overall, the multiple regression analysis explained 37.9% of the total variance in the number of points at the end of the seasons. The running distance with possession at ≥ 21 km/h was the variable that best explained the variance of the ranking points (18.1%), followed by distance with possession at < 21 km/h (13.9%). The running distances without possession explained less than 4% each.

Table 14. Pearson correlation coefficients (r) for the association between the points obtained at the end of the season and running distance with and without the ball.

Match running variables	**R**
Distance	-0.11
Distance ≥ 21km/h	0.22
Distance < 21km/h	-0.14
Distance with possession	0.52*
Distance with possession ≥ 21km/h	0.57*
Distance without possession ≥ 21km/h	-0.27*
Distance with possession < 21km/h	0.50*
Distance without possession < 21km/h	-0.36*

(*) The correlation was statistically significant at $P < 0.05$.

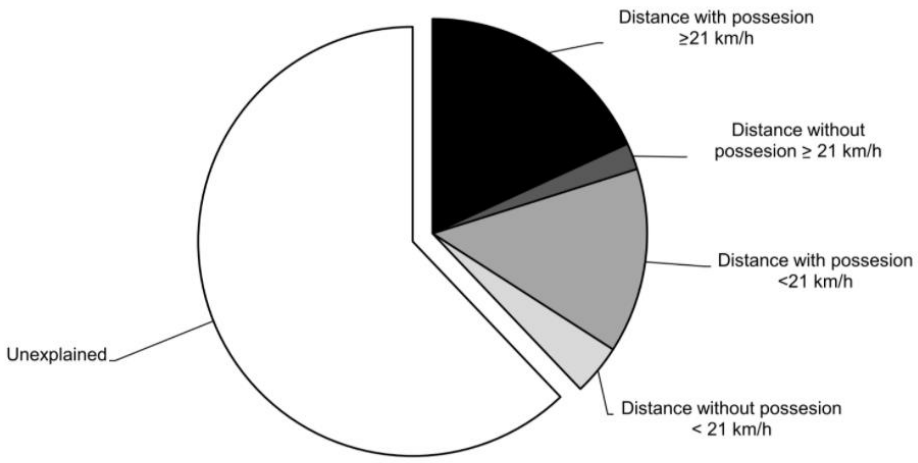


Figure 12. Percentage of variance in the number of points obtained at the end of the season as explained by running distances with or without the ball.

Study 6: Influence of players' maximum running speed on the team's ranking position at the end of the Spanish *LaLiga*.

Objective

This objective was intended to evaluate the relevance of players' maximum speed on football performance during a national football league. A second aim was to investigate differences in maximum running speed among playing positions.

Methods

Design and procedures

The study sample was composed of 475 football players competing in the Spanish first-division football league (*LaLiga*) during the 2017–2018 season. This corresponds to the entire population of professional football players that competed at least for 30 min in the 2017–2018 season. From the total, 175 players were defenders, 196 were midfielders, and 105 were forwards (36.8/41.3/21.9%, respectively). The number of players per team and per playing position in the field, in addition to their maximum running speeds during the season, are detailed in Table 16. Of note, data from the players competing in the team classified in 13th position were not used in this investigation, as none of the matches played in its stadium reported data on running actions during the 2017–2018 season. In accordance with *LaLiga*'s ethical guidelines, this investigation does not include information that identifies football players.

Table 15. The number of players and players' maximum running speed according to the team's ranking in the 2017-2018 season of *LaLiga* championship.

Ranking	Total	Defender	Midfielder	Forward
1st	22 32.8±1.2	9 33.1±1.0	8 32.0±1.3	5 33.5±1.0
2nd	23 32.8±1.6	8 33.1±1.1	9 31.8±2.0	6 33.8±0.7
3rd	21 33.4±1.5	8 34.1±1.0	9 32.8±1.5	4 33.1±1.8
4th	23 33.0±1.2	9 33.0±0.5	11 32.9±1.5	3 33.9±1.4

5th	27 32.0±1.6	9 32.2±1.5	12 31.5±1.7	6 32.9±1.3
6th	24 32.7±1.3	9 33.2±0.8	7 32.5±0.8	8 32.4±1.9
7th	28 32.1±1.7	10 32.0±1.3	13 31.9±2.0	5 32.8±1.4
8th	26 32.1±1.6	10 32.1±1.5	9 31.0±1.4	7 33.5±1.2
9th	23 32.8±1.6	8 32.8±1.4	11 32.6±2.0	4 33.1±0.9
10th	20 32.8±1.3	8 33.0±1.5	8 32.3±1.4	4 33.3±0.8
11th	23 32.4±1.4	8 32.4±1.7	11 32.0±1.2	4 33.4±1.0
12th	22 32.3±1.7	9 32.2±2.1	7 32.4±1.2	6 32.4±1.9
14th	27 32.5±1.5	8 32.8±1.4	12 32.1±1.7	7 32.6±1.3
15th	29 32.6±1.4	9 33.3±0.7	11 32.5±1.8	9 31.9±1.1
16th	23 32.6±1.2	11 32.9±1.1	8 31.9±1.1	4 33.3±1.1
17th	23 32.8±1.7	9 32.9±1.1	10 32.2±2.1	4 34.3±0.7
18th	27 32.2±1.8	11 32.1±1.7	13 31.8±1.8	3 34.1±0.2
19th	33 32.5±1.3	11 32.6±1.0	15 31.9±1.4	7 33.4±0.8
20th	31 32.3±1.5	11 32.3±1.2	12 32.0±1.8	8 32.6±1.7

This investigation is a descriptive and comparative analysis to determine the importance of players' maximum/peak running speeds on football performance. Data were obtained from *LaLiga*, which authorized the use of the variables included in this investigation. The Spanish national first-division football league is composed of 20 teams competing in a total of 38 fixtures (for a total of 380 matches for the season). Data from the matches of the team classified in the 13th position were excluded from the investigation because the multicamera tracking system was not installed in its stadium during the season under investigation. Hence, this investigation contains data on 361 matches played across 38 fixtures. In each fixture, players' peak running speed, defined as the highest running speed

attained in a particular match, was obtained and recorded for all the field players, for a total of 7838 values across the season. Only peak running speeds of players competing during at least 30 min in the match were considered for analysis to ensure that the players had time to produce a football action at high/peak intensity. Maximum running speed was defined as the highest running speed obtained by a player during the entire season, using all the values recorded by this player during all the matches he participated in for at least 30 min. The data on goalkeepers were excluded due to the different nature of their movement patterns during the game. To determine the influence of players' peak/maximum running speeds on football performance, a comparison was made of the individual and team average running speeds (1) according to the ranking position at the end of the season and (2) according to ranking categories as follows: the league champion (1st); teams classified for the Champions League (2nd–4th); teams classified for the Europa League (5th and 6th); teams in the middle of the ranking (7th–17th); and the relegated teams (18th–20th). An analysis of teams' maximum speeds depending on the playing position was also performed by using three positions: defenders, midfielders, and forwards.

Statistical analysis

We set the significance level for the statistical analysis at $p < 0.05$ and all analyses and calculations were performed using the SPSS v.20 software package (IBM, Armonk, NY, USA). Initially, we used the Levene test to verify sample homogeneity and the Kolmogorov–Smirnov test to verify the normality of peak/maximum running speeds. Descriptive means and standard deviations were calculated in each team and for each playing position (Table 16). We used a one-way analysis of variance (ANOVA) of repeated measures to compare peak running speeds among the 38 fixtures that comprised

the championship. We used a two-way ANOVA (fixture x ranking category) to determine differences in the evolution of maximum running speed across the season among the ranking groups. The number and distribution of players according to their maximum running speeds were calculated using 1.0 km/h intervals. A two-way ANOVA (playing position x ranking) was used to search for differences among teams in the maximum running speed for any playing position. In the case of a significant F value in the ANOVAs, the differences between groups were identified by Tukey post hoc tests. For the differences in maximum running speed between playing positions, the effect size was calculated in Cohen's d units (Cohen, 2013). Pearson's correlation coefficients (r) were used to assess the association between a team's maximum running speed and ranking position at the end of the season. The size of a correlation coefficient was evaluated following Hinkle et al. (2003). Then, a multiple regression analysis was carried out in a stepwise interactive mode to assess the influence that a team's maximum running speed had on the ranking position at the end of the league. In the regression analysis, all match statistics were introduced based on their correlation with the residual ($p < 0.1$) and their intercorrelation with variables that already existed in the equation. The r^2 values were adjusted for the number of cases and parameters included in the analysis (Puente et al., 2015).

Results

Figure 16 depicts the peak running speeds obtained by the football teams during the season. In the upper panel, the data include the mean of all teams competing in *LaLiga* in each of the 38 fixtures that comprised the championship, and the one-way ANOVA revealed no statistically significant differences in the values of peak running speed among the different fixtures ($F = 1.282$; $p = 0.372$). In the lower panel, peak running speeds are presented according to different ranking groups. The two-way ANOVA revealed no main

effect of the ranking group in the maximum running speeds obtained during the season (F = 2.191; p = 0.134).

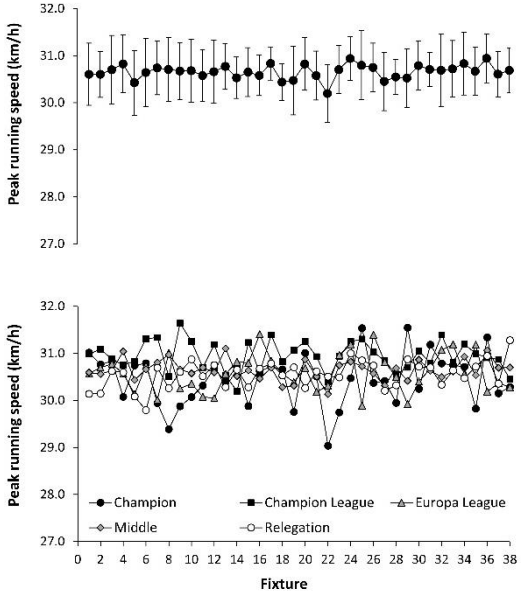
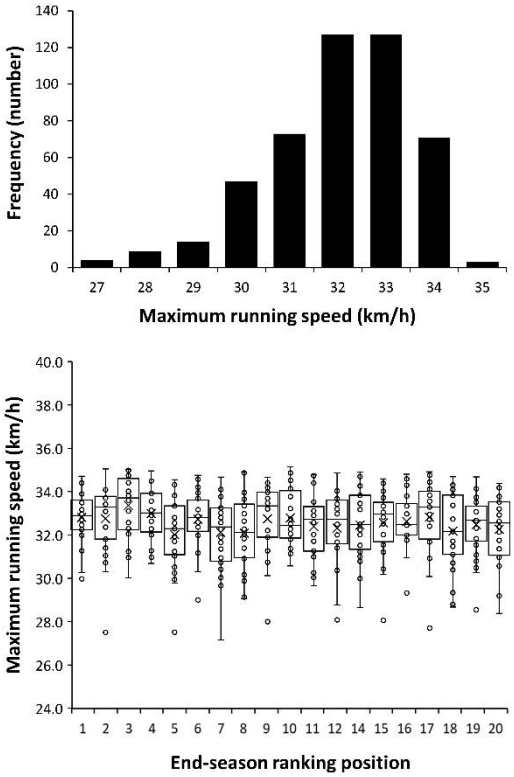


Figure 13. Peak running speed per fixture (upper panel) and peak running speed in teams with different ranking categories (lower panel) in La Liga 2017-2018.

The number of players distributed according to their maximum running speeds during the 2017–2018 season is presented in Figure 17. Most players (53.5%) were in the range of 32.0–33.9 km/h, with 71 players (14.9%) surpassing 34.0 km/h and only 3 players (0.6%) with maximum running speeds of over 35.0 km/h. Still, there were 27 players (5.7%) who did not reach 30.0 km/h during the competitive season. Nevertheless, teams' maximum speeds were unrelated to the end of season ranking position obtained, as the one-way ANOVA revealed no differences in the maximum running speed values among the different teams competing in *LaLiga* (F = 1.308; p = 0.177).



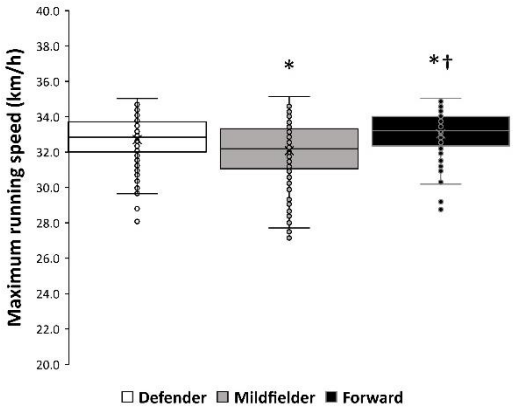
cData represents the maximum running speed obtained by each player in the 2017-2018 season. Note: There were no data for the team classified in the 13th position.

Figure 14. Number of players according to their maximum running speed (upper panel) and individual maximum running speed according to the end-season ranking position of the teams competing in *LaLiga* 2017-2018.

Additionally, the correlation coefficient between teams' maximum speeds and ranking position was low (r = -0.356, p = 0.135). There was a main effect of the playing position on maximum running speed (F = 18.765; p < 0.001).

Overall, forwards were the fastest players (33.03 ± 1.35 km/h) with a higher maximum running speed than defenders (32.72 ± 1.32 km/h; p = 0.025, d = 0.23) and midfielders (32.08 ± 1.63 km/h; p < 0.001, d = 0.63). Defenders were also faster than midfielders (Figure 18; p < 0.001, d = 0.43). However, there was not any interaction between the ranking position of the team and the playing position (Table 16; F = 0.897; p = 0.643).

The correlation coefficient between teams' maximum speeds and ranking position was low for defenders (r = -0.334, p = 0.163) and small for midfielders (r = -0.125, p = 0.610) and forwards (r = -0.065, p = 0.791). Finally, the variance in the ranking position obtained at the end of the league as explained by the team's maximum speed was of only 7.5% (contribution r^2 adjusted = 0.075, p = 0.427).



(*) Different from defender at p < 0.05. (†) Different from midfielder at p < 0.05.

Figure 15. Individual maximum running speed according to the playing position in the field in La Liga 2017-2018

Study 7: Players' physical performance in *LaLiga* across the season: insights for competition continuation after COVID-19

Objectives

The aim of this study was to verify at which time of the season, the athletes have the better physical running performance.

Methods

This study is a descriptive analysis of the running performance of teams competing in *LaLiga* across the last 4 seasons (from 2015–2016 to 2018–2019). The analysis includes the average running distance per game for each of the 38 matchdays that compose *LaLiga*, for a total of 1,520 matches analysed..

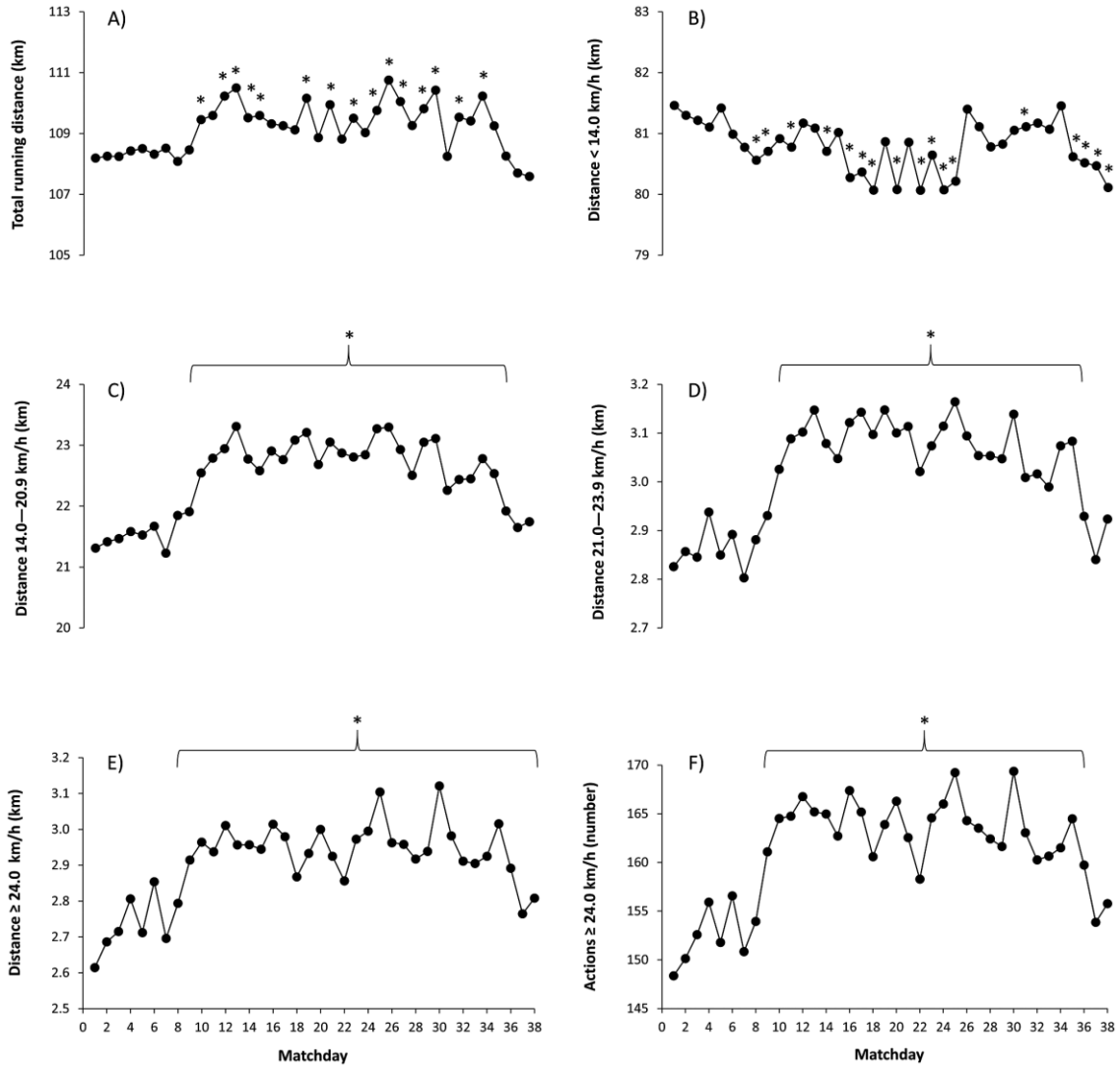
Statistical analysis

The analysis includes the mean of 152 matchdays across four seasons, including 1520 matches of the first Spanish league. We used the Levene's test for the sphericity and the Shapiro-Wilk to identify sample normality. After this, we used the one-way ANOVA to compare means between the first matchday and the each matchday left to finish the competition. After a significant F value, we used the LSD post-hoc to identify the differences. The significance level was set at P <0,050.

Results

After the present analysis, we have found the following outcomes: there was a main effect of the matchday on total running distance per match (F = 2.44, P = 0.001). In comparison to matchday-1, the total running distance covered during the game in several fixtures after matchday-10 was significantly longer (Figure 19A). There was also a main effect of the matchday on the distance covered at < 14.0 km/h (F = 1.63, P = 0.010). However, in this case, the running distance at this speed threshold was progressively decreased from

matchday-1 and it was significantly lower than matchday-1 at several matchdays after matchday-8 (Figure 19B). Regarding the distance covered between 14.0 and 20.9 km/h ($F = 5.76$, $P < 0.001$), between 21.0 and 23.9 km/h ($F = 3.22$, $P < 0.001$) and at above 24.0 km/h ($F = 2.50$, $P < 0.001$), there was a main effect of the matchday on the running performance at these speed thresholds, and the post-hoc analysis revealed that the running patterns progressively increased during the first 8–10 matchdays and then reached a plateau which was significantly different to matchday-1 (Figure 19C, 16D and 16E). A similar pattern was found for the number of sprints performed at ≥ 24.0 km/h ($F = 2.78$, $P < 0.001$; Figure 19F). In all running variables, there was a progressive decrease in the last four matchdays.



A) Total running distance, B) running distance covered at < 14.0 km/h, C) running distance covered between 14.0 and 20.9 km/h, D) running distance covered between 21.0 and 23.9 km/h, E) running distance covered at ≥ 24.0 km/h, F) number of sprints covered at ≥ 24 km/h. Each dot represents mean running distance on each matchday in the last four seasons (from 2015/16 to 2018/19). (*) Different from matchday-1 at $P < 0.05$.

Figure 16. Total running distance per match, distance at different speed thresholds and number of sprints across the 38 matchdays that composed *LaLiga*.

Study 8: Running patterns in *LaLiga* before and after suspension of the competition due to covid-19.

Objectives

The aim of this article is providing a comparative analysis of match running performance in teams competing in *LaLiga* before and after the lockdown due to COVID-19.

Methods

Sample.

The study sample was composed of 530 and 555 football players competing in *LaLiga* Santander for the 2018–2019 and 2019–2020 seasons, respectively. A total of 342 football players played on both seasons while the remaining 401 players only played on one of the two seasons under investigation. This sample corresponds to the entire population of professional football players that competed in *LaLiga* for these two seasons. The inclusion criteria were (a) being a football player competing in the first division of football in Spain, (b) being professionally associated to one of the twenty teams competing in *LaLiga* and (c) playing at least one match in either the 2018–2019 and 2019–2020 seasons.

Design and procedures

This study is a descriptive and comparative analysis of match running performance in all teams competing in *LaLiga* in the 2018–2019 and 2019–2020 seasons. To aid in determining the effect of lockdown in football running performance, a pairwise comparison of running patterns was performed between these two seasons. The 2018–2019 season was established as a "control" season while the 2019–2020 season was considered as the "experimental" season because entailed normal competition for 27 matches, a suspension for 12 weeks and resumption to finish the 11 fixtures remaining. The analysis includes the average running distance per game for each of the 38 matchdays

that compose the first division of professional football in Spain, for a total of 560 matches analysed (*i.e.*, 380 matches per season). Additionally, the number of substitutions per match and match duration were also extracted to assess the effect of the in-game regulations introduced after the resumption of the competition.

Statistical Analysis

Statistical analyses were carried out using the software IBM SPSS Statistics for Macintosh, Version 26.0 (IBM Corp., Armonk, NY, United States). Data were normally distributed in all variables as determined by the Shapiro-Wilk test. Additionally, the sphericity assumption was checked with Mauchly's test. If this assumption presented a probability of $P < 0.05$, the Greenhouse-Geisser correction was used. To identify the effects of the lockdown on match running performance variables, we used a two-way analysis of variance (ANOVA) with within-between comparisons (season x matchday), and an LSD post-hoc analysis in those variables with a significant F test. To specifically examine the effect of lockdown on the fixtures performed after the resumption of the football competition, a sub-analysis comparing the last 11 fixtures (from the fixture 28 to the fixture 38) of the 2018–2019 and 2019–2020 seasons was performed. For this sub-analysis, we used unpaired t tests while the effect size was also calculated by using Cohen's d units (Cohen, 2013). The significance level was set at $P < 0.050$.

Results

The two-way ANOVA revealed that there was no main effect of the season or season x matchday interaction on total running distance per match, in the distances covered < 14.0 km/h, in the distance covered between 21.0 and 23.9 km/h, and in the distance covered at ≥ 24.0 km/h (Figure 20; see Table 16 for F and P values). Likewise, there was no main effect of the season nor season x matchday interaction in the number of sprints performed at ≥ 24.0 km/h. However, there was a main effect of the season on the distance covered

at 14.0–20.9 km/h (P = 0.019) with the post-hoc analysis revealing lower distances in the 2019–2020 season vs. 2018–2019 season for matchdays 32, 34, and 35 (P < 0.050). Additionally, the distance covered at 14.0–20.9 km/h was lower on matchdays 32, 34, 35, 36, 37, and 37 with respect to matchday 27 of the 2019–2020 season (P < 0.050). The two-way ANOVA also revealed main effects of the season, matchday and an interaction between these two factors in the number of players' substitutions that the teams used per match (Table 17). Specifically, the number of substitutions was higher in all pairwise comparisons between the 2018–2019 vs. 2019– 2020 season from matchday 28 to matchday 38 (Figure 20; P < 0.050). Furthermore, the number of substitutions was higher from matchday 28 to matchday 38 when compared to matchday 27 of the 2019–2020 (P < 0.050). There was also a main effect of the season on match duration (Table 17), indicating that match duration was higher from matchday 28 to matchday 38 in the 2019–2020 season with respect to the previous season (P <0.050) while match duration was higher from matchday 28 to matchday 38 when compared to matchday 27 within the 2019–2020 season (P < 0.05).

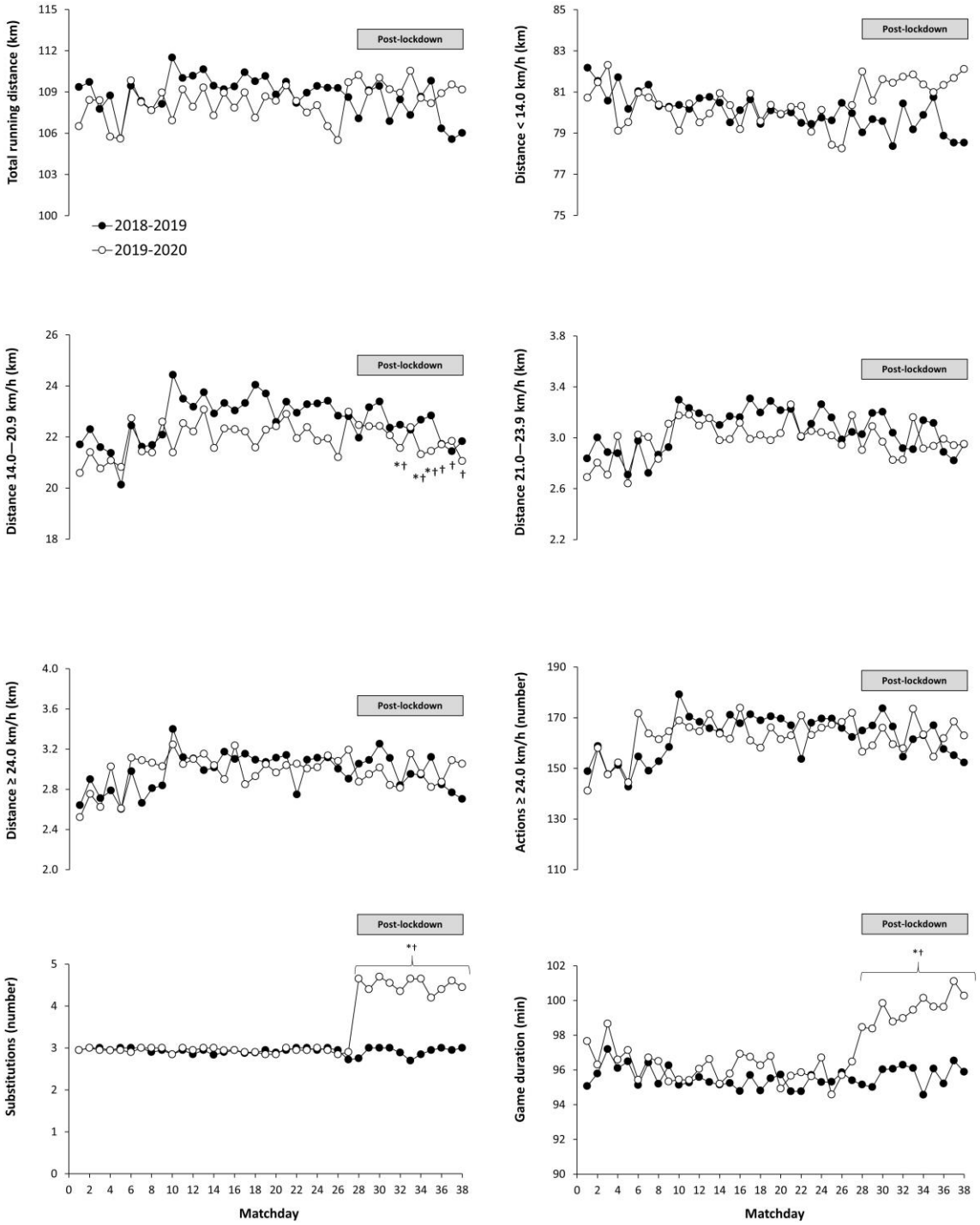
Table 16. Main effects (season × matchday) and interaction in running patterns of professional football teams in *LaLiga* when comparing the 2018-2019 and 2019-2020 seasons.

Variable	Season	Matchday	Interaction
Total running distance	F= 1.361	F= 1.405	F= 1.588
	P = 0.288	*P* = 0.254	*P* = 0.193
Distance at < 14.0 km/h	F= 1.321	F= 0.751	F= 0.893
	P = 0.294	*P* = 0.415	*P* = 0.433
Distance at 14.0—20.9 km/h	F= 11.657	F= 1.553	F= 1.037
	P = 0.019	*P* = 0.234	*P* = 0.414
Distance at 21.0—23.9 km/h	F= 1.564	F= 2.079	F= 1.588
	P = 0.266	*P* = 0.128	*P* = 0.193
Distance at ≥ 24.0 km/h	F= 3.470	F= 1.305	F= 1.482
	P = 0.112	*P* = 0.294	*P* = 0.220
Actions at ≥ 24.0 km/h	F= 2.077	F= 0.981	F= 1.151
	P = 0.209	*P* = 0.436	*P* = 0.361
Number of substitutions	F= 308.197	F= 19.603	F= 22.890
	P < 0.001	*P* < 0.001	*P* < 0.001
Match duration	F= 7.200	F= 3.522	F= 7.344
	P < 0.001	*P* = 0.385	*P* = 0.110

In the sub-analysis of the last 11 matchdays of each season, total running distance and the distance at < 14.0 km/h were higher in the 2019–2020 season when compared to the 2018– 2019 season (P < 0.050; Table 18). Additionally, the number of substitutions and match duration was higher the 2019–2020 season when compared to the 2018–2019 season (P < 0.050). On the contrary, the distance covered between 14.0 and 20.9 km/h was lower in the 2019–2020 season when compared to the 2018– 2019 season (P = 0.034). There were no other differences between seasons in the remaining running performance variables in the last 11 matchdays of the seasons under investigations.

Table 17. Averaged running patterns of professional football teams in *LaLiga* in the last 11 fixtures of the 2018-2019 and 2019-2020 seasons.

Variable	2018-2019	2019-2020	*P* value	Effect size
Total running distance	107.7±1.5	109.3±0.7	0.015	1.10
Distance at < 14.0 km/h	79.3±0.8	81.5.3±0.4	<0.001	2.75
Distance at 14.0—20.9 km/h	22.4±0.6	21.9±0.5	0.034	-0.81
Distance at 21.0—23.9 km/h	3.0±0.1	3.0±0.1	0.226	0.10
Distance at ≥ 24.0 km/h	3.0±0.2	2.9±0.1	0.759	-0.13
Actions at ≥ 24.0 km/h	162.1±6.6	162.1±5.6	0.994	0.00
Number of substitutions	2.9±0.1	4.5±0.2	<0.001	14.7
Match duration	95.7±0.6	99.5±0.8	<0.001	6.6



(A) Total running distance, (B) running distance covered at <14.0 km/h, (C) running distance covered between 14.0 and 20.9 km/h, (D) running distance covered between 21.0 and 23.9 km/h, (E) running distance covered at ≥24.0 km/h, (F) number of sprints covered at ≥24 km/h, (G) number of players' substitutions, (H) game duration. Each dot represents mean value for 20 teams on each matchday for each season (*) Different from the same matchday in the 2018–2019 season, P < 0.05. (†) Different from matchday 27 in the 2019–2020 season, P < 0.05. Note: In the 2019–2020 season, the competition was suspended after matchday 27 due to the COVID-19 pandemic. The competition was resumed after 12 weeks (8 weeks of lockdown and 4 weeks of retraining) to complete the 38 matchdays that comprised LaLiga.

Figure 17. Total running distance per match, distance at different speed thresholds, number of sprints, players' substitutions, and game duration in *LaLiga* in the 2018–2019 and 2019–2020 seasons.

DISCUSSION

A new paradigm to understand success in professional football: analysis of match statistics in *LaLiga* for 8 complete seasons

Studies 1, 2, 3 and 4 presented on this Thesis were carried out using the database of eight seasons (2010-2011 to 2017-2018) from *LaLiga*. However, each one has specifics objectives using different match statistics in comparative, relational and descriptive designs to answer questions related our initial hypothesis. Study 1 was tailored to gauge the magnitude of traditional match statistics on overall football performance. For this purpose, we used accumulated values obtained at the end of eight complete seasons in *LaLiga*, the best-ranked national football championship in Europe (Vales-Vázquez et al., 2018). We selected the number of points as the key variable to explain football performance in *LaLiga* because it offers a continuous categorization of each team's performance and success, instead of using less useful categorizations such as dichotomic classifications (winning/losing teams) or ordinal classifications (ranking). By analysing the results of 3040 games, the main conclusions were: a) the number of shots (r = 0.42) and the number of corners (r = 0.42) were the attacking variables that had the highest bivariate association with end-season ranking points, apart from the obvious correlation between the number of goals and the ranking points (r = 0.49); b) the effectiveness against conceded shots (r = 0.36) and the number of recoveries (r = 0.27) were the defensive variables that had the highest association with ranking points at the end of the championship; c) stepwise multiple regression analysis was able to explain 84.1% of the total variance in the number of points in relation to offensive statistics and 73.5% in relation to the defensive statistics. The statistical models predicted the number of points obtained in the championship with a high amount of precision (Figure 3); d) shooting

accuracy and effectiveness against rival shots were the variables that explained more of the ranking points variance. This information suggests that football performance is a concept explained by the interrelationship of several variables but shooting accuracy while attacking and the avoidance of clear shooting positions from the opposing team during defence are the most highly correlated indicators of obtained points at the end of the championship. The bivariate correlation analysis coincides (Tables 6 and 7) with previous investigations (Lepschy et al., 2018) that have found statistically significant associations between multiple match statistics and football performance. In addition, there is a clear change in most match statistics when comparing the teams that won the *LaLiga* championship, the teams that classified for continental competitions, and the teams that lost their category. This analysis contributes to the idea that most match statistics somewhat influence football performance, but also hinder the efforts of coaches and performance analysts since match statistics do not help in distinguishing between which ones are more important in order to succeed in football. Study 1 differential is its multiple regression analysis to individually assess the effect magnitude of each match statistic on football performance. With the inclusion of attacking match statistics, the multiple regression analysis was able to explain 84.1% of the total variance in the number of ranking points at the end of the season. Interestingly, shooting accuracy, in terms of the number of goals obtained for a given number of shots, was the attacking variable that explained more of ranking point variance at the end of the seasons (46.1%, Figure 2; upper panel). This same result was obtained when comparing winning and losing teams that participated in the Champions League (Szwarc, 2007) and the Bundesliga (Broich et al., 2014), even though these two investigations analysed a lower amount of matches. In addition, shooting accuracy was one of the match statistics that differentiated between best-ranked and least-ranked teams in *LaLiga* 2008–2009 (Lago-Ballesteros & Lago-

Peñas, 2010) and *LaLiga* 2012–2013. However, the effect of shooting accuracy was considered to be similar to other attacking match statistics in these previous analyses in *LaLiga* because they did not include statistics to assess the magnitude of the effect of each variable. In Study 1, shooting accuracy was followed by the number of shots (20.5%), corners (4.6%), and crosses (2.7%): variables intrinsically developed during game actions that are close to the opposing team's goal. This agrees with previous reports that have suggested that variables favouring effective shooting, such as individual player skills (Ali, 2011; Williams, 2000), home play (Tucker et al., 2005), and the number of assists (Kempe & Memmert, 2018) are intrinsically related to football performance. In contrast, passing accuracy only explained 2.6% of the variance in the number of ranking points. The number of passes and successful passes were excluded from the regression analysis due to the high intercorrelation with passing accuracy. While the number of passes, passing accuracy, and ball possession have been previously correlated with football performance (Luhtanen et al., 2001; Rampinini et al., 2009) particularly in *LaLiga* (Liu et al., 2015),it has also been suggested that variables related to passing and organizing might be poor predictors when team quality and home advantage are accounted for (Collet, 2013; Harrop & Nevill, 2014). Study 1 results reveal that passing accuracy gave a smaller contribution to ranking points obtained in a professional league at least in comparison to other game variables related to shooting and goal scoring. These outcomes suggest that a more vertical style of play, where shot finalization on the goal becomes the main offensive objective, may be a more successful strategy to succeed in football instead of the prevalent idea of maintaining ball possession and passes over the opponent. The current analysis also explained 73.5% of the total variance in the number of ranking points by using match statistics related to defensive actions. Although the explained variance is lower than the one obtained with offensive variables, the high association between

defensive match statistics and ranking points demonstrates that defensive strategy is also strongly linked to overall football success. The effectiveness against conceded shooting, which is defined as a low number of goals per shot conceded, was the variable that explained more of ranking point variance at the end of the seasons (28.5%, Figure 2; lower panel). Avoiding clear shots of the opposing team has been previously categorized as a key performance variable in football (Lepschy et al., 2018). However, this is more difficult during away games and when the opposing team is well-trained (Sarmento et al., 2014; Taylor et al., 2008). The variance explained by the effectiveness against conceded shooting was followed by the variance explained by the number of shots conceded (19.2%). Taken together, these results propose the concept of avoiding opponent shots as the main strategy to improve football performance through defensive actions. This concept reinforces the idea that the best football teams not only shoot more and with higher accuracy, but that they also concede fewer clear shots (Evangelos et al., 2013). A low number of committed fouls, as previously suggested (Oberstone, 2009), and a high number of recoveries (Vogelbein et al., 2014) might also contribute to more points during a match. Thus, these two factors should also be considered for a more complete and effective football playing style.

Study 2 was aimed to perform a comparative analysis of successful and unsuccessful football teams in the *LaLiga* championship., which constitutes the longest analysis on this topic. In addition, the comparison between successful and unsuccessful teams has taken into account match location and used two different statistical approaches to categorize the contribution of each in-game action to overall football performance. The main outcomes of Study 2 reflect that the in-game actions that differentiate the top 3 and bottom 3 football teams in *LaLiga* were very similar when playing at home and away (Tables 8, 9) which reflects that success in football might be driven by a similar game-play style

despite match location. Offensively, the match statistic with the greatest difference, in terms of effect size, between the top 3 and bottom 3 football teams was shooting accuracy. Defensively, the greatest difference between best vs worse teams was the number of corners received. All this information might be useful to define success in elite Spanish football and help coaches and football analysts to understand the strategy followed by top-ranked teams that compete in one of the most important football championships (Vales-Vázquez et al., 2018). In a study of 380 matches in *LaLiga* –season 2008-2009–, it was found that top-ranked teams scored more goals, shot more frequently, particularly on goal, and needed fewer opportunities than worse-ranked teams (Lago-Ballesteros & Lago-Peñas, 2010). The results of the present Thesis coincide in part with previous investigations because the variable showing the greatest difference between the top 3 and bottom 3 football teams was shooting accuracy (Figure 4). Although the results of this Thesis cannot be generalized to all football situations and competitions, the clear importance of shooting accuracy might impact tactical-strategic aspects of elite teams' training. Shooting accuracy was followed by the number of offsides and corners which, despite not being direct shooting actions, are reflective of a game style focused on direct play to score. As found by others (Lago-Peñas et al., 2011), one of the characteristics of successful teams is that they create more attack opportunities especially in the field area close to the opponents' goal. Although of Study 1constitutes an analysis of 8 complete seasons to produce a study with a high statistical power, it is worth mentioning that the season-to-season analysis reflects that the match statistics with the greatest difference between the top 3 and bottom 3 football teams were fairly maintained during the whole period analysed. Other match statistics such as passes and passing accuracy also presented high effect sizes for the top 3 - bottom 3 comparison while other offensive factors such as free kick goals and crosses were even higher in the bottom 3 teams. Although the

significance of these data is debatable, passing should be to gain offensive zones and with the clear intention of attacking, and providing opportunities for scoring. Recent studies have also found that successful teams use ball possession to attack while unsuccessful teams tend to use possession to avoid losing the ball (Casal et al., 2019). One of the most novel findings of Study 2 is that the offensive match statistics that best differentiate the top 3 and bottom 3 football teams were very similar when the teams played at home and away (Table 8). Nevertheless, subtle nuances are found; overall, shooting accuracy was key to success and this criterion was maintained when playing at home but the number of shots was even more important when playing away. In addition, the magnitudes of the effect sizes for the top 3 – bottom 3 comparison in all shooting and passing variables were higher at home than away, which suggests that the difference between successful and unsuccessful teams in offensive variables might increase with match location (Lago & Martín, 2007). Although match location, quality of opposition, and match status should be useful to adapt game tactics (Liu, Hopkins, et al., 2016), the current data on successful teams in *LaLiga* suggest that the main objective of offensive strategy –obtaining clear situations for shooting- should be maintained when playing at home and away. Although less attention has been paid to defensive variables (Mackenzie & Cushion, 2013), the current analysis indicates that successful and unsuccessful team are also very different in terms of defense match statistics (Figure 5). Overall, the number of corners received was the variable with the highest effect size in the top 3 – bottom 3 comparison, even above the number of shots conceded. Although this might be a particularity of this analysis, the high rate of corners conceded is a common finding in worse-ranked teams (Castellano et al., 2012). Broadly, only 2% of the corners end in goal but the influence of a goal obtained from a corner might determine victory in < 75% of the games (Casal et al., 2015). Effectiveness against rivals' shooting also presented a large between-group difference but

in this case, this match statistics was better in unsuccessful teams both at home and away. This means that the defensive efficacy of worse-ranked teams is not inferior to top-ranked teams but the former offers more opportunities for attack to the opposing team (Delgado-Bordonau et al., 2013; Evangelos et al., 2013). Study 2 has been carried out with the intention of identifying key game indicators that differentiate successful and unsuccessful teams to determine a more effective model of play. In summary, the study of the top 3 and bottom 3 ranked teams in *LaLiga* for 8 seasons might be indicative of a sport where shooting accuracy prevails over other offensive statistics. While all the attacking game actions investigated here were statistically higher in the top 3 teams vs bottom 3 teams, those performed close to the penalty area presented higher effect sizes (see Figure 4). Regarding defensive game actions, the number of corners and the number of shots conceded were the variables with the highest differences in terms of size between successful and unsuccessful teams. While a greater efficacy against rival's shooting was present in worse-ranked teams, it is probably due to the higher number of shots received. In this sense, it is probably necessary that less successful teams enhance game tactics or change their playing style to avoid/reduce rival's shooting during the match. Finally, the identification of the game statistics related to success was stable when comparing matches played at home and away, suggesting that a similar game style should be maintained despite match location in order to maximize football performance.

Study 3 was thoroughly tailored to determine the match statistics that best differentiated between 1st and 2nd place teams in *LaLiga*. This information is key at understanding which differences in match-play result in in a championship winner, and it uses information from the football league with the more remarkable international prestige and competitive quality. The main outcomes of Study 3 were: a) while the number of home

wins, draws, and losses were similar for the 1st and 2nd place teams, the championship winner obtained more victories while away at the expense of less away draws and away losses (Figure 6). b) a higher number of scored goals and lower number of received goals while playing away also distinguished the championship winner from the 2nd place team. However, the between-team differences in goals scored/received at home had a lower magnitude of effect. c) a higher shooting accuracy while attacking and less conceded shots, corners, free kick goals, and penalty kicks while defending were differentiated the championship winner and the second-place team. This analysis clearly determines that the key determinant to winning *LaLiga* was obtaining match wins while playing away because 1st and 2nd place teams obtain similar results while playing at home. With this in mind, drawing with the rival while playing away is not enough to winning the championship because the second-place team obtained more draws in total and while playing away. This information suggests that football teams fighting for the victory in a national football league must play offensively with the aim of obtaining victory in away games. An overall higher shooting accuracy and a lower number of conceded shooting, particularly from corners and free-kicks, are also factors that might be essential in winning the football championship. Study 2 is novel because it is the first analysis that establishes differences in the teams that are competing for a national football championship (1st and 2nd ranked teams). In addition, despite the low number of teams that fulfilled this definition, it includes accumulated values obtained at the end of eight complete seasons in *LaLiga* for a total of 592 matches. While a myriad of match statistics (*e.g.*, number of shots, shooting accuracy, ball possession, number of passes, passing accuracy, etc.) have been identified as key football performance indicators when comparing successful and less-successful football teams (Lago-Ballesteros & Lago-Peñas, 2010; Lepschy et al., 2020; Pappalardo & Cintia, 2018; Ermanno Rampinini et al.,

2009), most of these variables were very comparable between the 1st and 2nd place teams (Tables 12 and 13). Figures 7 and 8 depict an overview of the magnitude of effect size identified for each variable pf Study 2. Game statistics with trivial effect sizes have not been included in these figures. In Figure 7, variables in which the championship winner obtained higher measures than the 2nd place team are depicted with 90% confidence intervals. Away wins and the total number of wins were variables had large effects in winning the football championship. This was then followed by shooting accuracy (moderate effect size). Although other match statistics presented small effect sizes when comparing the 1st and 2nd place teams, the extent of the confidence intervals impedes the categorisation of these variables as key performance indicators. While passing accuracy and ball possession have been previously identified as football performance indicators (Luhtanen et al., 2001;Rampinini et al., 2009), also in *LaLiga* (Liu, Gómez, et al., 2016), all match statistics related to passing had small effect sizes between the teams. As previously suggested (Collet, 2013; Harrop & Nevill, 2014), it seems that a high numbers of passes or a high efficacy in passing have limited influence in overall football success and it might not be a definitory variable to win a nation football championship. To this regard, it is probable that successful passing may be a key aspect in football performance only if it provides a source of attacking plays culminating in shots at goal (Oberstone, 2009). In fact, the models that concede a key role for shooting and shooting accuracy among all the match statistics can fairly predict football success as aforementioned in this Thesis in Study 1 and (Pappalardo & Cintia, 2018). All this information together suggests that, in addition to its role to define a high-ranked team vs low-ranked teams, shooting performance is also definitive to win the championship and the total number of wins were variables had large effects in winning the football championship. This was then followed by shooting accuracy (moderate effect size). As opposed to Figure 7, Figure 8 includes

variables in which the championship winner obtained lower ratings than the 2nd place team. Following the same criteria, lower number of total losses (particularly away), less draws while playing away, and less conceded shots (particularly from corner and free kicks) had moderate effect sizes in winning the championship. Interestingly, although the number of corners is relatively low (around five corners per match and per team; (Castellano et al., 2012), the number of corners against was the match statistic with the highest effect size between 1st and 2nd place teams (excluding the ones related to match results; Figure 7). This contrasts with findings of previous investigations were the number of corners was similar in winning and losing teams in World Cup tournaments (Castellano et al., 2012) and in the UEFA Champions League (Lago-Peñas et al., 2011). As the teams included in Study 3were the top-two teams in *LaLiga*, and they are potentially characterized by conceding a low number of occasions to the rival, as aforementioned in Study 1, it is probable conceding a corner has higher impact in highly ranked teams because this game action can be one of the few manner of approaching to the rival's goal area and obtaining an opportunity of shooting in low-ranked teams. A low number of yellow cards and goals received while away also had a moderate-to-small effect size. Thus, although several match statistics were identified as having a small effect in differentiating between the two teams with the highest ranking at the end of the season, only a few were presented moderate influence on the classification at the end of the season. Avoiding clear shooting of the opposing team, especially from rivals' free kick actions close to the area, might also be a key performance variable in winning the championship (Lepschy et al., 2018). Although evading rivals' shooting is more difficult during away games (Sarmento et al., 2014; Taylor et al., 2008), this might be crucial in obtaining victories in away games. All this information might be useful in modulating match plays for teams pursuing the national football championship. The advantage of

playing at home (Goumas, 2017) produced wins in ~84% of the matches played at home (~16 home wins from 19 possible home wins in one complete season). However, the championship winner obtains 73% of victories while playing away (~14 away wins from 19 possible away wins). For the second-place team, this value is reduced to 62%. Drawing away seems to not be enough to obtain the football championship since the 2nd ranked teams obtained 20% of away draws vs 16% of away draws for the 1st place team. Thus, the use of an offensive style of play and tactical approaches in the teams that are fighting for a championship should be maintained while playing away.

Association of match running performance with and without ball possession to football performance.

Previous investigations have found that match running performance poorly correlated with the final points accumulated during a national football league (Clemente et al., 2019; Di Salvo et al., 2009; Hoppe et al., 2015; Longo et al., 2019). In contrast, the running distance with ball possession and the number of football actions with the ball were positively associated with the ranking position at the end of the league, although this is not always the case (Clemente et al., 2019). Overall, recent research points towards a positive association between match running actions with ball possession and success in football (Hoppe et al., 2015). Study 5 is innovative because it has analysed running patterns with and without ball possession according to the ranking points, to the classification for European competitions, and to the positions that led to relegation to an inferior category. The champion was the team with the lowest running distance per match (total and < 21 km/h; Figure 12) while the running distances were similarly high in teams classified for the Champions League, teams classified for the Europa League, teams in the Middle of the classification and Relegation teams. In contrast, both the league winner

and the Champions League teams ran a greater distance with ball possession at both ≥21 and <21 km/h (Figure 13). In fact, the proportion of running distance with ball possession was the highest in the league champion (43.5% of the total running distance) followed by Champions League teams (38.2% of the total running distance) with ~36% of the running distance with the ball in the remaining teams. These data indicate that more successful teams cover a high proportion of the total distance performed when they are in possession of the ball, so the running distance with ball possession might be a definitive variable to win the league, with less influence in the remaining positions of the ranking. In recent years, the investigations aiming to detect successful playing patterns in football through the analysis of match statistics have proliferated along with the increasing popularity of this sport. Among them, one of the most sought factors has been ball possession (Casal et al., 2019). Evidence shows that successful teams in a national league normally have longer possession times than less successful teams (Carling et al., 2007; Jones et al., 2004). In addition, successful teams regain ball possession after losing it more quickly than worse-ranked teams (Vogelbein et al., 2014). However, high ball possession does not guarantee better football performance because there is evidence suggesting that ball possession might feature in teams that are either losing or trying to tie the match (Paul Simon Bradley et al., 2014; Lago-Peñas et al., 2010). In addition, when accounting for the opponent team's quality and the home advantage, ball possession is no longer a predictor of success (Collet, 2013). Study 5, by including the analysis of 3 complete seasons, adds new information to this topic because it indicates that running actions at ≥ 21 km/h when in possession of the ball might be important to win the league or to classify for the Champions League while the relevance of running with the ball is lower in the remaining football teams. This finding is contrary to outcomes of Clemente et al. (2019) when examining *LaLiga* 2013–2014 season. In that season, *LaLiga* was won by Atlético

de Madrid while in the last 16 competitions the winners have been either Real Madrid or Barcelona. The difference between these two investigations might indicate that the influence of running with the ball on football success is a general outcome that might not apply to certain teams with distinct game styles. In addition, it raises the necessity of investigating several seasons when trying to determine the influence of running patterns on football success, to avoid the bias of running performance of unusual football players or teams (Kattuman et al., 2019). The higher running distance with the ball in the more successful teams, particularly at ≥ 21 km/h, might be related to technic-tactic components of the match play, indicating that players are prone to run fast when their teams are in possession of the ball to offer clear ways of passing or high-intensity actions to loss their marks. Interestingly, this might indicate that an effective manner of maintaining possession with constant player's movement rather than "keeping possession of the ball" is a characteristic of more successful teams in *LaLiga*. Although the running distance with the ball positively correlated with the points obtained at the end of the season (Table 15), the distance covered with ball possession in teams ranked from 5th to 20th positions was similar (Figure 13). Thus, it seems that ball possession, particularly when performing high-speed actions, might be a contributor to football success but it might be subjected to other technical and tactical skills more associated with victory such as shooting (Lepschy et al., 2018). Match running performance variables only explained 37.9% of the variance in the points earned at the end of the season (Figure 15). Interestingly, the distances covered with ball possession (above and below 21 km/h) were the main contributors to the explained variance while the running distance without ball possession had minimal influence in the analysis. The variance explained for the number of ranking points with the current model was lower than the variance explained by including only the distance covered with ball possession in the Bundesliga (*i.e.* 60% of variance; (Hoppe et al., 2015).

While Study 5 included the data on 4 complete seasons (2015–2016 to 2018–2019), the investigation by Hoppe et al. (2015) only analysed the Bundesliga season 2012/2013. It is probable that the game style of the teams that were successful in that particular season in the Bundesliga influenced the high variance explained by match running performance with ball possession in this investigation. In fact, a recent analysis of the influence of match statistics on teams' success in *LaLiga* over a period of 8 years in Study 1 has found that 84.1% of the total variance in the number of points at the end of the seasons was explained by offensive statistics (high shooting accuracy and number of shots were the primary attacking match statistics) while 73.5% of the variance in the number of points was explained by defensive statistics (conceding a low number of the rival's shots and a low proportion of goals per shot conceded were the primary defensive match statistics). Together, all this information suggests that the match running activities might be associated with only one third of the ranking points obtained during a football league while almost two thirds of the variance in the ranking points are associated with football actions not directly related to match running. From a practical perspective and considering that football success might only be achieved with the optimal interaction of physical, technical and tactical capacities, these outcomes might indicate training of those match actions more associated with victory (*e.g.* shooting) should be prioritised over the training of physical conditioning variables. This is just speculation, and further research is necessary to confirm this suggestion.

Influence of players' maximum running speed on the team's ranking position at the end of *LaLiga*.

With the incorporation of microtechnology into elite football (mainly, the use of Global Positioning System devices and multicamera tracking systems), sport scientists and physical trainers are now analysing a high number of physical and physiological variables

that may have the potential to contribute to overall football performance. This represents, in most cases, an excess of data that complicates the understanding of what variables are important for the game (Casamichana et al., 2019). Additionally, the existence of a high number of variables may lead to oversimplification of the game by using them to categorize players. In this regard, the maximum running speed that a player can obtain during a match has become a widely used variable to assess a player's physical talent, despite the evidence to argue that this variable is important for a player's and team's performance being scarce. Peak/maximum running speed represents one single action during the match, while professional football players perform more than 150 intense actions during match play (Mohr et al., 2003). Hence, the potential evaluation of a player's physical talent, by using only one action during match play, may lead to incorrect assumptions, at least in elite football. Despite the popularity of this performance variable, we are not aware of any previous investigations that have aimed to determine the influence of players' peak/maximum running speeds on the team's overall football performance. Study 6 presents an analysis of the fluctuations of peak running speeds obtained during matches throughout a complete season of *LaLiga*. In addition, the players' maximum running speeds have been compared to the ranking obtained at the end of the championship, while differences in maximum running speed among playing positions have been analyzed. Overall, Study 6 demonstrates that peak running speed was maintained relatively constant throughout the championship, a characteristic shared by the Champion, the teams classified for the Champions League, the teams classified for the Europa League, middle teams, and the relegated teams (Figure 16). Additionally, all teams competing in *LaLiga* had squads with comparable maximum running speeds, irrespective of their ranking position at the end of the championship (Figure 17). The similarity in maximum running speeds among teams was equally present in defenders,

midfielders, and forwards (Table 16), although forwards were the fastest players in each team (Figure 18). In addition, the correlation coefficient between teams' maximum speed and ranking position was low and the variance in the ranking position obtained at the end of the league explained by team's maximum speed was of only 7.5%. Together, this information points towards a poor association between players' maximum/peak running speeds and the team's overall football performance during a national league. This notion does not dispute the importance of covering high volumes at high intensity for football performance but suggests that most, if not all, professional teams in *LaLiga* possess players able to reach over 30 km/h, limiting the discriminatory utility of maximum running speeds to distinguish between better- and worse-ranked teams. Recently, it has been found that football teams competing in a national football league needed 8–10 fixtures from the beginning of the season until they reached a plateau in match running performance (Brito de Souza et al., 2021). The necessity of competing in 8–10 matches before reaching a steady-state physical performance was evident for the running distance at over 24 km/h and for the number of running actions performed above this threshold. However, the current analysis indicates that on average for all the teams competing in *LaLiga*, players' peak running speeds were 30.6 ± 0.7 km/h for the first fixture, and a comparable value was obtained throughout the competition (Figure 16). This result suggests that professional football players are able to reach maximum or near-to-maximum running velocities from the first competitive match, even when they are not ready to perform a large volume of high intensity running. While maximum running speed during a match is mainly related to mechanical determinants aimed to produce great vertical ground reaction forces per unit of body mass (Buchheit et al., 2014; Weyand et al., 2010), the capacity to produce a high amount of running actions at high intensity is more related to metabolic parameters such as the capacity to supply energy from different

pathways during the running action and during the recovery, and the ability to reduce the intramuscular accumulation of metabolic by-products (Girard et al., 2011; Mendez-Villanueva et al., 2012). Therefore, it seems that professional football players possess the mechanical capacity to perform at least one running action at a very high speed from the beginning of the championship, but they need several fixtures to obtain the physiological adaptations to produce high values of running distance at high intensity and sprinting velocities. Peak running speed and the amount of running performed at high intensity are physical variables that represent different performance outcomes during a match (Rampinini, Coutts, et al., 2007; Rampinini, Bishop, et al., 2007). Peak running speed is normally obtained during an offensive or defensive football action without the ball and in a field position that allows the distance necessary to obtain appropriate acceleration and maximum velocity. Players obtain their peak running speed during a critical action of the game but this represents only one of the hundreds of high intensity actions and dozens of sprints performed during a match (Haugen et al., 2014; Mohr et al., 2003). Accordingly, while several previous investigations have coincided in establishing the importance of high intensity running during a match for overall football performance (Haugen et al., 2014; Mohr et al., 2003; Rampinini, Coutts, et al., 2007), Study 6 suggests that players' peak/maximum running speeds are comparable in all teams competing in *LaLiga*, irrespective of their ranking and competitive level. In this regard, as aforementioned in Study 5 the distance covered at over 21 km/h during a national league has a modest capacity to discriminate between successful and less successful teams, especially if the distance is covered with the ball. However, the utility of the physical demands during a match to predict football performance is lower when compared to match statistics such as shooting accuracy, the number of shots performed, and the capacity to prevent the rival from shooting as aforementioned in Study 1 and Study 5. All

this information points towards a poor capacity of teams' maximum running speeds to anticipate the football performance of a squad. From a practical perspective, this information also suggests the convenience of focusing training on more useful determinants of football performance like the development of a high capacity to repeat sprints during a match and tactical and strategic interventions to enhance shooting efficacy, reducing the time devoted to improving players' maximum running speeds. The upper panel in Figure 17 indicates that 94.3% of players (448 out of 475) competing in *LaLiga* are capable of running at over 30.0 km/h. Only three players were able to run at over 35.0 km/h, while the fastest players reached 35.2 km/h. Overall, most players were able to obtain sprinting velocities between 32 and 33 km/h (Figure 17). Although these values of maximum running speed are excellent for football players (Rampinini, Coutts, et al., 2007; Rampinini, Bishop, et al., 2007), they are much lower than the peak velocity obtained by elite-level athletes during sprint events (Haugen et al., 2014). Furthermore, the presence of this high number of players running at over 30 km/h hinders the capacity of using maximum speed actions to overcome rivals during match play. Midfielders and defenders perform more high-intensity running and sprinting (Vigne et al., 2010), but, as previously suggested, the fastest players are usually the forwards (Haugen et al., 2020). This pattern was found in most teams (Table 16) and suggests that the playing field position of a defender has evolved to become a position with fast players to increase their aptitude to defend against fast forward players, and vice versa.

Players' physical performance in *LaLiga*: insights for competition continuation after COVID-19.

Study 7 reveals that, in the prior four competitive seasons of *LaLiga*, players' physical performance was lower at the beginning of the season and the teams needed approximately 8–10 matchdays to reach a steady state running performance. As the

duration of the transition period and the preseason period in these prior four seasons were of similar length to the duration of home confinement due to COVID-19 (8 weeks) and similar to the time allowed to prepare players before resuming football competition in Spain (4 weeks), these data suggest that football players will progressively increase their performance across the 11 matchdays remaining to complete the championship

Study 8 reveals that, despite the lockdown imposed by the Spanish health authorities during spring 2020 to control the first wave of the COVID-19 pandemic, running performance in the professional football teams of *LaLiga* was well preserved after the resumption of the competition, which took place after 12 weeks of competition suspension. This maintenance of overall running performance during the match was evident when comparing Study 8 reveals that, despite the lockdown imposed by the Spanish health authorities during spring 2020 to control the first wave of the COVID-19 pandemic, running performance in the professional football teams of *LaLiga* was well preserved after the resumption of the competition, which took place after 12 weeks of competition suspension. This maintenance of overall running performance during the match was evident when comparing football authorities established for professional football after the lockdown. In fact, it was predicted that, when resuming football competition after the lockdown, professional players of *LaLiga* would experience physical challenges similar to the ones they usually undergo during the first official matches of the season (*i.e*., a progressive increase in running performance during the first official matches (Brito de Souza et al., 2021)) because the lockdown was long enough to expect detraining effects (Pereira et al., 2020). This scenario was predicted with the data at that time which indicated muscle weakness induced by the lockdown (Moreno-Pérez et al., 2020) despite staff and football players trying to maintain their football -specific physical condition by training at home. However, this potential scenario did not

materialise because the Spanish football authorities ensured players' health and safety and established regulations that avoided excessive fatigue while aiding football performance (Herrero-Gonzalez et al., 2020). First, a retraining period of at least 4 weeks was set from the end of home confinement to the first competitive match. In this time, professional teams prepared their return to play following the recommendations of the Spanish Sports Council, in agreement with the Royal Spanish football Federation (RSFF) and *LaLiga*, which established regulations to allow individual only exercise routines for the first week of retraining with a progressive inclusion of small-group exercises until completing team trainings and 11-per side match simulation routines in the last weeks of the retraining period. Second, a minimum period of 72 h was set between matches as lower between-game recovery periods may entail accumulated fatigue and stress (Mohr et al., 2016) and could potentially lead to higher injury incidence (Bengtsson et al., 2013). Interestingly, the running patterns after the lockdown were preserved despite the teams completing the 11 matchdays remaining to finish the 2019–2020 season in ~39 days (*i.e.*, one game every 3.5 days). Of note, the previous year, the last 11 matchdays were completed in 63 days (*i.e.*, one game every 5.7 days). In the opinion of these authors, the specific modifications of the in-game regulations allowed after the lockdown were also key to maintaining players' physical running patterns (especially those above 21 km/h) and hence, the integrity of the competition. The RSFF and *LaLiga* agreed to permit two extra players' substitutions (for a total of up to 5 substitutions per match) although teams had to request substitutions in only three turns. The current data indicate that most teams used this in-game allowance as the mean number of substitutions in the last 11 fixtures of the 2018–2019 season was 2.9 substitutions per game and it reached 4.5 substitutions per game in the 2019–2020 season (Table 18). Habitually, substitutes cover greater running distances than players who complete the entire match (Bradley et al., 2014) which

points toward a favourable outcome of the allowance of up to 5 substitutions to preserve running performance after the lockdown. In this regard, some authors have recently proposed keeping the increase in substitutions from three to up to five permanently, with the aim of mitigating overall football physical demands (Mota et al., 2020). Interestingly, the time chosen for the first substitution did not vary after the lockdown (58 ± 3 min in 2018–2019 and 57 ± 2 min in 2019–2020 for the las 11 matchdays) and the time played by substitutes was similar (25 ± 2 min in 2018–2019 and 26 ± 1 min in 2019–2020 for the las 11 matchdays) suggesting that team managers do not anticipate substitutions despite possessing two more substitutions than before. Additionally, a mandatory use of refreshment pauses at minute 30 and 75 of each match was established to allow enhanced in-game recovery as the game was stopped for ~2 min in each half. As a result, game duration increased from 96 min in the last 11 fixtures of the 2018–2019 season to 100 min for the same period of the 2019–2020 season (Table 17). This likely produced that total running distance and distance at < 14 km/h were higher in the 2019–2020 vs 2018–2019 season (Table 18), as players usually moved at a low intensity running to the sideline for refreshment. To compensate for the time used for these pauses, referees increased game duration in each half as reflected in Study 8, but the effective time of play was probably conserved. To date, there is no data to determine how effective these refreshment pauses are to help players' for in-game recovery, but the maintenance of the distance run at ≥ 21 km/h and the similar number of actions above 24 km/h in the postlockdown period suggests that these drink breaks were be helpful to maintain running performance despite the congested calendar of the last 11 fixtures of the 2019–2020 season. The Study 8 describes an unusual situation produced by a virus pandemic and provides data on how health and football governing bodies were right about the

proposition of new in-game regulations and by setting an appropriate time for retraining phase after home confinement.

LIMITATIONS

The present thesis has some limitations that should be considered for future investigations and to understand the utility of the outcomes generated for football:

1. For Studies 1 and 2, the main limitation is that we did not provide information about the location of the shot in the pitch area, despite this variable has been considered as important information to understand football performance (Lepschy et al., 2018; Sarmento, Figueiredo, et al., 2018).
2. In Study 3, the differences in the number of points at the end of the season between the 1st and 2nd place teams varied from 1 point (2015–2016) to 14 points (2017–2018).
3. In Study 4, contextual variables as match location and the match status were not included in the analysis and they may be important because their influence in the results of this study.
4. In Study 5 and 6 we did not obtain information about the sectors of the playing field where the running actions were developed. Future investigations should be geared to determining running actions, with and without the ball, in a specific area of the football pitch that might be more associated with football performance.
5. Studies 7 and 8 do not contain information about players' internal load during the matches or an evaluation of wellness before the matches.

These limitations occurred not always for a methodological error, nonetheless for the impossibility and unfeasibility of analysis. Consequently, we selected the most important variables based on the scientific literature. In addition, the limitations presented in this Thesis may direct future investigations to close possible gaps in this area.

CONCLUSION

1. In conclusion, shooting accuracy while attacking along with avoiding clear positions of shots from the opposing team during defensive plays are the indicators best associated with success at the end of the *LaLiga* championship. Scoring in the 2nd half, especially between minute 61 and 75 of the match, was associated with the number of ranking points obtained in *LaLiga*. Additionally, a higher number of wins when playing away was the best indicator of performance to differentiate between the championship winner and the second-place team. Therefore, the first hypothesis of this Theis was accepted in part since only the number of passes and passing accuracy were not among the variables most associated with football success.
2. Confirming the second hypothesis of the Thesis, the best football teams cover a greater distance with the ball than the less successful teams but the contribution of the match running performance to overall football success was low.
3. Our third hypothesis was rejected as players' maximum running speeds had a poor association with the team's ranking position at the end of *LaLiga*.
4. Habitually, football teams need approximately 8-10 matchdays to reach a steady-state running performance However, this pattern was not reproduced when *LaLiga* was resumed after the first wave of the COVID-19 pandemic. In fact, running performance was maintained after the resumption of the competition probably because of the in-game regulations introduced. This means that the fourth hypothesis of this Thesis is rejected.

PRACTICAL APPLICATIONS

From a practical perspective we have some suggestions based on this Doctoral Thesis.

1. The use of training routines that improve shooting accuracy might be essential to increase the efficacy of offensive sequences. The use of fast attacking routines (with and without opponents) with the main objective of shooting on goal with a low number of passes might be recommended to improve offensive behaviors of the team. The use of exercises that improve tactics during corners (when attacking and defending) might be also critical for football performance as this game action is a clear indicator that differentiated successful and unsuccessful teams in *LaLiga*. Although the means of obtaining an effective offensive style while keeping high ratings in defensive variables may be different depending on the team's characteristics, the use of training exercises based on a direct style that assures the finalisation of the play with a shot may be a strategy to achieve this objective. In addition, exercises that promote aggressive pressing after losing the ball may be also recommended as one of the best manners to reduce the number of rival's shots. Coaches should consider the high physical challenges that this style of play entails (Castellano et al., 2014) in order to assure appropriate physical conditioning during training, players' substitutions during the match and players' rotation between matches. From a practical perspective, high-ranking football coaches and players aiming for the national football championship should focus on increasing their likelihood of winning away matches while maintaining home victories. The results of Study 4 are useful not only for the configuration of team tactics, but also for the development of training strategies that allow the maintenance of physical performance throughout the match In this regard, the use

of tactics to score in the last stages of a match may be critical for obtaining a higher number of points earned during a professional football league. As the scoring patterns are not league-dependent (Alberti et al., 2013) the results obtained in *LaLiga* may be extrapolated to other major European leagues.

2. The convenience of focusing on training routines to improve high-speed running actions with the ball. In particular, football teams should have a general playing style but also the capacity to modulate the team's style in depending on the quality of the rival, match location and match status (Aquino et al., 2017). Training methodologies that include physical conditioning exercises with the ball might be chosen over traditional physical training without the ball. Nevertheless, the low contribution of running with and without ball possession to the variance explained in the ranking points might point towards conceding more importance to the training of other technical and tactical skills than to physical conditioning. As recently suggested, periodisation training emphasising technical-tactical content should be used to improve match running performance, especially at young ages (Palucci Vieira et al., 2019). Physical training in elite football should be more focused on enhancing the ability to repeat sprints of sub-maximum intensity (*e.g.*, between 21 and 30 km/h) to obtain high volumes of running distance at >24 km/h, rather than on improving players' maximum running speed. This is important as the training routines used for such objectives may be substantially different. Additionally, a key portion of physical and conditioning training should be devoted to increasing a player's capacity to accelerate/decelerate in short distances as they perform four times as many accelerations as reported sprints per match (Ingebrigtsen et al., 2015). Lastly, the physical training devoted to

developing maximum running speed could be focused on ensuring that players obtain at least 30–32 km/h of peak velocity during match play, as this is the peak running speed that most players produce during a game. The obtaining of higher velocities will likely impact a few actions during the game, but as suggested by the results of this study, they will have a low influence on the overall team performance at the end of the league. Of note, the utility of possessing a team squad with players able to obtain high peak/maximum running speeds may depend on the playing style. It is probable that teams with direct play when attacking and exerting high pressure while defending may benefit from faster players.

3. Overall, this Thesis advocates that those teams that are better prepared, in physical and conditioning terms, to achieve high running performance from the first match of the competition may increase their possibilities of succeeding (Brito Souza et al., 2020). The analysis of the data of the 2019-2020 season is useful in the case of future lockdowns that entail sports competition suspension and posterior resumption.

CONFLICT OF INTERESTS

No potential conflict of interest was reported by the Doctoral Student.

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BIBLIOGRAPHY

Ade, J., Fitzpatrick, J., & Bradley, P. S. (2016). High-intensity efforts in elite soccer matches and associated movement patterns, technical skills and tactical actions. Information for position-specific training drills. *Journal of Sports Sciences*, *34*(24), 2205–2214. https://doi.org/10.1080/02640414.2016.1217343

Alberti, G., Iaia, F. M., Arcelli, E., Cavaggioni, L., & Rampinini, E. (2013). Goal scoring patterns in major European soccer leagues. *Sport Sciences for Health*, *9*(3), 151–153. https://doi.org/10.1007/s11332-013-0154-9

Ali, A. (2011). Measuring soccer skill performance: A review. *Scandinavian Journal of Medicine and Science in Sports*, *21*(2), 170–183. https://doi.org/10.1111/j.1600-0838.2010.01256.x

Ali, A., & Farrally, M. (1991). A computer-video aided time motion analysis technique for match analysis. *Journal of Sports Medicine and Physical Fitness*, *31*(1), 82–88. https://pubmed.ncbi.nlm.nih.gov/1861489/

Almeida, C. H., Ferreira, A. P., & Volossovitch, A. (2014). Effects of match location, match status and quality of opposition on regaining possession in UEFA champions league. *Journal of Human Kinetics*. https://doi.org/10.2478/hukin-2014-0048

Aquino, R., Munhoz Martins, G. H., Palucci Vieira, L. H., & Menezes, R. P. (2017). Influence of match location, quality of opponents, and match status on movement patterns in Brazilian professional football players. *Journal of Strength and Conditioning Research*, *31*(8), 2155–2161. https://doi.org/10.1519/JSC.0000000000001674

Armatas, V., Giannakos, A., Skoufas, D., & Papadopoulou, S. (2009). Evaluation of goals scored in top ranking soccer matches: greek “superleague” 2006-07. *Serbian Journal of Sports Sciences*, *3*(1), 39–43.

Asian Clemente, Requena, Jukic, Nayler, Hernández, & Carling. (2019). Is Physical Performance a Differentiating Element between More or Less Successful Football Teams? *Sports*. https://doi.org/10.3390/sports7100216

Baboota, R., & Kaur, H. (2019). Predictive analysis and modelling football results using machine learning approach for English Premier League. *International Journal of Forecasting*, *35*(2), 741–755. https://doi.org/10.1016/j.ijforecast.2018.01.003

Bengtsson, H., Ekstrand, J., & Hägglund, M. (2013). Muscle injury rates in professional football increase with fixture congestion: An 11-year follow-up of the UEFA Champions League injury study. *British Journal of Sports Medicine*, *47*(12), 743–747. https://doi.org/10.1136/bjsports-2013-092383

Bisciotti, G. N., Eirale, C., Corsini, A., Baudot, C., Saillant, G., & Chalabi, H. (2020). Return to football training and competition after lockdown caused by the COVID-19 pandemic: Medical recommendations. *Biology of Sport*, *37*(3), 313–319. https://doi.org/10.5114/biolsport.2020.96652

Bradley, Paul S., Lago-Peñas, C., & Rey, E. (2014). Evaluation of the match performances of substitution players in elite soccer. *International Journal of Sports Physiology and Performance*, *9*(3), 415–424. https://doi.org/10.1123/IJSPP.2013-0304

Bradley, Paul Simon, Lago-Peñas, C., Rey, E., & Sampaio, J. (2014). The influence of situational variables on ball possession in the English Premier League. *Journal of Sports Sciences*. https://doi.org/10.1080/02640414.2014.887850

Brito de Souza, D., González-García, J., Campo, R. L. D., Resta, R., Buldú, J. M., Wilk,

M., & Coso, J. Del. (2021). Players' physical performance in LaLiga across the season: Insights for competition continuation after COVID-19. *Biology of Sport*, *38*(1), 3–7. https://doi.org/10.5114/BIOLSPORT.2020.96856

Brito Souza, D., López-Del Campo, R., Blanco-Pita, H., Resta, R., & Del Coso, J. (2019). A new paradigm to understand success in professional football: analysis of match statistics in LaLiga for 8 complete seasons. *International Journal of Performance Analysis in Sport*, *19*(4), 543–555. https://doi.org/10.1080/24748668.2019.1632580

Brito Souza, D., López-Del Campo, R., Blanco-Pita, H., Resta, R., & Del Coso, J. (2020). Association of match running performance with and without ball possession to football performance. *International Journal of Performance Analysis in Sport*, *20*(3), 483–494. https://doi.org/10.1080/24748668.2020.1762279

Broich, H., Broich, H., Mester, J., Seifriz, F., & YUE, Z. (2014). Statistical Analysis for the First Bundesliga in the Current Soccer Season. *Progress in Applied Mathematics*, *7*(2), 1–8. https://doi.org/10.3968/4886

Buchheit, M., Samozino, P., Glynn, J. A., Michael, B. S., Al Haddad, H., Mendez-Villanueva, A., & Morin, J. B. (2014). Mechanical determinants of acceleration and maximal sprinting speed in highly trained young soccer players. *Journal of Sports Sciences*, *32*(20), 1906–1913. https://doi.org/10.1080/02640414.2014.965191

Bush, M., Barnes, C., Archer, D. T., Hogg, B., & Bradley, P. S. (2015). Evolution of match performance parameters for various playing positions in the English Premier League. *Human Movement Science*, *39*, 1–11. https://doi.org/10.1016/j.humov.2014.10.003

Campos-Vazquez, M. A., Toscano-Bendala, F. J., Mora-Ferrera, J. C., & Suarez-Arrones, L. J. (2017). Relationship between internal load indicators and changes on intermittent performance after the preseason in professional soccer players. *Journal of Strength and Conditioning Research*, *31*(6), 1477–1485. https://doi.org/10.1519/JSC.0000000000001613

Carling, C., Williams, A. M., & Reilly, T. (2007). *A Systematic Approach to Improving Performance* (U. Routledge. New York (ed.)). Handbook of Soccer Match Analysis.

Carmody, S., Murray, A., Borodina, M., Gouttebarge, V., & Massey, A. (2020). When can professional sport recommence safely during the COVID-19 pandemic? Risk assessment and factors to consider. In *British Journal of Sports Medicine* (Vol. 54, Issue 16, pp. 946–948). BMJ Publishing Group. https://doi.org/10.1136/bjsports-2020-102539

Casal, C. A., Anguera, M. T., Maneiro, R., & Losada, J. L. (2019). Possession in football: More than a quantitative aspect - A mixed method study. *Frontiers in Psychology*, *10*, 1–12. https://doi.org/10.3389/fpsyg.2019.00501

Casal, C. A., Maneiro, R., Ardá, T., Losada, J. L., & Rial, A. (2015). Analysis of corner kick success in elite football. *International Journal of Performance Analysis in Sport*, *15*(2), 430–451. https://doi.org/10.1080/24748668.2015.11868805

Casamichana, D., Castellano, J., Gómez Díaz, A., & Martín-García, A. (2019). Looking for Complementary Intensity Variables in Different Training Games in Football. *Journal of Strength and Conditioning Research, Publish Ah*. https://doi.org/10.1519/jsc.0000000000003025

Castellano, J., Alvarez-Pastor, D., & Bradley, P. S. (2014). Evaluation of research using computerised tracking systems (amisco® and prozone®) to analyse physical performance in elite soccer: A systematic review. In *Sports Medicine* (Vol. 44,

Issue 5, pp. 701–712). Springer. https://doi.org/10.1007/s40279-014-0144-3
Castellano, J., Casamichana, D., Campos-Vázquez, M. A., & Langarika-Rocafort, A. (2019). Interchangeability of two tracking systems to register physical demands in football: Multiple camera video versus GPS technology. *Archivos de Medicina Del Deporte*, *36*(3), 157–165.
Castellano, J., Casamichana, D., & Lago, C. (2012). The use of match statistics that discriminate between successful and unsuccessful soccer teams. *Journal of Human Kinetics*, *31*, 139–147. https://doi.org/10.2478/v10078-012-0015-7
Chmura, P., Konefał, M., Wong, D. P., Figueiredo, A. J., Kowalczuk, E., Rokita, A., Chmura, J., & Andrzejewski, M. (2019). Players' physical performance decreased after two-thirds of the season: Results of 3 consecutive seasons in the German first bundesliga. *International Journal of Environmental Research and Public Health*, *16*(11). https://doi.org/10.3390/ijerph16112044
Cohen, J. (2013). Statistical Power Analysis for the Behavioral Sciences. In *Statistical Power Analysis for the Behavioral Sciences*. https://doi.org/10.4324/9780203771587
Collet, C. (2013). The possession game? A comparative analysis of ball retention and team success in European and international football, 2007-2010. *Journal of Sports Sciences*, *31*(2), 123–136. https://doi.org/10.1080/02640414.2012.727455
Corsini, A., Bisciotti, G. N., Eirale, C., & Volpi, P. (2020). Football cannot restart soon during the COVID-19 emergency! A critical perspective from the Italian experience and a call for action. In *British Journal of Sports Medicine* (Vol. 54, Issue 20). Br J Sports Med. https://doi.org/10.1136/bjsports-2020-102306
Davenport, T. . (2014). Analytics in sports: the new science of winning. *International Institute for Analytics*, 1–28.
Delgado-Bordonau, J. L., Domenech-Monforte, C., Guzmán, J. F., & Méndez-Villanueva, A. (2013). Offensive and defensive team performance: relation to successful and unsuccessful participation in the 2010 Soccer World Cup. *Journal of Human Sport and Exercise*, *8*(4), 894–904. https://doi.org/10.4100/jhse.2013.84.02
den Hollander, S., Jones, B., Lambert, M., & Hendricks, S. (2018). The what and how of video analysis research in rugby union: a critical review. *Sports Medicine - Open*, *4*(1), 27. https://doi.org/10.1186/s40798-018-0142-3
Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine*, *28*(3), 222–227. https://doi.org/10.1055/s-2006-924294
Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in premier league soccer. *International Journal of Sports Medicine*, *30*(3), 205–212. https://doi.org/10.1055/s-0028-1105950
Eirale, C., Bisciotti, G., Corsini, A., Baudot, C., Saillant, G., & Chalabi, H. (2020). Medical recommendations for home-confined footballers' training during the COVID-19 pandemic: From evidence to practical application. In *Biology of Sport* (Vol. 37, Issue 2, pp. 203–207). Biol Sport. https://doi.org/10.5114/BIOLSPORT.2020.94348
Evangelos, B., Eleftherios, M., Aris, S., Ioannis, G., Aristotelis, G., & Antonios, S. (2013). Offense and defense statistical indicators that determine the Greek Superleague teams placement on the table 2011 - 12. *Journal of Physical Education and Sport*, *13*(3), 338–347. https://doi.org/10.7752/jpes.2013.03055
Evangelos, B., Gioldasis, A., Ioannis, G., & Georgia, A. (2018). Relationship between

time and goal scoring of European soccer teams with different league ranking. *Journal of Human Sport and Exercise*, *13*(3), 518–529. https://doi.org/10.14198/jhse.2018.133.04

Faude, O., Koch, T., & Meyer, T. (2012). Straight sprinting is the most frequent action in goal situations in professional football. *Journal of Sports Sciences*, *30*(7), 625–631. https://doi.org/10.1080/02640414.2012.665940

FIFA. (2007). *FIFA: Big Count 2006 - Comparison 2006 : 270 Million People Active in Football*. FIFA Communications Division. https://doi.org/10.1016/j.tetlet.2012.06.022

García-Unanue, J., Pérez-Gómez, J., Giménez, J. V., Felipe, J. L., Gómez-Pomares, S., Gallardo, L., & Sánchez-Sánchez, J. (2018). Influence of contextual variables and the pressure to keep category on physical match performance in soccer players. *PLoS ONE*, *13*(9), e0204256. https://doi.org/10.1371/journal.pone.0204256

Girard, O., Mendez-Villanueva, A., & Bishop, D. (2011). Repeated-sprint ability part I: Factors contributing to fatigue. *Sports Medicine*, *41*(8), 673–694. https://doi.org/10.2165/11590550-000000000-00000

Gomez-Piqueras, P., Gonzalez-Villora, S., Castellano, J., & Teoldo, I. (2019). Relation between the physical demands and success in professional soccer players. *Journal of Human Sport and Exercise*, *14*(1), 1–11. https://doi.org/10.14198/jhse.2019.141.01

Gómez, M. A., Gómez-Lopez, M., Lago, C., & Sampaio, J. (2012). Effects of game location and final outcome on game-related statistics in each zone of the pitch in professional football. *European Journal of Sport Science*, *12*(5), 393–398. https://doi.org/10.1080/17461391.2011.566373

Gómez, M. Á., Lago, C., Gómez, M. T., & Furley, P. (2019). Analysis of elite soccer players' performance before and after signing a new contract. *PLoS ONE*, *14*(1), e0211058. https://doi.org/10.1371/journal.pone.0211058

Gonçalves, B. V., Figueira, B. E., Maçãs, V., & Sampaio, J. (2014). Effect of player position on movement behaviour, physical and physiological performances during an 11-a-side football game. *Journal of Sports Sciences*, *32*(2), 191–199. https://doi.org/10.1080/02640414.2013.816761

Goumas, C. (2017). Modelling home advantage for individual teams in UEFA Champions League football. *Journal of Sport and Health Science*, *6*(3), 321–326. https://doi.org/10.1016/j.jshs.2015.12.008

Harper, D. J., Carling, C., & Kiely, J. (2019). High-Intensity Acceleration and Deceleration Demands in Elite Team Sports Competitive Match Play: A Systematic Review and Meta-Analysis of Observational Studies. In *Sports Medicine* (Vol. 49, Issue 12, pp. 1923–1947). Sports Med. https://doi.org/10.1007/s40279-019-01170-1

Harrop, K., & Nevill, A. (2014). Performance indicators that predict success in an English Professional League One Soccer Team. *International Journal of Performance Analysis in Sport*. https://doi.org/10.1080/24748668.2014.11868767

Haugen, T. A., Breitschädel, F., & Seiler, S. (2020). Sprint mechanical properties in soccer players according to playing standard, position, age and sex. *Journal of Sports Sciences*, *38*(9), 1070–1076. https://doi.org/10.1080/02640414.2020.1741955

Haugen, T. A., Tønnessen, E., Hisdal, J., & Seiler, S. (2014). The role and development of sprinting speed in soccer. In *International Journal of Sports Physiology and Performance* (Vol. 9, Issue 3, pp. 432–441). Int J Sports Physiol Perform. https://doi.org/10.1123/IJSPP.2013-0121

Herrero-Gonzalez, H., Martín-Acero, R., Del Coso, J., Lalín-Novoa, C., Pol, R., Martín-Escudero, P., De La Torre, A. I., Hughes, C., Mohr, M., Biosca, F., & Ramos, R. (2020). Position statement of the Royal Spanish Football Federation for the resumption of football activities after the COVID-19 pandemic (June 2020). In *British Journal of Sports Medicine* (Vol. 54, Issue 19, pp. 1133–1134). Br J Sports Med. https://doi.org/10.1136/bjsports-2020-102640

Hinkle, D.E.;Wiersma,W.; Jurs, S. G. (2003). *Applied Statistics for the Behavioral Sciences*. Houghton Mi_in College Division: Boston, MA, USA,.

Hopkins, W. G. (2020). *A spreadsheet for deriving a confidence interval, mechanistic.* https://www.sportsci.org/2007/wghinf.htm

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise*, *41*(1), 3–13. https://doi.org/10.1249/MSS.0b013e31818cb278

Hoppe, M. W., Slomka, M., Baumgart, C., Weber, H., & Freiwald, J. (2015). Match running performance and success across a season in German Bundesliga soccer teams. *International Journal of Sports Medicine*, *36*(7), 563–566. https://doi.org/10.1055/s-0034-1398578

IFFHS. (2021). *La Liga, leader in the XXIst century of the IFFHS ranking the world's strongest national league.* https://www.iffhs.com/posts/1030

Ingebrigtsen, J., Dalen, T., Hjelde, G. H., Drust, B., & Wisløff, U. (2015). Acceleration and sprint profiles of a professional elite football team in match play. *European Journal of Sport Science*, *15*(2), 101–110. https://doi.org/10.1080/17461391.2014.933879

Janković, A., Leontijević, B., Jelušić, V., Pašić, M., & Mićović, B. (2011). Influence of tactics efficiency on results in serbian soccer super league in season 2009/2010. *Journal of Physical Education and Sport*, *11*(1), 32–41.

Jones, P. D., James, N., & Mellalieu, S. D. (2004). Possession as a performance indicator in soccer. *International Journal of Performance Analysis in Sport*, *4*(1), 98–102. https://doi.org/10.1080/24748668.2004.11868295

Kattuman, P., Loch, C., & Kurchian, C. (2019). Management succession and success in a professional soccer team. *PLoS ONE*, *14*(3), e0212634. https://doi.org/10.1371/journal.pone.0212634

Kempe, M., & Memmert, D. (2018). "Good, better, creative": the influence of creativity on goal scoring in elite soccer. *Journal of Sports Sciences*, *36*(21), 2419–2423. https://doi.org/10.1080/02640414.2018.1459153

Kempe, M., Vogelbein, M., Memmert, D., & Nopp, S. (2014). Possession vs. Direct Play: Evaluating Tactical Behavior in Elite Soccer. *International Journal of Sports Science*, *4*(6A), 35–41. https://doi.org/10.5923/s.sports.201401.05

Kirkland A. (2020). *La Liga given green light to restart on June 8 by Spanish prime minister Available online*. ESPN.

Krustrup, P., Mohr, M., Steensberg, A., Bencke, J., Klær, M., & Bangsbo, J. (2006). Muscle and blood metabolites during a soccer game: Implications for sprint performance. *Medicine and Science in Sports and Exercise*, *38*(6), 1165–1174. https://doi.org/10.1249/01.mss.0000222845.89262.cd

Kubayi, A., & Toriola, A. (2019). Trends of goal scoring patterns in soccer: A retrospective analysis of five successive FIFA World Cup tournaments. *Journal of Human Kinetics*, *69*(1), 231–238. https://doi.org/10.2478/hukin-2019-0015

Lago-Ballesteros, J., & Lago-Peñas, C. (2010). Performance in Team Sports: Identifying the Keys to Success in Soccer. *Journal of Human Kinetics*, *25*(1), 85–

91. https://doi.org/10.2478/v10078-010-0035-0
Lago-Peñas, C., Gómez-Ruano, M., Megías-Navarro, D., & Pollard, R. (2016). Home advantage in football: Examining the effect of scoring first on match outcome in the five major European leagues. *International Journal of Performance Analysis in Sport*, *16*(2), 411–421. https://doi.org/10.1080/24748668.2016.11868897
Lago-Peñas, C., Lago-Ballesteros, J., Dellal, A., & Gómez, M. (2010). Game-related statistics that discriminated winning, drawing and losing teams from the Spanish soccer league. *Journal of Sports Science and Medicine*, *9*(2), 288–293. /pmc/articles/PMC3761743/
Lago-Peñas, C., Lago-Ballesteros, J., & Rey, E. (2011). Differences in performance indicators between winning and losing teams in the UEFA Champions League. *Journal of Human Kinetics*. https://doi.org/10.2478/v10078-011-0011-3
Lago, C. (2009). The influence of match location, quality of opposition, and match status on possession strategies in professional association football. *Journal of Sports Sciences*, *27*(13), 1463–1469. https://doi.org/10.1080/02640410903131681
Lago, C., & Martín, R. (2007). Determinants of possession of the ball in soccer. *Journal of Sports Sciences*, *25*(9), 969–974. https://doi.org/10.1080/02640410600944626
Lefebvre, L. M., & Passer, M. W. (1974). The effects of game location and importance on aggression in team sport. *International Journal of Sport Psychology*, *5*(2), 102–110. https://psycnet.apa.org/record/1975-27467-001
Lepschy, H., Wäsche, H., & Woll, A. (2018). How to be Successful in Football : A Systematic Review Abstract : *The Open Sports Sciences Journal*, *11*, 3–23. https://doi.org/10.2174/1875399X01811010003
Lepschy, H., Wäsche, H., & Woll, A. (2020). Success factors in football: an analysis of the German Bundesliga. *International Journal of Performance Analysis in Sport*, *20*(2), 150–164. https://doi.org/10.1080/24748668.2020.1726157
Linke, D., Link, D., & Lames, M. (2020). Football-specific validity of TRACAB's optical video tracking systems. *PLoS ONE*, *15*(3). https://doi.org/10.1371/journal.pone.0230179
Linke, D., Link, D., Weber, H., & Lames, M. (2018). Decline in match running performance in football is affected by an increase in game interruptions. *Journal of Sports Science and Medicine*, *17*(4), 662–667.
Liu, H., Gómez, M. A., Gonçalves, B., & Sampaio, J. (2016). Technical performance and match-to-match variation in elite football teams. *Journal of Sports Sciences*, *34*(6), 509–518. https://doi.org/10.1080/02640414.2015.1117121
Liu, H., Gomez, M. Á., Lago-Peñas, C., & Sampaio, J. (2015). Match statistics related to winning in the group stage of 2014 Brazil FIFA World Cup. *Journal of Sports Sciences*. https://doi.org/10.1080/02640414.2015.1022578
Liu, H., Hopkins, W. G., & Gómez, M. A. (2016). Modelling relationships between match events and match outcome in elite football. *European Journal of Sport Science*, *16*(5), 516–525. https://doi.org/10.1080/17461391.2015.1042527
Liu, H., Hopkins, W., Gómez, M. A., & Molinuevo, J. S. (2013). Inter-operator reliability of live football match statistics from OPTA Sportsdata. *International Journal of Performance Analysis in Sport*. https://doi.org/10.1080/24748668.2013.11868690
Longo, U. G., Sofi, F., Candela, V., Dinu, M., Cimmino, M., Massaroni, C., Schena, E., & Denaro, V. (2019). Performance Activities and Match Outcomes of Professional Soccer Teams during the 2016/2017 Serie A Season. *Medicina*, *55*(8). https://doi.org/10.3390/MEDICINA55080469
López, L. (2019). *Posesión, pero con pegada: así es el ADN del campeón de LaLiga*

Santander. MARCA. https://noesfutboleslaliga.marca.com/directos-al-futuro/posesion-pero-con-pegada-asi-es-el-adn-del-campeon-de-laliga-santander
Luhtanen, P., Belinskij, A., Häyrinen, M., & Vänttinen, T. (2001). A comparative tournament analysis between the EURO 1996 and 2000 in soccer. *International Journal of Performance Analysis in Sport*, *1*(1), 74–82. https://doi.org/10.1080/24748668.2001.11868250
Mackenzie, R., & Cushion, C. (2013). Performance analysis in football: a critical review and implications for future research. *Journal of Sports Sciences*, *31*(6), 639–676. https://doi.org/10.1080/02640414.2012.746720
Martín, A. (2019). *¡Atención, hincha! No pidas a tu equipo que corra si quieres que gane.* El País. https://elpais.com/deportes/2019/04/04/es_laliga/1554379055_967933.html
Mendez-Villanueva, A., Buchheit, M., Simpson, B., & Bourdon, P. C. (2013). Match play intensity distribution in youth soccer. *International Journal of Sports Medicine*, *34*(2), 101–110. https://doi.org/10.1055/s-0032-1306323
Mendez-Villanueva, A., Edge, J., Suriano, R., Hamer, P., & Bishop, D. (2012). The Recovery of Repeated-Sprint Exercise Is Associated with PCr Resynthesis, while Muscle pH and EMG Amplitude Remain Depressed. *PLoS ONE*, *7*(12). https://doi.org/10.1371/journal.pone.0051977
Merhej, C., Beal, R., Ramchurn, S., & Matthews, T. (2021). *What Happened Next? Using Deep Learning to Value Defensive Actions in Football Event-Data*. *21*. https://doi.org/10.1145/3447548.3467090
Millington, B., & Millington, R. (2015). 'The Datafication of Everything': Toward a Sociology of Sport and Big Data. *Sociology of Sport Journal*, *32*(2), 140–160. https://doi.org/10.1123/SSJ.2014-0069
Mohr, M., Draganidis, D., Chatzinikolaou, A., Barbero-Álvarez, J. C., Castagna, C., Douroudos, I., Avloniti, A., Margeli, A., Papassotiriou, I., Flouris, A. D., Jamurtas, A. Z., Krustrup, P., & Fatouros, I. G. (2016). Muscle damage, inflammatory, immune and performance responses to three football games in 1 week in competitive male players. *European Journal of Applied Physiology*, *116*(1), 179–193. https://doi.org/10.1007/s00421-015-3245-2
Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences*, *21*(7), 519–528. https://doi.org/10.1080/0264041031000071182
Moreno-Pérez, V., Del Coso, J., Romero-Rodríguez, D., Marcé-Hernández, L., Peñaranda, M., & Madruga-Parera, M. (2020). Effects of home confinement due to COVID-19 pandemic on eccentric hamstring muscle strength in football players. *Scandinavian Journal of Medicine and Science in Sports*, *30*(10), 2010–2012. https://doi.org/10.1111/sms.13768
Mota, G. R., Dos Santos, I. A., Arriel, R. A., & Marocolo, M. (2020). Is it high time to increase elite soccer substitutions permanently? *International Journal of Environmental Research and Public Health*, *17*(19), 1–13. https://doi.org/10.3390/ijerph17197008
Nevo, D., & Ritov, Y. (2013). Around the goal: Examining the effect of the first goal on the second goal in soccer using survival analysis methods. *Journal of Quantitative Analysis in Sports*, *9*(2), 165–177. https://doi.org/10.1515/jqas-2012-0004
Njororai, W. (2014). Timing of goals scored in selected European and South American soccer leagues , FIFA and UEFA tournaments and the critical phases of a match. *International Journal of Sports Science*, *4*, 56–64. https://doi.org/10.5923/s.sports.201401.08

Njororai, W. W. S. (2013). Analysis of goals scored in the 2010 world cup soccer tournament held in South Africa. *Journal of Physical Education and Sport*, *13*(1), 6–13. https://doi.org/10.7752/jpes.2013.01002

Oberstone, J. (2009). Differentiating the Top English Premier League Football Clubs from the Rest of the Pack: Identifying the Keys to Success. *Journal of Quantitative Analysis in Sports*, *5*(3), 1–27. https://doi.org/10.2202/1559-0410.1183

Oliva-Lozano, J. M., Fortes, V., Krustrup, P., & Muyor, J. M. (2020). Acceleration and sprint profiles of professional male football players in relation to playing position. *PLoS ONE*, *15*(8 August). https://doi.org/10.1371/journal.pone.0236959

Oliva-Lozano, J. M., Rojas-Valverde, D., Gómez-Carmona, C. D., Fortes, V., & Pino-Ortega, J. (2021). Impact of contextual variables on the representative external load profile of Spanish professional soccer match-play: A full season study. *European Journal of Sport Science*, *21*(4), 497–506. https://doi.org/10.1080/17461391.2020.1751305

Pappalardo, L., & Cintia, P. (2018). Quantifying the relation between performance and success in soccer. *Advances in Complex Systems*, *21*(3–4). https://doi.org/10.1142/S021952591750014X

Pereira, L. A., Freitas, T. T., Pivetti, B., Alcaraz, P. E., Jeffreys, I., & Loturco, I. (2020). Short-Term Detraining Does Not Impair Strength, Speed, and Power Performance in Elite Young Soccer Players. *Sports*, *8*(11), 1–8. https://doi.org/10.3390/sports8110141

Pons, E., García-Calvo, T., Resta, R., Blanco, H., del Campo, R. L., García, J. D., & Pulido, J. J. (2019). A comparison of a GPS device and a multi-camera video technology during official soccer matches: Agreement between systems. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0220729

Pratas, José M., Volossovitch, A., & Carita, A. I. (2018). Analysis of Scoring Sequences in Matches of the Portuguese Premier League. *Journal of Human Kinetics*, *64*(1), 255–263. https://doi.org/10.1515/hukin-2017-0199

Pratas, José Maria, Volossovitch, A., & Carita, A. I. (2016). The effect of performance indicators on the time the first goal is scored in football matches. *International Journal of Performance Analysis in Sport*, *16*(1), 347–354. https://doi.org/10.1080/24748668.2016.11868891

Primorac, D., Matišić, V., Molnar, V., Bahtijarević, Z., & Polašek, O. (2020). Pre-season football preparation in the era of COVID-19: Croatian football association model. *Journal of Global Health*, *10*(1). https://doi.org/10.7189/JOGH.10.010352

Puente, C., Coso, J. Del, Salinero, J. J., & Abián-Vicén, J. (2015). Basketball performance indicators during the ACB regular season from 2003 to 2013. *International Journal of Performance Analysis in Sport*, *15*(3), 935–948. https://doi.org/10.1080/24748668.2015.11868842

Rago, V., Silva, J., Mohr, M., Randers, M., Barreira, D., Krustrup, P., & Rebelo, A. (2018). Influence of opponent standard on activity profile and fatigue development during preseasonal friendly soccer matches: a team study. *Research in Sports Medicine*, *26*(4), 413–424. https://doi.org/10.1080/15438627.2018.1492400

Rampinini, E., Coutts, A. J., Castagna, C., Sassi, R., & Impellizzeri, F. M. (2007). Variation in top level soccer match performance. *International Journal of Sports Medicine*. https://doi.org/10.1055/s-2007-965158

Rampinini, Ermanno., Bishop, D., Marcora, S. M., Ferrari Bravo, D., Sassi, R., & Impellizzeri, F. M. (2007). Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. *International Journal of Sports Medicine*, *28*(3), 228–235. https://doi.org/10.1055/s-2006-

924340
Rampinini, Ermanno, Impellizzeri, F. M., Castagna, C., Azzalin, A., Bravo, D. F., & Wisløff, U. (2008). Effect of match-related fatigue on short-passing ability in young soccer players. *Medicine and Science in Sports and Exercise*, *40*(5), 934–942. https://doi.org/10.1249/MSS.0b013e3181666eb8
Rampinini, Ermanno, Impellizzeri, F. M., Castagna, C., Coutts, A. J., & Wisløff, U. (2009). Technical performance during soccer matches of the Italian Serie A league: Effect of fatigue and competitive level. *Journal of Science and Medicine in Sport*, *12*(1), 227–233. https://doi.org/10.1016/j.jsams.2007.10.002
Rein, R., & Memmert, D. (2016). Big data and tactical analysis in elite soccer: future challenges and opportunities for sports science. In *SpringerPlus*. https://doi.org/10.1186/s40064-016-3108-2
Russell, M., Benton, D., & Kingsley, M. (2011). The effects of fatigue on soccer skills performed during a soccer match simulation. *International Journal of Sports Physiology and Performance*, *6*(2), 221–233. https://doi.org/10.1123/ijspp.6.2.221
Sarmento, H., Anguera, M. T., Pereira, A., & Araújo, D. (2018). Talent Identification and Development in Male Football: A Systematic Review. *Sports Medicine*, *48*(4), 907–931. https://doi.org/10.1007/s40279-017-0851-7
Sarmento, H., Clemente, F. M., Araújo, D., Davids, K., McRobert, A., & Figueiredo, A. (2018). What Performance Analysts Need to Know About Research Trends in Association Football (2012–2016): A Systematic Review. *Sports Medicine*, *48*(4), 799–836. https://doi.org/10.1007/s40279-017-0836-6
Sarmento, H., Figueiredo, A., Lago-Peñas, C., Milanovic, Z., Barbosa, A., Tadeu, P., & Bradley, P. S. (2018). Influence of tactical and situational variables on offensive sequences during elite football matches. *Journal of Strength and Conditioning Research*, *32*(8), 2331–2339. https://doi.org/10.1519/jsc.0000000000002147
Sarmento, H., Marcelino, R., Anguera, M. T., CampaniÇo, J., Matos, N., & LeitÃo, J. C. (2014). Match analysis in football: a systematic review. *Journal of Sports Sciences*, *32*(20), 1831–1843. https://doi.org/10.1080/02640414.2014.898852
Seçkin, A., & Pollard, R. (2008). Home Advantage in Turkish Professional Soccer. *Perceptual and Motor Skills*. https://doi.org/10.2466/pms.107.1.51-54
Silva, J. R., Brito, J., Akenhead, R., & Nassis, G. P. (2016). The Transition Period in Soccer: A Window of Opportunity. *Sports Medicine*. https://doi.org/10.1007/s40279-015-0419-3
Smith, M. R., Coutts, A. J., Merlini, M., Deprez, D., Lenoir, M., & Marcora, S. M. (2016). Mental fatigue impairs soccer-specific physical and technical performance. *Medicine and Science in Sports and Exercise*, *48*(2), 267–276. https://doi.org/10.1249/MSS.0000000000000762
Suarez-Arrones, L., Torreño, N., Requena, B., Sáez De Villarreal, E., Casamichana, D., Barbero-Alvarez, J. C., & Munguía-Izquierdo, D. (2015). Match-play activity proile in professional soccer players during oficial games and the relationship between external and internal load. *Journal of Sports Medicine and Physical Fitness*, *55*(12), 1417–1422. https://www.minervamedica.it/en/journals/sports-med-physical-fitness/article.php?cod=R40Y2015N12A1417
Szwarc, A. (2007). Efficacy of successful and unsuccessful soccer teams taking part in finals of Champions League. *Research Yearbook*, *13*(2), 221–225. http://journals.indexcopernicus.com/abstracted.php?icid=838944
Taylor, J. B., Mellalieu, S. D., James, N., & Shearer, D. A. (2008). The influence of match location, quality of opposition, and match status on technical performance in professional association football. *Journal of Sports Sciences*, *26*(9), 885–895.

https://doi.org/10.1080/02640410701836887
Tønnessen, E., Hem, E., Leirstein, S., Haugen, T., & Seiler, S. (2013). Maximal aerobic power characteristics of male professional soccer players, 1989-2012. *International Journal of Sports Physiology and Performance*, *8*(3), 323–329. https://doi.org/10.1123/ijspp.8.3.323
Tucker, W., Mellalieu, D. S., James, N., & Taylor, B. J. (2005). Game Location Effects in Professional Soccer: A Case Study. *International Journal of Performance Analysis in Sport*, *5*(2), 23–35. https://doi.org/10.1080/24748668.2005.11868325
Vales-Vázquez, Á., Casal-López, C., Gómez-Rodríguez, P., Blanco-Pita, H., & Serra-Olivares, J. (2018). Competitive profile differences between the best-ranked European football championships. *Human Movement*, *2017*(5), 97–105. https://doi.org/10.5114/hm.2017.73619
Vigne, G., Gaudino, C., Rogowski, I., Alloatti, G., & Hautier, C. (2010). Activity profile in elite Italian soccer team. *International Journal of Sports Medicine*, *31*(5), 304–310. https://doi.org/10.1055/s-0030-1248320
Vogelbein, M., Nopp, S., & Hökelmann, A. (2014). Defensive transition in soccer - are prompt possession regains a measure of success? A quantitative analysis of German Fußball-Bundesliga 2010/2011. *Journal of Sports Sciences*, *32*(11), 1076–1083. https://doi.org/10.1080/02640414.2013.879671
Weyand, P. G., Sandell, R. F., Prime, D. N. L., & Bundle, M. W. (2010). The biological limits to running speed are imposed from the ground up. *Journal of Applied Physiology*, *108*(4), 950–961. https://doi.org/10.1152/japplphysiol.00947.2009
WHO. (2020). *World Health Organization Archived: WHO Timeline*. WHO. https://www.who.int/news/item/27-04-2020-who-timeline---covid-19
Williams, A. M. (2000). Perceptual skill in soccer: Implications for talent identification and development. *Journal of Sports Sciences*, *18*(9), 737–750. https://doi.org/10.1080/02640410050120113
Yiannakos, A., & Armatas, V. (2006). Evaluation of the goal scoring patterns in European Championship in Portugal 2004. *International Journal of Performance Analysis in Sport*, *6*(1), 178–188. https://doi.org/10.1080/24748668.2006.11868366

ATTACHMENT

Attachment 1. UCJC board review

Universidad Camilo José Cela

INFORME DE LA COMISIÓN DE ÉTICA DE INVESTIGACIÓN

Dr. Francisco López Muñoz, Presidente del Comité de Ética de la Investigación de la Universidad Camilo José Cela (CEI-UCJC)

INFORMA

Que habiendo tenido en cuenta la propuesta de investigación:

Título: How to be successful in professional football: analysis of the tactics, technical and physical components of professional football teams of la liga.

Investigadores: Diego Brito de Souza

NO ES NECESARIO la realización de la preceptiva evaluación por el Comité de Ética de la Investigación dado **que la propuesta NO engloba** ninguno de los siguientes aspectos con implicaciones éticas o sobre la bioseguridad según la Ley 14/2007, de 3 de julio, de Investigación biomédica, Título 1 (art. 1):

- Experimentación clínica con seres humanos y ensayos clínicos con medicamentos y productos sanitarios.
- Las investigaciones relacionadas con la salud humana que impliquen procedimientos invasivos.
- La donación y utilización de ovocitos, espermatozoides, preembriones, embriones y fetos humanos o de sus células, tejidos u órganos con fines de investigación biomédica y sus posibles aplicaciones clínicas.
- Experimentación animal.
- La realización de análisis genéticos y el tratamiento de datos genéticos de carácter personal.
- El tratamiento de muestras biológicas.
- El almacenamiento y movimiento de muestras biológicas.
- Los biobancos.

No obstante, tal y como expresa el equipo de investigación, el estudio se encuentra sujeto a las disposiciones éticas institucionales de la Universidad Camilo José Cela y la Declaración de Helsinki. No existe conflicto de intereses por parte de los investigadores. El investigador principal cuenta con la autorización de la entidad colaboradora (LaLiga) a través de la aplicación Mediacoach® para el análisis de los datos anonimizados facilitados por los participantes. No se recogen datos sensibles de los participantes.

Y para que conste, se expide el presente certificado en Madrid, a 16 de diciembre de 2019

Firmado: D. Francisco López Muñoz
Presidente del Comité Ético de la Investigación

Attachment 2. *LaLiga* Authorization

To whom it may concern,

Mr. Luis Gil Torres, of legal age, holding National Identity Document (D.N.I.) number 52736005H, acting in the name and on behalf of LIGA NACIONAL DE FÚTBOL PROFESIONAL (hereinafter referred to as, "LaLiga"), with registered office at calle Torrelaguna 60, 28043 Madrid, with Tax Identification Number G-78069762, in his capacity, as Head of Competitions and Player´s Office of LaLiga

HEREBY DECLARES:

I. Whereas LaLiga is a sports association governed by private law which is solely and obligatorily comprised of all the sports corporations and clubs that take part in the official nation-wide professional football competitions of the First and Second Division.

II. Whereas LaLiga possesses a system called "Mediacoach". This system integrating video analysis, game tracking and medium and high-level statistical data, to allow a personalized analysis of football matches for different exploitation purposes. Mediacoach is integrated by a number of applications and information systems to acquire tracking data, eventing data, integrate video sources (TV, specific panoramic video, and others), transmission and consolidation of the different sources in repositories as well as a number of applications to allow a personalized analysis and exploitation of all data sources). LaLiga has an agreement for five years length with Perform Media Chanel Limited (hereinafter "Stats-Perform"), signed in May 2018, where Stats-Perform is the official provider of LaLiga, and Stats-Perform Eventing becomes the official Eventing of LaLiga. Included in the agreement is the right to use Stats-Perform Data feeds in LaLiga.

III. Whereas authorizes Diego Brito Souza to use the data of Mediacoach in the solely in the research: "The football championship is won when playing away: difference in match statistics between the winner and the second-place team in LaLiga" submitted on March 22th 2020 by Mr Diego Brito Souza", on the terms and conditions set out by LaLiga.

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IV. Finished the research may not neither use or carry out a commercial exploitation of the rights granted herein, nor use the data of Mediacoach.

V. The data can only be used during the course of the research and publication of the paper in scientific journals.

VI. All the investigators expressly recognize that they do not acquire hereby any right on the data, brands, logos, names and other industrial or intellectual property rights of LaLiga, but instead the right to use only for the purposes and in the conditions set out herein.

In witness, whereof for all pertinent purpose, this letter is issued in Madrid on May 20, 2020.

Mr. Luis Gil Torres
Head of Competitions and Player's Office of LaLiga

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Attached studies.

Study 1: A new paradigm to understand success in professional football: analysis of match statistics in *LaLiga* for 8 complete seasons

Study 2: An Extensive Comparative Analysis of Successful and Unsuccessful Football Teams in *LaLiga*

Study 3: The football championship is won when playing away: difference in match statistics between the winner and the second-place team in *LaLiga*

Study 4: Relationship between time of goal scoring and classification in *LaLiga*: an analysis of 8 complete seasons

Study 5: Association of match running performance with and without ball possession to football performance

Study 6: Influence of Players' Maximum Running Speed on the Team's Ranking Position at the End of the Spanish *LaLiga*

Study 7: Players' physical performance in *LaLiga* across the season: insights for competition continuation after COVID-19

Study 8: Running Patterns in *LaLiga* Before and After Suspension of the Competition Due to COVID-19

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A new paradigm to understand success in professional football: analysis of match statistics in *LaLiga* for 8 complete seasons

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ABSTRACT

The aim of this study was to identify match statistics that best explain the number of points obtained in a professional football league at the end of the season. To fulfill this aim, accumulated attacking and defensive match statistics along with the points earned at the end of each season were obtained from *LaLiga* (2010–2011 to 2017–2018). The analysis included a total of 3040 football matches. Bivariate correlation analysis shows that the number of shots (r = 0.42) and the number of corners (r = 0.42) were the attacking variables with the highest association to the number of points earned during the season. The defensive effectiveness against shooting conceded (r = −0.36) and the number of recoveries (r = 0.27) were the defensive variables with the highest association to the points earned during the season. A multiple regression analysis was able to explain 84.1% of the total variance in the number of points with attacking statistics and 73.5% with defensive statistics. In conclusion, shooting accuracy while attacking along with avoiding clear positions of shots from the opposing team during defensive plays are the indicators best associated with the points obtained at the end of the *LaLiga* championship.

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Soccer; match analysis; success; performance; elite football

1. Introduction

Success in football (soccer), as in other team-oriented sports, is a complex construct in where a myriad of intrinsic and extrinsic factors contributes to the overall performance of the match or tournament. Particularly, players' physical conditioning, football-specific technical aptitudes, and team tactics are some of the main contributors to football performance (Sarmento, Anguera, Pereira, & Araújo, 2018), although different contextual factors have also been recently reported as key elements for football performance (García-Unanue et al., 2018; Gómez, Lago, Gómez, & Furley, 2019; Sarmento et al., 2018). However, unlike other team sports, football is a low scoring game where match wins are often obtained through small score differences between football teams. Although scoring a goal is traditionally perceived as the most obvious representation of football success, most player and

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team actions do not result in a goal scored, and thus, the final match score does not always represent an objective categorization of a team's football performance (Lepschy, Wäsche, & Woll, 2018). For this reason, previous research has analysed variables that result in higher tournament rankings (Sarmento et al., 2018).

Previous investigations have tried to understand the complexity of football. They established that the quality of the opposing team, match location, and match result are strongly related to a successful match (Lago, 2009; Liu, Gómez, Gonçalves, & Sampaio, 2015; Sarmento et al., 2014; Taylor, Mellalieu, James, & Shearer, 2008). These variables might affect football performance and success because they have the capacity to influence game development, as measured by different match statistics (Lago-Peñas, Lago-Ballesteros, Dellal, & Gómez, 2010). Several game actions have been proposed as key football performance indicators as their effects are being reviewed and summarized only recently (Lepschy et al., 2018; Mackenzie & Cushion, 2013; Sarmento et al., 2014). Overall, the number of shots, number of goals obtained by a given number of shots (e.g. shot accuracy/efficiency), ball possession, number of passes, and passing accuracy are the match statistics most frequently used to differentiate between winners and losers (Castellano, Casamichana, & Lago, 2012; Lago-Peñas, Lago-Ballesteros, & Rey, 2011; Mao, Peng, Liu, & Gómez, 2016; Szwarc, 2007) and/or better-ranked and least-ranked teams (Lago-Ballesteros & Lago-Peñas, 2010; Rampinini, Impellizzeri, Castagna, Coutts, & Wisløff, 2009). Interestingly enough, these variables also appear in investigations in professional national leagues (Harrop & Nevill, 2014; Rampinini et al., 2009), continental leagues (Lago-Peñas et al., 2011), and World Cup championships (Castellano et al., 2012; Liu, Gomez, Lago-Peñas, & Sampaio, 2015). However, the low amount of players and games included in most investigations along with defensive match statistic underrepresentation are common limitations in investigations that analyse football performance (Mackenzie & Cushion, 2013). In addition, these previous investigations suggest that almost all match statistics are statistically associated to football performance (Lepschy et al., 2018; Sarmento et al., 2018), which complicates the efforts of coaches and performance analysts. It becomes difficult to distinguish between what game actions should be prioritized through football playing styles in order to improve the likelihood of competitive match wins.

Despite this effort to understand football performance, previous investigations have been unable to compare the magnitude that each match statistic contributes to success in elite football. These investigations have always analyzed short periods of time, and thus, they might be partially biased by the effect produced by extraordinary players' performance, injuries, or even the leadership styles imposed by the team's coaches (Kattuman, Loch, & Kurchian, 2019).

Although the difficulty of analyzing several seasons is comprehensible, the use of results obtained from one season or one tournament might produce partially biased outcomes. For this reason, the aim of this study was to identify match statistics that best explain football success in a professional football league. We have used the number of points obtained at the end of a competitive season as the (dependent) variable of success and the accumulated match statistics at the end of the season as the predictive (independent) variables. To further strengthen our analysis and reduce the influence of confounding variables, we used data from eight complete seasons of a professional football league. We hypothesized that passing accuracy, the number of shots, and

shooting accuracy would be the variables that best explained football success in this context.

2. Methods

The design of this descriptive, correlational investigation is based on suggestions made by Mackenzie and Cushion (2013) in order to have a rigorous approach in analyzing football performance. The design of this investigation has taken multiple factors into consideration, including the sample (i.e. elite football teams across 8 complete seasons), competitive nature of football (i.e. a professional football league), and the operational definitions of the investigated variables (i.e. match statistics and ranking points). For this investigation, the term "ranking points" depicts the number of points earned during the season once the championship has been finished. Data were obtained from the Spanish Professional Football League (*LaLiga*) for the seasons between 2010–2011 and 2017–2018. *LaLiga* authorized the use of these data for the purpose of this investigation. In accordance with *LaLiga's* ethical guidelines, this investigation does not include information that identifies football players. The University Institutional Review Board of Camilo José Cela University approved this investigation.

Table 1 contains information about the average number of ranking points obtained at the end of each season in the 1st division league. It also highlights points obtained by the champion team, teams classified for the Champions League and Europa League, the relegated teams, and the last-classified team. The end-season match statistics of football teams that competed in the championship were also obtained, for an analysis of 3040 football matches and 32 different teams that competed during the eight years analyzed (38 matches per season and per football team). The data were extracted by the match statistics software Media Coach®, based on the track analysis tool OPTA Sportsdata (Spain). The reliability of this current tracking system was tested with an intra-class correlation coefficient that ranges from 0.88 to 1.00 (Liu, Hopkins, Gómez, & Molinuevo, 2013). Because we used the accumulated match statistics and ranking points, we were required to use 160 comparative data points (20 teams per season and 8 seasons).

Because the objective of this investigation was to determine the match statistics that best correlated with overall football performance in a professional league, we used the number of points obtained at the end of the seasons as the variable that best represented football performance (dependent variable). The remaining match statistics selected for this investigation and their operational definitions are presented in Table 2. These

Table 1. Points obtained by the teams competing in the last 8 seasons in the Spanish professional football league (*LaLiga*).

Season	Average ± SD	Champion	Champions League	Europa League	Relegation	Last
2010–2011	53 ± 17	96	≥ 62	≥ 58	≤ 43	30
2011–2012	52 ± 17	100	≥ 58	≥ 55	≤ 41	27
2012–2013	53 ± 18	100	≥ 66	≥ 57	≤ 36	34
2013–2014	53 ± 18	90	≥ 70	≥ 59	≤ 39	25
2014–2015	52 ± 21	94	≥ 77	≥ 60	≤ 35	20
2015–2016	52 ± 18	91	≥ 64	≥ 60	≤ 38	32
2016–2017	53 ± 21	93	≥ 72	≥ 64	≤ 31	20
2017–2018	53 ± 18	93	≥ 73	≥ 60	≤ 29	20

Table 2. Operational definitions of match statistics and events used for the investigation.

Attacking variables	Specifications
Goal	Score obtained by the attacking team when the ball completely passes over a goal line
Shot	Attempt to score a goal of the attacking team, made with any legal part of the body, either on or off target
Shooting accuracy	Goals/shots
Pass	Attempted exchange of the ball between two players of the attacking team
Successful pass	Successful exchange of the ball between two players of the attacking team
Passing accuracy	Successful passes/passes
Cross	Action made by a player with the objective of introducing the ball within the opposition team
Penalty kick	Single shot on the goal while it is defended only by the opposing team's goalkeeper
Turnover	Loss of ball possession to the opposing team due to mistake or poor control
Foul received	Infringement committed by the opposing the team and sanctioned by the referee
Corner	Ball crosses the end line of opponent's side and the last person in contact with the ball was an opponent
Free kick goal	Goal scored for the attacking team as the result of a direct or indirect free kick
Offside	Infringement committed by the attacking team as a result of a player being offside
Defensive variables	
Goal received	Score obtained by the opposing team when the ball passes completely over a goal line
Shot conceded	Attempt to score a goal made by the opposing team
Effectiveness against conceded shooting	Goals received/shots conceded
Foul committed	Infringement committed by the defending team and sanctioned by the referee
Penalty kick conceded	Single shot on the goal while it is defended only by the defending team's goalkeeper
Corner against	Ball crosses the end line of defending team's side and the last person in contact with the ball was an opponent
Yellow cards	Sanction by the referee to one of the players of the defending team
Red cards	Sanction by the referee to one of the players of the defending team that ends in player expulsion
Free kick goals received	Goal received as the result of a direct or indirect free kick
Recovery	Obtaining the ball possession due to a defensive action

variables were selected based on previous studies regarding this topic (Lago-Peñas et al., 2010; Liu et al., 2015; Rampinini et al., 2009). In order to improve the applicability of this study's results to professional football, the accumulated match statistics were distributed in attacking/offensive actions and defensive actions.

2.1. Statistical analysis

We used Pearson's correlation coefficient (r) to assess the association between each team's match statistics and the points obtained at the end of the season. Afterwards, we performed a multiple regression analysis in a stepwise interactive mode in order to assess the influence that each match statistic had on the points obtained at the end of the league. This analysis was inspired by a similar investigation in a professional basketball league (Puente, Coso, Salinero, & Abián-Vicén, 2015). In the regression analysis, all match statistics were introduced based on their correlation with the residual ($p < 0.1$) and their intercorrelation with variables that already included in the equation. Of note, we excluded the number of goals (attacking variable) and the number of goals received (defense variable) from the multiple regression analysis because the number of ranking points is primarily based on the number of goals obtained/received by the teams in each game. By using a threshold of 5 points in the variance inflation factor

(VIF), redundant variables were excluded to avoid multicollinearity. The produced regression equation was accepted at a significance level of $P < 0.01$. The r^2 values were adjusted for the number of cases and parameters in the analysis. Using the standardized regression coefficients, the relative contribution of each different variable in relation to the explained variances was calculated as follows:

Partial contribution r^2 adjusted = ([Standardized regression coefficient for parameter]/Σ [of all standardized regression coefficients in equation]).

The significance level for the statistical analysis was set at $P < 0.05$ and all analysis and calculations were performed using the SPSS v.20 software package (SPSS Inc., USA).

3. Results

Table 3 contains Pearson's correlation coefficients that are based on data from the specified eight seasons. Table 3 also contains information about the attacking match statistics according to the ranking obtained in the *LaLiga* championship. As expected, the number of goals was the attacking variable with the highest association to the points obtained at the end of the seasons, although the number of shots, the number of corners, the shooting accuracy, the number of passes, and the number of successful passes also presented high correlations to the ranking points (all $p < 0.05$). Table 4 shows Pearson's correlation coefficients between the points obtained at the end of the season and defensive match statistics of the football teams. In this case, the number of goals received was the variable with the highest association to the ranking points, followed by the defense's effectiveness against rival' shooting and the number of recoveries (all $p < 0.05$).

Figure 1 depicts the variance in the points obtained as explained by each match statistic related to (a) attacking and (b) defensive team actions. Overall, the multiple regression analysis explained 84.1% of the total variance in the number of points at the end of the seasons in regards to offensive statistics. For the defensive statistics, the multiple regression analysis explained 73.5% of the variance. Shooting accuracy, followed by the number of shots, was the attacking variable that best explained the variance of the ranking points. The defense's effectiveness against rival shots and the number of conceded shots were the variables that explained the highest amount of variance in the number of points. Figure 2 includes a comparison between the predicted and actual number of points obtained at the end of the season with the two models of prediction. The predicted model with offensive variables correlated with actual ranking points at $r = 0.92$ ($p < 0.05$) and the predicted model with defensive variables correlated with ranking points at $r = 0.87$ ($p < 0.05$).

3.1. Predictive model of ranking points based on offensive match statistics

Predicted number of points = −33.409+(Shots×0.070)+(Shooting accuracy×4.476) +(Passing accuracy×-0.143)+(Total crosses×-0.005)+(Penalty kicks×-0.097) +(Turnovers×0.002)+(Fouls received×-0.001)+(Corners×0.039)+(Free kick goals×-0.049)+(Offsides×0.034)

Table 3. Pearson correlation coefficients (r) for the association between the points obtained at the end of the season and attacking match statistics. (*) denotes that the correlation was statistically significant at $p < 0.05$.

Attacking variables	r	All	Champion	Champions League	Europa League	Relegation	Last
Goals (number)	0.49*	53 ± 21	104 ± 14	79 ± 23	59 ± 6	38 ± 7	31 ± 6
Shots (number)	0.42*	470 ± 82	598 ± 75	556 ± 113	475 ± 53	429 ± 49	422 ± 47
Shooting accuracy (%)	0.31*	11 ± 3	18 ± 2	14 ± 2	12 ± 2	9 ± 1	7 ± 1
Passes (number)	0.34*	17,912 ± 3111	25,113 ± 4367	20,607 ± 3124	18,213 ± 1784	16,446 ± 1813	15,687 ± 715
Successful passes (number)	0.34*	13,554 ± 3351	21,396 ± 4590	16,516 ± 3400	13,937 ± 1976	12,008 ± 1897	11,284 ± 807
Passing accuracy (%)	0.27*	75 ± 5	85 ± 4	80 ± 4	76 ± 4	73 ± 4	72 ± 2
Crosses (number)	0.16*	764 ± 141	690 ± 185	798 ± 175	735 ± 170	774 ± 128	755 ± 101
Penalty kicks(number)	0.26*	5 ± 3	9 ± 5	7 ± 3	7 ± 3	5 ± 3	4 ± 2
Turnovers (number)	0.09	4962 ± 360	4757 ± 248	4899 ± 333	4890 ± 352	4970 ± 318	4956 ± 198
Fouls received (number)	0.17*	538 ± 51	560 ± 21	558 ± 59	534 ± 40	515 ± 69	524 ± 45
Corners(number)	0.42*	199 ± 33	235 ± 17	228 ± 36	205 ± 29	189 ± 25	175 ± 26
Free kick goals (number)	0.35*	11 ± 4	15 ± 4	15 ± 6	11 ± 5	10 ± 3	8 ± 2
Offsides (number)	0.29*	97 ± 20	131 ± 10	110 ± 22	100 ± 20	91 ± 21	85 ± 19

Table 4. Pearson correlation coefficients (R) for the association between the points obtained at the end of the season and defensive match statistics. (*) denotes that the correlation was statistically significant at $p < 0.05$.

Defensive variables	r	All	Champion	Champions League	Europa League	Relegation	Last
Goals received (number)	−0.49*	53 ± 13	30 ± 8	37 ± 9	50 ± 8	67 ± 11	69 ± 8
Shots conceded (number)	−0.22*	470 ± 70	354 ± 45	414 ± 56	465 ± 44	524 ± 30	522 ± 75
Effectiveness against shooting conceded (%)	−0.36*	89 ± 2	92 ± 2	91 ± 2	89 ± 2	87 ± 2	87 ± 2
Fouls committed (number)	−0.02	538 ± 66	427 ± 63	498 ± 69	549 ± 59	537 ± 49	567 ± 43
Penalty kicks conceded (number)	−0.18*	5 ± 2	3 ± 2	4 ± 2	6 ± 2	6 ± 3	6 ± 2
Corners against (number)	−0.18*	199 ± 33	144 ± 14	172 ± 33	203 ± 24	217 ± 26	223 ± 32
Yellow cards (number)	−0.08	57 ± 11	44 ± 11	54 ± 11	60 ± 10	55 ± 8	62 ± 8
Red cards (number)	−0.08	1 ± 1	1 ± 1	2 ± 2	2 ± 1	1 ± 1	1 ± 1
Free kick goals received (number)	−0.24*	11 ± 4	5 ± 2	9 ± 3	11 ± 3	14 ± 3	13 ± 4
Recoveries (number)	0.27*	1882 ± 176	2016 ± 108	1972 ± 143	1896 ± 119	1814 ± 175	1772 ± 166

3.2. Predictive model of ranking points based on defensive match statistics

Predicted number of points = 173.987+(Opponent shot accuracy×-4.138)+(Shots conceded-0.097)+(Recoveries×0.008)+(Fouls committed×-0.038)+(Penalty kick conceded×0.197)+(Corners against×-0.093)+(Yellow cards×-0.031)+(Red cards×-0.267)+(Free kick goals received×-0.113)

4. Discussion

This investigation was tailored to gauge the magnitude of traditional match statistics on overall football performance. For this purpose, we used accumulated values obtained at the end of eight complete seasons in *LaLiga*, the best-ranked national football championship in Europe (Vales-Vázquez, Casal-López, Gómez-Rodríguez, Blanco-Pita, & Serra-Olivares, 2017). We selected the number of points as the key variable to explain football performance in *LaLiga* because it offers a continuous categorization of each team's performance and success, instead of using less useful categorizations such as dichotomic classifications (winning/losing teams) or ordinal classifications (ranking). By analyzing the results of 3040 games, the main conclusions were: a) the number of shots (r = 0.42) and the number of corners (r = 0.42) were the attacking variables that had the highest bivariate association with end-season ranking points, apart from the obvious correlation between the number of goals and the ranking points (r = 0.49); b) the effectiveness against conceded shots (r = 0.36) and the number of recoveries (r = 0.27) were the defensive variables that had the highest association with ranking points at the end of the championship; c) stepwise multiple regression analysis was able to explain 84.1% of the total variance in the number of points in relation to offensive statistics and 73.5% in relation to the defensive statistics. The statistical models predicted the number of points obtained in the championship with a high amount of precision (Figure 2); d) shooting accuracy and effectiveness against rival shots were the variables that explained more of the ranking points variance. This information suggests that football performance is a concept explained by the interrelationship of several

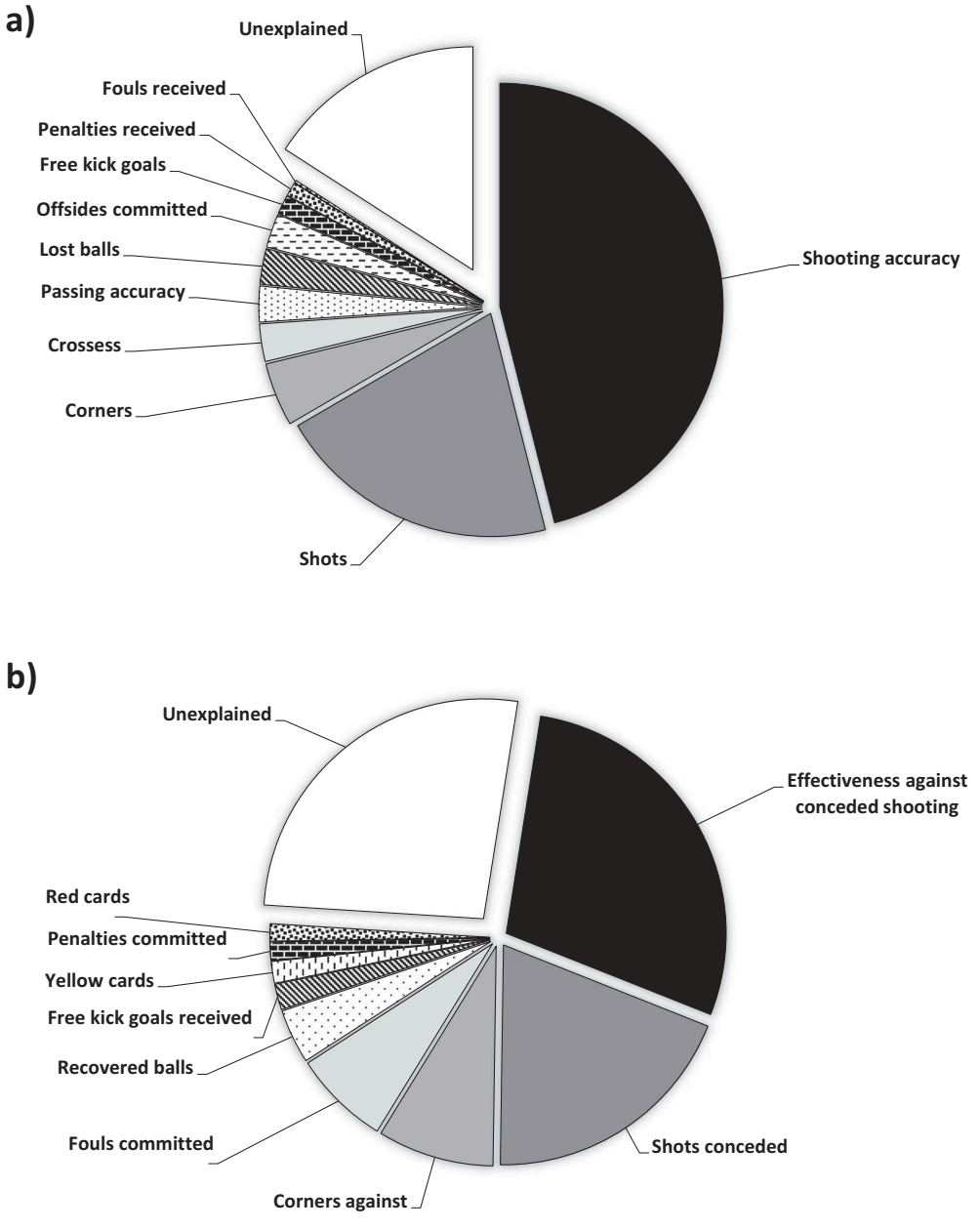

Figure 1. Percentage of variance in the number of points obtained at the end of the season as explained by match statistics from 8 complete seasons in *LaLiga*: a) match statistics related to teams' attack actions; b) match statistics related to teams' defense actions.

variables, but shooting accuracy while attacking and the avoidance of clear shooting positions from the opposing team during defense are the most highly correlated indicators of obtained points at the end of the championship.

The bivariate correlation analysis coincides (Tables 3 and 4) with previous investigations (Lepschy et al., 2018) that have found statistically significant associations between

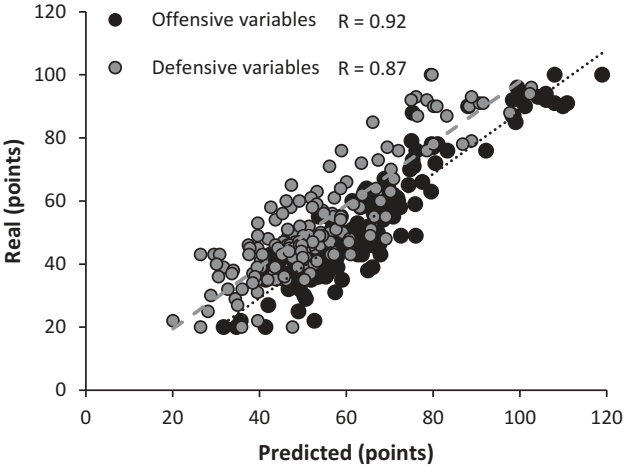

Figure 2. Correlation between the actual and predicted number of points at the end of 8 seasons in *LaLiga*. The prediction was based on a multiple regression analysis performed with offensive or defensive match statistics. Each dot represents one team at the end of the season, for a total of 160 real-predicted comparisons.

multiple match statistics and football performance. In addition, there is a clear change in most match statistics when comparing the teams that won the *LaLiga* championship, the teams that classified for continental competitions, and the teams that lost their category. This analysis contributes to the idea that most match statistics somewhat influence football performance, but also hinder the efforts of coaches and performance analysts since match statistics do not help in distinguishing between which ones are more important in order to succeed in football.

One of this investigation's differences is its multiple regression analysis to individually assess the effect magnitude of each match statistic on football performance. With the inclusion of attacking match statistics, the multiple regression analysis was able to explain 84.1% of the total variance in the number of ranking points at the end of the season. Interestingly, shooting accuracy, in terms of the number of goals obtained for a given number of shots, was the attacking variable that explained more of ranking point variance at the end of the seasons (46.1%, Figure 1; upper panel). This same result was obtained when comparing winning and losing teams that participated in the Champions League (Szwarc, 2007) and the Bundesliga (Broich, Mester, Seifriz, & Yue, 2014), even though these two investigations analyzed a lower amount of matches. In addition, shooting accuracy was one of the match statistics that differentiated between best-ranked and least-ranked teams in *LaLiga* 2008–2009 (Lago-Ballesteros & Lago-Peñas, 2010) and *LaLiga* 2012–2013. However, the effect of shooting accuracy was considered to be similar to other attacking match statistics in these previous analyses in *LaLiga* because they did not include statistics to assess the magnitude of the effect of each variable. In the current investigation, shooting accuracy was followed by the number of shots (20.5%), corners (4.6%), and crosses (2.7%): variables intrinsically developed during game actions that are close to the opposing team's goal. This agrees with previous reports that have suggested that variables favoring effective shooting, such as individual player skills (Ali, 2011; Williams, 2000), home play (Tucker, Mellalieu, James, & Taylor, 2005), and the number of assists (Kempe & Memmert, 2018) are intrinsically related to football performance.

In contrast, passing accuracy only explained 2.6% of the variance in the number of ranking points. The number of passes and successful passes were excluded from the regression analysis due to the high intercorrelation with passing accuracy. While the number of passes, passing accuracy, and ball possession have been previously correlated with football performance (Luhtanen, Belinskij, Hayrinen, & Vanttinen, 2001; Rampinini et al., 2009) – particularly in *LaLiga* (Liu et al., 2015)-, it has also been suggested that variables related to passing and organizing might be poor predictors when team quality and home advantage are accounted for (Collet, 2013; Harrop & Nevill, 2014). The results of the current investigation reveal that passing accuracy gave a smaller contribution to ranking points obtained in a professional leagueat least in comparison to other game variables related to shooting and goal scoring These outcomes suggest that a more vertical style of play, where shot finalization on the goal becomes the main offensive objective, may be a more successful strategy to succeed in football instead of the prevalent idea of maintaining ball possession and passes over the opponent.

The current analysis also explained 73.5% of the total variance in the number of ranking points by using match statistics related to defensive actions. Although the explained variance is lower than the one obtained with offensive variables, the high association between defensive match statistics and ranking points demonstrates that defensive strategy is also strongly linked to overall football success. The effectiveness against conceded shooting, which is defined as a low number of goals per shot conceded, was the variable that explained more of ranking point variance at the end of the seasons (28.5%, Figure 1; lower panel). Avoiding clear shots of the opposing team has been previously categorized as a key performance variable in football (Lepschy et al., 2018). However, this is more difficult during away games and when the opposing team is well-trained (Sarmento et al., 2014; Taylor et al., 2008). The variance explained by the effectiveness against conceded shooting was followed by the variance explained by the number of shots conceded (19.2%). Taken together, these results propose the concept of avoiding opponent shots as the main strategy to improve football performance through defensive actions. This concept reinforces the idea that the best football teams not only shoot more and with higher accuracy, but that they also concede fewer clear shots (Evangelos et al., 2013). A low number of committed fouls, as previously suggested (Oberstone, 2009), and a high number of recoveries (Vogelbein, Nopp, & Hökelmann, 2014) might also contribute to more points during a match. Thus, these two factors should also be considered for a more complete and effective football playing style.

This analysis has some limitations that should be discussed to improve the applicability of its results. Previous investigations have identified that the quality of the opposing team, match location, and some other physical variables are strongly related to team's success (Lago, 2009; Liu et al., 2015; Sarmento et al., 2014; Taylor et al., 2008). Although this investigation has not used these arguments, the influence of these variables on the our results are likely to be minimal because we have used accumulated statistics from eight complete seasons of a professional league. Thus, all of the football teams competed against the same rivals and the number of home and away games are equal. A second limitation is that despite pitch area having been considered as important information to understand football performance, we were not able to obtain data about it (Lepschy et al., 2018; Sarmento et al., 2018). Finally, the current investigation deals with football team match statistics. Translating match outcomes to team practices should be done at two levels: the team and individual levels. It is here where

playing position, physical conditioning, and technique should be considered to adapt the information of this study.

In conclusion, success in a professional football league depends on the collective contribution of several game actions. However, some game actions are more important than others (Figure 1). Shooting accuracy while attacking along with the avoidance of clear shots from the opposing team are the indicators that are most associated with the number of obtained points at the end of the *LaLiga* championship. Although the number of passes and passing accuracy had a statistically significant association to the number of ranking points, their contribution to the variance of the number of obtained points at the end of the season was minor. These outcomes suggest that a more vertical playing style, where shooting is the key factor of the team's offensive strategy, might be the best recommended strategy to obtain points – at least in *LaLiga*. In addition, the intensity of defensive actions in zones where the opposing team might be inclined to shoot should be the focus of the defensive team. The information provided by this study, especially due to the inclusion of 3040 matches and all of the teams in the championship, suggests that these outcomes are not only useful for higher ranked teams, but also lower ranked teams to avoid relegation. The current investigation aids in providing a more thorough and powerful understanding of football for coaches and players. From a practical perspective, training programs should be tailored to focus on improving variables related to goal scoring, perhaps to the disadvantage of enhancing variables related to passing and organizing. This application might contribute to the generation of a new paradigm to better understand success in professional football, particularly in Spanish football.

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References

Ali, A. (2011). Measuring soccer skill performance: A review. *Scandinavian Journal of Medicine & Science in Sports*, *21*(2), 170–183.

Broich, H., Mester, J., Seifriz, F., & Yue, Z. (2014). Statistical analysis for the first Bundesliga in the Current Soccer Season. *Progress in Applied Mathematics*. doi:10.3968/4886

Castellano, J., Casamichana, D., & Lago, C. (2012). The use of match statistics that discriminate between successful and unsuccessful soccer teams. *Journal of Human Kinetics*. doi:10.2478/v10078-012-0015-7

Collet, C. (2013). The possession game? A comparative analysis of ball retention and team success in European and international football, 2007-2010. *Journal of Sports Sciences*, *31*(2), 123–136.

Evangelos, B., Eleftherios, M., Aris, S., Ioannis, G., Aristotelis, G., & Antonios, S. (2013). Offense and defense statistical indicators that determine the Greek Superleague teams placement on the table 2011-12. *Journal of Physical Education and Sport*. doi:10.7752/jpes.2013.03055

García-Unanue, J., Pérez-Gómez, J., Giménez, J.-V., Felipe, J. L., Gómez-Pomares, S., Gallardo, L., & Sánchez-Sánchez, J. (2018). Influence of contextual variables and the pressure to keep category on physical match performance in soccer players. *Plos One*, *13*(9), e0204256.

Gómez, M.-Á., Lago, C., Gómez, M.-T., & Furley, P. (2019). Analysis of elite soccer players' performance before and after signing a new contract. *Plos One*, *14*(1), e0211058.

Harrop, K., & Nevill, A. (2014). Performance indicators that predict success in an English Professional League One Soccer Team. *International Journal of Performance Analysis in Sport*. doi:10.1080/24748668.2014.11868767

Kattuman, P., Loch, C., & Kurchian, C. (2019). Management succession and success in a professional soccer team. *Plos One*, *14*(3), e0212634.

Kempe, M., & Memmert, D. (2018). "Good, better, creative": The influence of creativity on goal scoring in elite soccer. *Journal of Sports Sciences*, *36*(21), 2419–2423.

Lago, C. (2009). The influence of match location, quality of opposition, and match status on possession strategies in professional association football. *Journal of Sports Sciences*. doi:10.1080/02640410903131681

Lago-Ballesteros, J., & Lago-Peñas, C. (2010). Performance in team sports: Identifying the keys to success in soccer. *Journal of Human Kinetics*. doi:10.2478/v10078-010-0035-0

Lago-Peñas, C., Lago-Ballesteros, J., Dellal, A., & Gómez, M. (2010). Game-related statistics that discriminated winning, drawing and losing teams from the Spanish soccer league. *Journal of Sports Science and Medicine*. doi:10.1080/09168451.2014.878218

Lago-Peñas, C., Lago-Ballesteros, J., & Rey, E. (2011). Differences in performance indicators between winning and losing teams in the UEFA Champions League. *Journal of Human Kinetics*. doi:10.2478/v10078-011-0011-3

Lepschy, H., Wäsche, H., & Woll, A. (2018). How to be successful in football : A systematic review abstract. *The Open Sports Sciences Journal*, *11*, 3–23.

Liu, H., Gómez, M. A., Gonçalves, B., & Sampaio, J. (2015). Technical performance and match-to-match variation in elite football teams. *Journal of Sports Sciences*. doi:10.1080/02640414.2015.1117121

Liu, H., Gomez, M. Á., Lago-Peñas, C., & Sampaio, J. (2015). Match statistics related to winning in the group stage of 2014 Brazil FIFA World Cup. *Journal of Sports Sciences*. doi:10.1080/02640414.2015.1022578

Liu, H., Hopkins, W., Gómez, M. A., & Molinuevo, J. S. (2013). Inter-operator reliability of live football match statistics from OPTA Sportsdata. *International Journal of Performance Analysis in Sport*. doi:10.1080/24748668.2013.11868690

Luhtanen, P., Belinskij, A., Hayrinen, M., & Vanttinen, T. (2001). A comparative tournament analysis between the EURO 1996 and 2000 in soccer. *International Journal of Performance Analysis in Sport*. doi:10.1080/24748668.2001.11868250

Mackenzie, R., & Cushion, C. (2013). Performance analysis in football: A critical review and implications for future research. *Journal of Sports Sciences*, *31*(6), 639–676.

Mao, L., Peng, Z., Liu, H., & Gómez, M. A. (2016). Identifying keys to win in the chinese professional soccer league. *International Journal of Performance Analysis in Sport*. doi:10.1080/24748668.2016.11868940

Oberstone, J. (2009). Differentiating the top english premier league football clubs from the rest of the pack: identifying the keys to success. *Journal of Quantitative Analysis in Sports*. doi:10.2202/1559-0410.1183

Puente, C., Coso, J. D., Salinero, J. J., & Abián-Vicén, J. (2015). Basketball performance indicators during the ACB regular season from 2003 to 2013. *International Journal of Performance Analysis in Sport*. doi:10.1080/24748668.2015.11868842

Rampinini, E., Impellizzeri, F. M., Castagna, C., Coutts, A. J., & Wisløff, U. (2009). Technical performance during soccer matches of the Italian Serie A league: Effect of fatigue and competitive level. *Journal of Science and Medicine in Sport*, *12*(1), 227–233.

Sarmento, H., Anguera, M. T., Pereira, A., & Araújo, D. (2018). Talent Identification and development in male football: A systematic review. *Sports Medicine*, *48*(4), 907–931.

Sarmento, H., Clemente, F. M., Araújo, D., Davids, K., McRobert, A., & Figueiredo, A. (2018). What performance analysts need to know about research trends in association football (2012–2016): A systematic review. *Sports Medicine*, *48*(4), 799–836.

Sarmento, H., Marcelino, R., Anguera, M. T., CampaniÇo, J., Matos, N., & LeitÃo, J. C. (2014). Match analysis in football: A systematic review. *Journal of Sports Sciences*, *32*(20), 1831–1843.

Szwarc, A. (2007). Efficacy of successful and unsuccessful Soccer teams taking part in finals of champions league. *Research Yearbook*, *13*(2), 221–225. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.577.5781&rep=rep1&type=pdf

Taylor, J. B., Mellalieu, S. D., James, N., & Shearer, D. A. (2008). The influence of match location, quality of opposition, and match status on technical performance in professional association football. *Journal of Sports Sciences*, *26*(9), 885–895.

Tucker, W., Mellalieu, D. S., James, N., & Taylor, B. J. (2005). Game location effects in professional Soccer: A case study. *International Journal of Performance Analysis in Sport*, *5*(2), 23–35.

Vales-Vázquez, Á., Casal-López, C., Gómez-Rodríguez, P., Blanco-Pita, H., & Serra-Olivares, J. (2017). Competitive profile differences between the best-ranked European football championships. *Human Movement*, *18*(5), 97–105.

Vogelbein, M., Nopp, S., & Hökelmann, A. (2014). Defensive transition in soccer - are prompt possession regains a measure of success? A quantitative analysis of German Fußball-Bundesliga 2010/2011. *Journal of Sports Sciences*, *32*(11), 1076–1083.

Williams, A. M. (2000). Perceptual skill in soccer: Implications for talent identification and development. *Journal of Sports Sciences*, *18*(9), 737–750.

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An Extensive Comparative Analysis of Successful and Unsuccessful Football Teams in LaLiga

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The characterization of the in-game actions with the strongest influence on victory in football might be useful for designing playing styles that enhance teams' performance. The aim of this study was to analyze in-game match statistics on the top-3 and bottom-3 teams ranked in LaLiga. Accumulated offensive and defensive match statistics when playing at home and away were obtained from LaLiga for 8 consecutive seasons. Data extraction was performed by computerized video-analysis. The top-3 and bottom-3 teams were compared using independent *t*-test analysis and the magnitude of the difference was cataloged with effect sizes. Overall, the offensive variable with the greatest magnitude of difference in the top-3 *vs.* bottom-3 comparison was shooting accuracy (ES ± 90% confidence interval = 4.15 ± 0.52) followed by the number of offsides (2.25 ± 0.60) and corners (2.14 ± 0.61). However, when playing away, the offensive variable with the greatest magnitude of difference in the top-3 *vs* bottom-3 comparison was the number of shots (3.30 ± 0.44). The defensive variables that best differentiated top 3 - bottom 3 teams were the number of corners (2.16 ± 0.43) and shots conceded (2.04 ± 0.39). In conclusion, the match statistics that best discriminated successful from unsuccessful football teams were shooting accuracy while attacking and the number of shots conceded while defending.

Keywords: sports performance, match analysis, professional football, soccer, player

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INTRODUCTION

In this highly technological world, video analysis systems applied to sports performance have become an indispensable tool for coaches and technical assistants to collect information about individual's and team's activities during training and competitions (Den Hollander et al., 2018). Specifically, video analysis in football has helped to investigate several aspects of football performance such as technical, tactical, and physiological factors during competition (Sarmento et al., 2014). The speed and accuracy of current computerized video analysis has made possible to scrutinize the in-game actions of elite football teams in real time. Furthermore, the data

obtained with this tool has improved the planning and structuring of match and the training programes of high performance teams (Sarmento et al., 2018a). Furthermore, video analysis also constitutes an essential tool for research in team sports and several studies have been published in recent years to aid in understanding football performance, allowing an enhanced application of science to modern football (Lepschy et al., 2018; Sarmento et al., 2018c).

From a simplistic perspective, football performance is an easy concept because victory in this sport is merely based on the comparison of the number of goals scored by each of the two opposing teams at the end of the game. However, a solid body of research has been carried out to determine what aspects of football match-play increase the likelihood of scoring more goals, while avoiding rivals scoring. In order to solve this question, investigations on football performance analysis have compared all types of match statistics between successful and unsuccessful football teams (Oberstone, 2009; Rampinini et al., 2009; Castellano et al., 2012; Liu et al., 2015; Casal et al., 2019). Although extrinsic factors, such as home advantage (Seçkin and Pollard, 2010; Almeida et al., 2014), have been associated with football performance, comparative (Rampinini et al., 2009; Lago-Peñas et al., 2010), and predictive analysis of the statistics during play (Lago-Peñas et al., 2016) have reflected that several in-game actions are the strongest contributors to overall football success.

In a recent review by Lepschy et al. (2018), shooting accuracy was identified as the in-game action that best explained football performance, followed by other offensive variables such as the number of shots on goal, the percentage of ball possession and the rate of passing accuracy. During an elite football match, the success of an offensive sequence is higher when it starts with a counterattack/fast attack in comparison with a positional attack (Sarmento et al., 2018c). In addition, the number of passes performed in an offensive sequence decreases the probability of its success (Sarmento et al., 2018c) coinciding with the low contribution of the number of passes to the points obtained at the end of the season (Souza et al., 2019). A high proportion of the studies included in the review by Lepschy et al. (2018) did not consider the match location although this variable might greatly influence the players' technical actions that lead to victory (Liu et al., 2015). Furthermore, in a critical review by Mackenzie and Cushion (2013), these authors have suggested that the analysis of in-game actions to predict football performance should be contextualized by match location and thus, a clear identification of the in-game actions that might increase the likelihood of victory is necessary when playing at home *vs* when playing away.

As might be expected, previous investigations have found a clear discrepancy between successful and unsuccessful football teams in highly competitive championships around the world (Rampinini et al., 2009; Lago-Peñas et al., 2011; Liu et al., 2016a). However, these studies have analyzed in-game football actions obtained in only one season, while the year-to-year variability due to players' injuries or an outstanding player, and the game style imposed by the teams' coaches might have affected the outcomes of these analyses (Kattuman et al., 2019). In addition, the comparison made in these investigations rarely assesses the importance of each match statistic for overall football performance. The aim of this investigation was to perform a comprehensive comparative analysis of successful and unsuccessful football teams in the Spanish professional football championship (LaLiga) by including accumulated match statistics obtained during 8 competitive seasons. This analysis has considered match location, offensive and defensive event variables and contains a magnitude analysis to improve the work of football coaches and performance analysts.

MATERIALS AND METHODS

The current investigation represents a descriptive, comparative analysis of the end of season accumulated match statistics of professional football teams competing in LaLiga (20 teams per season). This research was inspired by a previous investigation carried out by Liu et al. (2016a) using match statistics from LaLiga 2012-2013 but the power of the analysis has been increased with the inclusion of 8 consecutive seasons (from 2010-2011 to 2017-2018). Data were obtained from LaLiga, which owns a software for video match analysis (Mediacoach®) based on the OPTA® (Spain) track analysis tool. During the matches, every in-game action is categorized by a mix software tool that included an automatized categorization of some actions by a computerized system (e.g., passes) and categorization by a trained analyst who uses a rigid set of definitions (e.g., yellow and red cards; Liu et al., 2013). The reliability of this current tracking system was tested with an intra-class correlation coefficient that ranges from 0.88 to 1.00 (Liu et al., 2013). To comply with LaLiga ethical guidelines, the information included in this investigation does not allow the recognition of football players' identities. LaLiga authorized the use of these data for the purpose of this investigation and the experimental protocols were approved by the University Institutional Review Board.

Although 20 professional teams compete in LaLiga every season, we have selected the top 3 and bottom 3 ranked teams at the end of each season in order to perform a comparative analysis of successful and unsuccessful teams. Thus, this study contains information about 24 successful football teams (the top 3 ranked teams for the seasons: 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016, 2016-2017 and 2017-2018) and 24 unsuccessful football teams (the bottom 3 ranked teams for the seasons: 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016, 2016-2017 and 2017-2018). The match statistics included in this study were based on previous studies with similar aims (Oberstone, 2009; Rampinini et al., 2009; Lago-Peñas et al., 2010; Liu et al., 2015) and they were categorized as offensive and defensive variables to improve the applicability of these results to professional football. A more detailed definition of the match statistics included in this investigation has been published elsewhere (Souza et al., 2019) while the operational definitions for each variable were as follow:

Shot: an attempt to score a goal; shooting accuracy: number of goals divided by the number of shots; pass: an attempt to

exchange the ball between two players of the team; passing accuracy: number of successful passes divided by the total number of passes; cross: an action made by a player with the objective of introducing the ball within the opposition team; penalty kick: a single shot on the goal while it is defended only by the opposing team's goalkeeper; turnover: a loss of ball possession as the result of an imprecision; foul received: an infringement committed by the opposing the team and sanctioned by the referee; corner: an action when the ball crosses the end line of opponent's side and the last person in contact with the ball was an opponent; free kick goal: a goal scored for the attacking team as the result of a direct or indirect free kick; offside: an infringement committed by the attacking team as a result of a player being offside.

Shot conceded: an attempt to score a goal made by the opposing team; effectiveness against conceded shooting: number of goals received divided by the number of shots conceded; foul committed: an infringement committed by the defending team and sanctioned by the referee; penalty kick conceded: a single shot on the goal while it is defended only by the defending team's goalkeeper; corner against; an action ball crosses the end line of defending team's side and the last person in contact with the ball was an opponent; yellow card: a sanction by the referee to one of the players of the defending team; red card: a sanction by the referee to one of the players of the defending team that ends in player expulsion; free kick goals received: a goal received as the result of a direct or indirect free kick; recovery: an action where the team obtains or regains the ball possession due to a defensive action.

To complete the information of this analysis, the end of season accumulated statistics were obtained and subsequently divided into matches played at home and away to allow a sub-analysis for match location.

Statistical Analysis

The data were electronically extracted from the Mediacoach reports and entered into a database designed for the purposes of this research. The data were extracted by one author (RLDC) using a spreadsheet (Excel 2016, Microsoft Office, WA, United States) and then they were checked for accuracy by another author (DBS). Then, data on the top 3 and bottom 3 football teams in each season were clustered and mean and standard deviation (SD) were obtained. The comparison between the top 3 and bottom 3 teams was performed with independent Student's *t*-test and the differences were considered as statistically relevant at $P < 0.05$. To complete the null-hypothesis statistical approach, the effect size (ES) was also calculated in all pairwise comparisons to assess the magnitude of the differences between the top 3 and bottom 3 ranked teams. Specifically, the ES ± 90% confidence intervals (CI) were calculated on log transformed data to reduce bias due to non-uniformity of error. A qualitative descriptor was included to represent the likelihood of differences among teams (< 1% no chances of change; 1 to 5%, very unlikely; 5 to 25%, unlikely; 25 to 75%, possible; 75 to 95%, likely; 95 to 99%, very likely; >99%, most likely). ES were interpreted according to the following ranges: <0.2, trivial; 0.2–0.6, small; 0.6–1.2, moderate; 1.2–2.0, large; 2.0–4.0, very large; and >4.0, extremely large (Hopkins et al., 2009). This same analysis was performed for the overall accumulated statistics and for the games played at home and away.

RESULTS

Figure 1 and **Table 1** contain data on the compariso'n between top 3 and bottom 3 teams for the offensive in-game actions. In all offensive actions, a statistically significant between-group difference was identified at the level of $P < 0.01$. However, the ES have been included to improve the categorization of the magnitude of the successful *vs.* unsuccessful teams' differences: overall, shooting accuracy was the offensive variable with the highest effect size for the top 3 - bottom 3 comparison (**Figure 1**) while the importance of shooting accuracy to differentiate top 3 *vs.* bottom 3 teams was maintained when playing at home and when playing away (**Table 1**). When attacking, the number of offsides and corners, passing accuracy, and the total number of passes presented large effect sizes for the top 3- bottom 3 comparison, with a most-likely difference among teams (**Figure 1**). At home, shooting accuracy, the number of offsides, passing accuracy and the number of corners also presented large effect sizes for the top 3 - bottom 3 comparison, while the number of free kick goals and the number of crosses were the variables with the lowest effect sizes. When playing away, the total number of shots was the variable with the greatest effect size, followed by shooting accuracy and the number of passes and passing accuracy (**Table 1**).

Figure 2 and **Table 2** depict data on the comparison of the top 3 *vs.* bottom 3 teams for all defensive game actions. Again, all defensive match statistics presented between-group differences at the level of $P < 0.01$. However, the match statistics with the highest effect size for the comparison of successful and unsuccessful teams were the number of corners, the number of shots conceded and the effectiveness against shooting conceded (**Figure 2**). On the contrary, the number of red cards, and the distribution of in-game/free kick goals received were the variables with the lowest effect sizes for the comparison between top 3 *vs.* bottom 3 teams. At home, the number of shots conceded was the variable with the greatest effect size (**Table 2**). When playing away, the number of corners conceded was the variable with the highest effect size (**Table 2**). Other variables such as recoveries, yellow cards and fouls committed also presented large and most-likely differences between successful and unsuccessful teams (**Figure 2**) and the effect sizes of these variables slightly changed for the comparisons made at home and away.

DISCUSSION

The aim of this investigation was to perform a comparative analysis of successful and unsuccessful football teams in the LaLiga championship. Although the comparison of

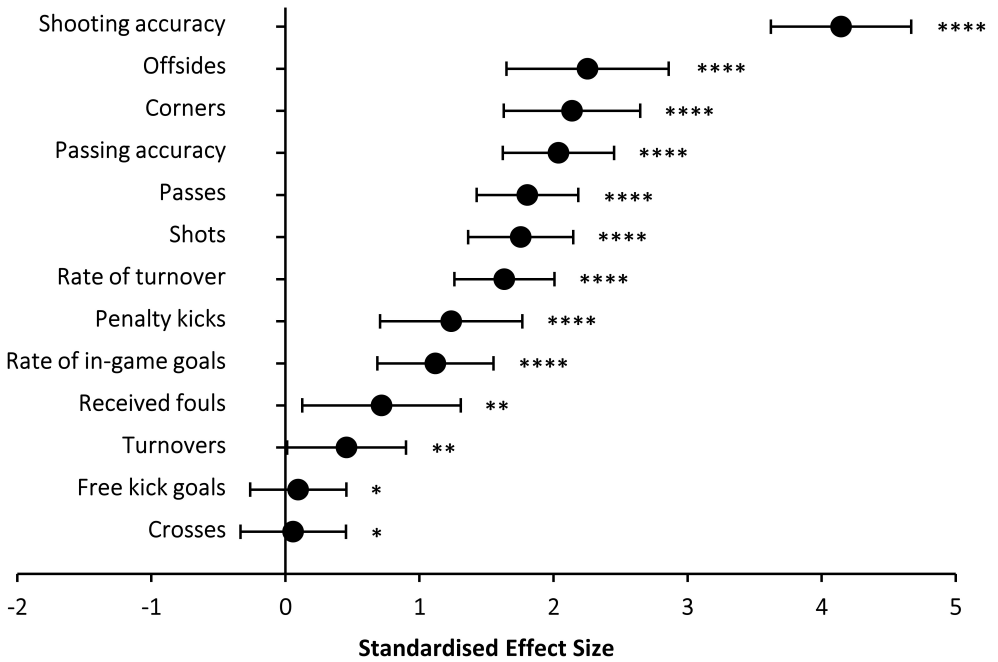

FIGURE 1 | Standardized effect size in offensive variables for the comparison between the top 3 – bottom 3 teams in LaLiga from 2010 to 2018. *possible; **likely; ****most likely.

TABLE 1 | Attacking variables for the top 3 and bottom 3 teams ranked in LaLiga from 2010 to 2018.

	Home			Away			Total		
Offensive variables	**Top 3**	**Bottom 3**	**ES (90%CI)**	**Top 3**	**Bottom 3**	**ES (90%CI)**	**Top 3**	**Bottom 3**	**ES (90%CI)**
Shooting accuracy (%)	16 ± 2	8 ± 1	4.15 (0.52)	15 ± 3	8 ± 2	2.76 (0.49)	16 ± 2	8 ± 1	4.15 (0.52)
Offsides (number)	64 ± 8	47 ± 12	2.46 (0.75)	59 ± 14	42 ± 10	1.48 (0.49)	123 ± 17	89 ± 20	2.25 (0.60)
Corners (number)	136 ± 15	106 ± 15	2.23 (0.53)	103 ± 18	78 ± 17	1.40 (0.48)	239 ± 27	184 ± 26	2.14 (0.61)
Passing accuracy (%)	83 ± 5	73 ± 3	2.33 (0.44)	81 ± 5	72 ± 3	1.70 (0.41)	82 ± 5	72 ± 3	2.04 (0.42)
Passes (number)	11712 ± 1998	8379 ± 795	1.88 (0.38)	10986 ± 2065	7814 ± 837	1.72(0.38)	22698 ± 4036	16193 ± 1560	1.81 (0.38)
Shots (number)	328 ± 54	243 ± 25	1.65 (0.39)	328 ± 54	183 ± 28	3.30 (0.44)	594 ± 102	427 ± 47	1.76 (0.39)
Rate of turnover (%)	21 ± 4	31 ± 3	1.86 (0.38)	23 ± 5	31 ± 3	1.36 (0.37)	22 ± 5	31 ± 3	1.63 (0.37)
Penalty kicks (number)	5 ± 3	3 ± 2	0.68 (0.47)	3 ± 2	2 ± 1	1.08 (0.50)	8 ± 4	4 ± 3	1.24 (0.53)
Rate of in-game goals (%)	83 ± 7	74 ± 6	1.12 (0.43)	83 ± 7	74 ± 12	1.13 (0.63)	83 ± 7	74 ± 6	1.12 (0.43)
Received fouls (number)	260 ± 24	259 ± 30	0.07 (0.53)	287 ± 31	260 ± 36	0.91 (0.52)	547 ± 42	518 ± 61	0.72 (0.59)
Turnovers (number)	2402 ± 172	2583 ± 141	0.99 (0.42)	2420 ± 152	2382 ± 177	0.25 (0.51)	4822 ± 301	4965 ± 279	0.46 (0.44)
Free kick goals (number)	17 ± 7	26 ± 6	1.12 (0.42)	26 ± 12	26 ± 6	0.06 (0.63)	17 ± 7	16 ± 2	0.10 (0.36)
Crosses (number)	426 ± 107	445 ± 63	0.24 (0.37)	342 ± 72	322 ± 64	0.22 (0.43)	768 ± 168	767 ± 118	0.06 (0.39)

The effect size (ES) has been calculated for the difference between the top 3 – bottom 3 teams when playing at home, away and overall. Data are mean ± SD for the data at the end of the season.

successful/winning *vs.* unsuccessful/losing football teams has been previously explored (Lago, 2009; Lago-Peñas et al., 2010; Liu et al., 2016a), the current analysis is innovative because it includes accumulated match statistics obtained during 8 competitive seasons, which constitutes the longest analysis on this topic. In addition, the comparison between successful and unsuccessful teams has taken into account match location and used two different statistical approaches to categorize the contribution of each in-game action to overall football performance. The main outcomes of this investigation reflect that the in-game actions that differentiate the top 3 and bottom 3 football teams in LaLiga were very similar when playing at home and away (**Tables 1**, **2**) which reflects that success in football might be driven by a similar game-play style despite match location. Offensively, the match statistic with the greatest difference, in terms of effect size, between the top 3 and bottom 3 football teams was shooting accuracy. Defensively, the greatest difference between best *vs* worse teams was the number of corners received. Taken together, these outcomes indicate that modern football has evolved from "long-ball"

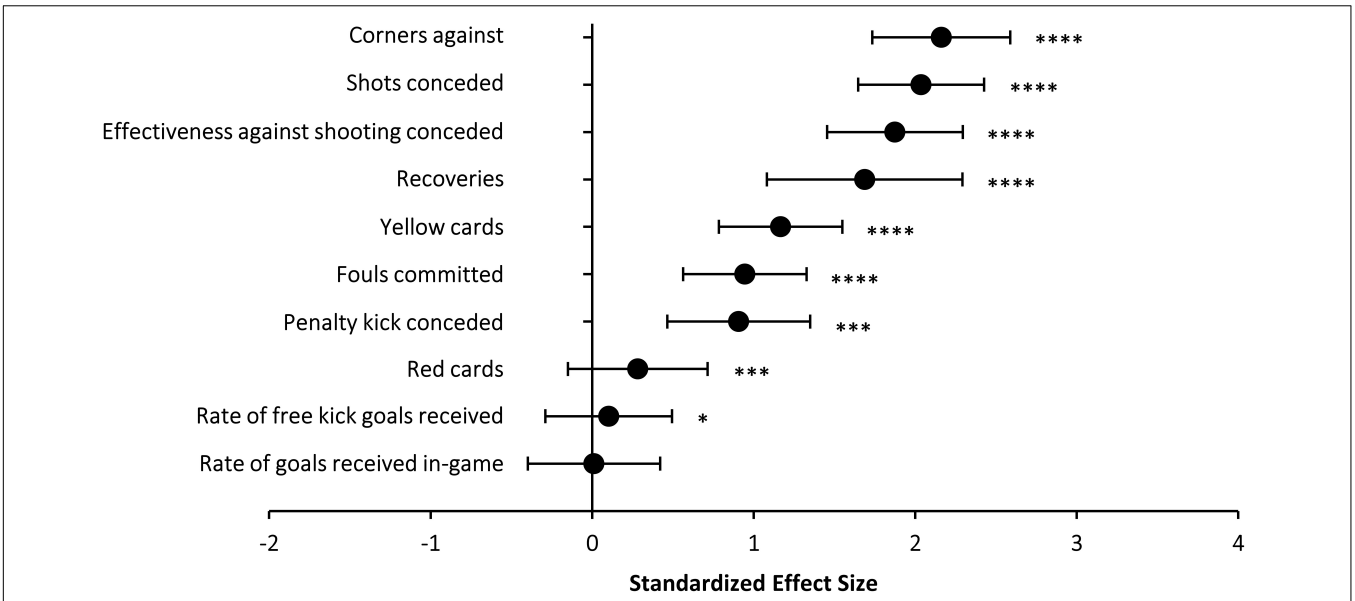

FIGURE 2 | Standardized effect size in defensive variables for the comparison between the top 3 – bottom 3 teams in LaLiga from 2010 to 2018. *possible; ***very likely; ****most likely.

TABLE 2 | Defensive variables for the top 3 and bottom 3 teams ranked in LaLiga from 2010 to 2018.

	Home			Away			Total		
Defense variables	**Top 3**	**Bottom 3**	**ES (90%CI)**	**Top 3**	**Bottom 3**	**ES (90%CI)**	**Top 3**	**Bottom 3**	**ES (90%CI)**
Corners against (number)	69 ± 14	95 ± 17	1.55 (0.43)	87 ± 15	124 ± 16	2.11 (0.42)	156 ± 24	219 ± 28	2.16 (0.43)
Shots conceded (number)	167 ± 30	231 ± 23	1.79 (0.38)	216 ± 32	292 ± 29	2.03(0.40)	383 ± 57	523 ± 48	2.04 (0.39)
Effectiveness against shooting conceded (%)	9 ± 2	12 ± 3	1.21 (0.42)	8 ± 2	14 ± 3	1.92(0.44)	9 ± 2	13 ± 2	1.87 (0.42)
Recoveries (number)	1015 ± 60	929 ± 91	1.49 (0.64)	985 ± 73	871 ± 87	1.61 (0.55)	2000 ± 122	1800 ± 169	1.69(0.61)
Yellow cards (number)	37 ± 10	55 ± 8	1.36 (0.38)	51 ± 12	57 ± 8	0.61 (0.37)	88 ± 20	113 ± 14	1.17 (0.38)
Fouls committed (number)	236 ± 38	274 ± 29	0.98(0.40)	236 ± 44	273 ± 24	0.84 (0.37)	472 ± 78	547 ± 48	0.95 (0.38)
Penalty kick conceded (number)	1 ± 1	2 ± 1	0.99 (0.54)	2 ± 2	4 ± 2	0.71 (0.52)	3 ± 2	6 ± 2	0.91 (0.44)
Red cards (number)	1 ± 1	2 ± 1	0.08 (0.56)	1 ± 2	1 ± 1	0.02 (0.50)	2 ± 2	3 ± 1	0.28 (0.43)
Free kick goals received (%)	21 ± 10	20 ± 8	0.14 (0.44)	20 ± 8	21 ± 7	0.07 (0.49)	20 ± 7	20 ± 5	0.10 (0.39)
Goals received in game (%)	79 ± 10	80 ± 8	0.12 (0.42)	80 ± 8	79 ± 7	0.17(0.45)	80 ± 7	80 ± 5	0.01 (0.41)

The effect size (ES) has been calculated for the difference between the top 3 – bottom 3 teams when playing at home, away and overall. Data are mean ± SD for the data at the end of the season.

to more direct playing styles where long passing frequency might not be better for scoring (Hughes and Franks, 2005). All this information might be useful to define success in elite Spanish football and help coaches and football analysts to understand the strategy followed by top-ranked teams that compete in one of the most important football championships (Vales-Vázquez et al., 2017).

In a study of 380 matches in LaLiga –season 2008-2009–, it was found that top-ranked teams scored more goals, shot more frequently, particularly on goal, and needed less opportunities than worse-ranked teams (Lago-Ballesteros and Lago-Peñas, 2010). In addition, in a study with 3,040 matches in LaLiga, shooting accuracy was the variable that explained more variance in the end-season points earned during the championship (Souza et al., 2019). The current analysis coincides in part with these investigations because the variable showing the greatest difference between the top 3 and bottom 3 football teams was shooting accuracy (**Figure 1**). Interestingly, a similar finding has been obtained in the Bundesliga (Broich et al., 2014), the Superleague in China (Mao et al., 2016), and when analyzing the final rounds of the European Champions League (Szwarc, 2007), and the 2010 World Cup (Delgado-Bordonau et al., 2013). Although the results of this investigation cannot be generalized to all football situations and competitions, the clear importance of shooting accuracy might impact tactical-strategic aspects of elite teams' training.

Shooting accuracy was followed by the number of offsides and corners which, despite not being direct shooting actions, are reflective of a game style focused on direct play to score. As found by others (Lago-Peñas, Lago-Ballesteros, Dellal, et al;

Lago-Peñas, Lago-Ballesteros, and Rey), one of the characteristics of successful teams is that they create more attack opportunities especially in the field area close to the opponents' goal. Although the current investigation constitutes an analysis of 8 complete seasons to produce a study with a high statistical power, it is worth mentioning that the season-to-season analysis reflects that the match statistics with the greatest difference between the top 3 and bottom 3 football teams were fairly maintained during the whole period analyzed. Other match statistics such as passes and passing accuracy also presented high effect sizes for the top 3 - bottom 3 comparison while other offensive factors such as free kick goals and crosses were even higher in the bottom 3 teams. Although the significance of these data is debatable, in the opinion of the authors of this investigation, passing should be to gain offensive zones and with the clear intention of attacking, and providing opportunities for scoring. Recent studies have also found that successful teams use ball possession to attack while unsuccessful teams tend to use possession to avoid losing the ball (Casal et al., 2019).

One of the most novel findings of this investigation is that the offensive match statistics that best differentiate the top 3 and bottom 3 football teams were very similar when the teams played at home and away (**Table 1**). Nevertheless, subtle nuances are found; overall, shooting accuracy was key to success and this criterion was maintained when playing at home but the number of shots was even more important when playing away. In addition, the magnitudes of the effect sizes for the top 3 – bottom 3 comparison in all shooting and passing variables were higher at home than away, which suggests that the difference between successful and unsuccessful teams in offensive variables might increase with match location (Lago and Martín, 2007). Although match location, quality of opposition, and match status should be useful to adapt game tactics (Liu et al., 2016b), the current data on successful teams in LaLiga suggest that the main objective of offensive strategy –obtaining clear situations for shooting- should be maintained when playing at home and away.

Although less attention has been paid to defensive variables (Mackenzie and Cushion, 2013), the current analysis indicates that successful and unsuccessful team are also very different in terms of defense match statistics (**Figure 2**). Overall, the number of corners received was the variable with the highest effect size in the top 3 – bottom 3 comparison, even above the number of shots conceded. Although this might be a particularity of this analysis, the high rate of corners conceded is a common finding in worse-ranked teams (Castellano et al., 2012). Broadly, only 2% of the corners end in goal but the influence of a goal obtained from a corner might determine victory in $< 75\%$ of the games (Casal et al., 2015). Effectiveness against rivals' shooting also presented a large between-group difference but in this case, this match statistics was better in unsuccessful teams both at home and away. This means that the defensive efficacy of worse-ranked teams is not inferior to top-ranked teams but the former offer more opportunities for attack to the opposing team (Delgado-Bordonau et al., 2013; Evangelos et al., 2013).

Despite the high statistical power obtained by the accumulated match statistics of 8 football seasons, the current research does have some limitations. Previous investigations have identified that the quality of the opposing team, players' physical conditioning and several contextual variables are strongly related to a team's success in football (Taylor et al., 2008; Lago, 2009; Liu et al., 2016a; Sarmento et al., 2018b). Although the current analysis does not include these variables, it is likely that their influence on the outcomes of the analysis are minimal due to the use of eight complete seasons of a professional league, that includes the same number of matches and the same rivals for all the teams under investigation. A second limitation is that the pitch area where the in-game action occurred was not recorded for this investigation and further research should be done to relate the outcomes of this study with pitch zones (Lepschy et al., 2018; Sarmento et al., 2018a). Despite these limitations, the findings of this analysis might contribute to understanding success in football.

This investigation has been carried out with the intention of identifying key game indicators that differentiate successful and unsuccessful teams to determine a more effective model of play. In summary, the study of the top 3 and bottom 3 ranked teams in LaLiga for 8 seasons might be indicative of a sport where shooting accuracy prevails over other offensive statistics. While all the attacking game actions investigated here were statistically higher in the top 3 teams *vs* bottom 3 teams, those performed close to the penalty area presented higher effect sizes (see **Figure 1**). Regarding defensive game actions, the number of corners and the number of shots conceded were the variables with the highest differences in terms of size between successful and unsuccessful teams. While a greater efficacy against rival's shooting was present in worse-ranked teams, it is probably due to the higher number of shots received. In this sense, it is probably necessary that less successful teams enhance game tactics or change their playing style to avoid/reduce rival's shooting during the match. Finally, the identification of the game statistics related to success was stable when comparing matches played at home and away, suggesting that a similar game style should be maintained despite match location in order to maximize football performance.

To improve football performance of elite teams, several practical applications can be gathered from the data obtained in this investigation. Specifically, the use of training routines that improve shooting accuracy might be essential to increase the efficacy of offensive sequences. The use of fast attacking routines (with and without opponents) with the main objective of shooting on goal with a low number of passes might be recommended to improve offensive behaviors of the team. The use of exercises that improve tactics during corners (when attacking and defending) might be also critical for football performance as this game action is a clear indicator that differentiated successful and unsuccessful teams in LaLiga. Finally, tailoring training exercises to improve the recovery of the ball before the rival team reaches offensive positions might be also beneficial to avoid the number of shots conceded while defending.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Camilo José Cela Institutional Review Board. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

RL-D, HB-P, and RR provided the data. DB and JD carried out the analysis of the data and drafted the manuscript. RL-D, HB-P, and RR critically reviewed the manuscript. All authors have participated in the conception of the experiment and approved the final version of the manuscript.

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REFERENCES

Almeida, C. H., Ferreira, A. P., and Volossovitch, A. (2014). Effects of match location, match status and quality of opposition on regaining possession in UEFA champions league. *J. Hum. Kinet.* 41, 203–214. doi: 10.2478/hukin-2014-0048

Broich, H., Mester, J., Seifriz, F., and Yue, Z. (2014). Statistical analysis for the first bundesliga in the current soccer season. *Prog. Appl. Math.* 7, 1–8. doi: 10.3968/4886

Casal, C. A., Anguera, M. T., Maneiro, R., and Losada, J. L. (2019). Possession in football: more than a quantitative aspect - A mixed method study. *Front. Psychol.* 10:501. doi: 10.3389/fpsyg.2019.00501

Casal, C. A., Maneiro, R., Ardá, T., Losada, J. L., and Rial, A. (2015). Analysis of corner kick success in elite football. *Int. J. Perform. Anal. Sport* 15, 430–451. doi: 10.1080/24748668.2015.11868805

Castellano, J., Casamichana, D., and Lago, C. (2012). The use of match statistics that discriminate between successful and unsuccessful soccer teams. *J. Hum. Kinet.* 31, 139–147. doi: 10.2478/v10078-012-0015-7

Delgado-Bordonau, J. L., Domenech-Monforte, C., Guzmán, J. F., and Méndez-Villanueva, A. (2013). Offensive and defensive team performance: relation to successful and unsuccessful participation in the 2010 Soccer World Cup. *J. Hum. Sport Exerc.* 8, 894–904. doi: 10.4100/jhse.2013.84.02

Den Hollander, S., Jones, B., Lambert, M., and Hendricks, S. (2018). The what and how of video analysis research in rugby union: a critical review. *Sport Med.Open* 4:27. doi: 10.1186/s40798-018-0142-3

Evangelos, B., Eleftherios, M., Aris, S., Ioannis, G., Aristotelis, G., and Antonios, S. (2013). Offense and defense statistical indicators that determine the Greek Superleague teams placement on the table 2011 - 12. *J. Phys. Educ. Sport* 13, 338–347. doi: 10.7752/jpes.2013.03055

Hopkins, W. G., Marshall, S. W., Batterham, A. M., and Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Med. Sci. Sports Exerc.* 41, 3–13. doi: 10.1249/MSS.0b013e31818c b278

Hughes, M., and Franks, I. (2005). Analysis of passing sequences, shots and goals in soccer. *J. Sports Sci.* 23, 509–514. doi: 10.1080/02640410410001716779

Kattuman, P., Loch, C., and Kurchian, C. (2019). Management succession and success in a professional soccer team. *PLoS One* 14:e0212634. doi: 10.1371/journal.pone.0212634

Lago, C. (2009). The influence of match location, quality of opposition, and match status on possession strategies in professional association football. *J. Sports Sci.* 27, 1463–1469. doi: 10.1080/02640410903131681

Lago, C., and Martín, R. (2007). Determinants of possession of the ball in soccer. *J. Sports Sci.* 25, 969–974. doi: 10.1080/02640410600944626

Lago-Ballesteros, J., and Lago-Peñas, C. (2010). Performance in team sports: identifying the keys to success in soccer. *J. Hum. Kinet.* 25, 85–91. doi: 10.2478/v10078-010-0035-0

Lago-Peñas, C., Gómez-Ruano, M., Megías-Navarro, D., and Pollard, R. (2016). Home advantage in football: examining the effect of scoring first on match outcome in the five major European leagues. *Int. J. Perform. Anal. Sport* 16, 411–421. doi: 10.1080/24748668.2016.11868897

Lago-Peñas, C., Lago-Ballesteros, J., Dellal, A., and Gómez, M. (2010). Game-related statistics that discriminated winning, drawing and losing teams from the Spanish soccer league. *J. Sport Sci. Med.* 9, 288–293. doi: 10.1080/09168451.2014.878218

Lago-Peñas, C., Lago-Ballesteros, J., and Rey, E. (2011). Differences in performance indicators between winning and losing teams in the UEFA Champions League. *J. Hum. Kinet.* 27, 135–146. doi: 10.2478/v10078-011-0011-3

Lepschy, H., Wäsche, H., and Woll, A. (2018). How to be successful in football : a systematic review abstract. *Open Sports Sci. J.* 11, 3–23. doi: 10.2174/1875399X01811010003

Liu, H., Gómez, M. A., Gonçalves, B., and Sampaio, J. (2015). Technical performance and match-to-match variation in elite football teams. *J. Sports Sci.* 34, 509–518. doi: 10.1080/02640414.2015.1117121

Liu, H., Gómez, M. A., Gonçalves, B., and Sampaio, J. (2016a). Technical performance and match-to-match variation in elite football teams. *J. Sports Sci.* 34, 509–518. doi: 10.1080/02640414.2015.1117121

Liu, H., Hopkins, W. G., and Gómez, M. A. (2016b). Modelling relationships between match events and match outcome in elite football. *Eur. J. Sport Sci.* 16, 516–525. doi: 10.1080/17461391.2015.1042527

Liu, H., Hopkins, W., Gómez, M. A., and Molinuevo, J. S. (2013). Inter-operator reliability of live football match statistics from OPTA Sportsdata. *Int. J. Perform. Anal. Sport* 13, 803–821. doi: 10.1080/24748668.2013.11868690

Mackenzie, R., and Cushion, C. (2013). Performance analysis in football: a critical review and implications for future research. *J. Sports Sci.* 31, 639–676. doi: 10.1080/02640414.2012.746720

Mao, L., Peng, Z., Liu, H., and Gómez, M. A. (2016). Identifying keys to win in the chinese professional soccer league. *Int. J. Perform. Anal. Sport* 16, 935–947. doi: 10.1080/24748668.2016.11868940

Oberstone, J. (2009). Differentiating the top english premier league football clubs from the rest of the pack: identifying the keys to success. *J. Quant. Anal. Sport.* 5:10. doi: 10.2202/1559-0410.1183

Rampinini, E., Impellizzeri, F. M., Castagna, C., Coutts, A. J., and Wisløff, U. (2009). Technical performance during soccer matches of the Italian Serie A league: effect of fatigue and competitive level. *J. Sci. Med. Sport* 12, 227–233. doi: 10.1016/j.jsams.2007.10.002

Sarmento, H., Anguera, M. T., Pereira, A., and Araújo, D. (2018a). Talent identification and development in male football: a systematic review. *Sport Med.* 48, 907–931. doi: 10.1007/s40279-017-0851-7

Sarmento, H., Clemente, F. M., Araújo, D., Davids, K., McRobert, A., and Figueiredo, A. (2018b). What performance analysts need to know about research trends in association football (2012–2016): a systematic review. *Sport Med.* 48, 799–836. doi: 10.1007/s40279-017-0836-6

Sarmento, H., Figueiredo, A., Lago-Peñas, C., Milanovic, Z., Barbosa, A., Tadeu, P., et al. (2018c). Influence of tactical and situational variables on offensive sequences during elite football matches. *J. Strength Cond. Res.* 32, 2331–2339. doi: 10.1519/JSC.0000000000002147

Sarmento, H., Marcelino, R., Anguera, M. T., CampaniÇo, J., Matos, N., and LeitÃo, J. C. (2014). Match analysis in football: a systematic review. *J. Sports Sci.* 32, 1831–1843. doi: 10.1080/02640414.2014.898852

Seçkin, A., and Pollard, R. (2010). Home advantage in turkish professional soccer. *Percept. Mot. Skills* 107, 51–54. doi: 10.2466/pms.107.1.51-54

Souza, D. B., Campo, R. L., Blanco-Pita, H., Resta, R., and Coso, J. D. (2019). A new paradigm to understand success in professional football: analysis of match statistics in LaLiga for 8 complete seasons. *Int. J. Perform. Anal. Sport* 19, 543–555. doi: 10.1080/24748668.2019.1632580

Szwarc, A. (2007). Efficacy of successful and unsuccessful soccer teams taking part in finals of champions league. *Res. Yearb.* 13, 221–225.

Taylor, J. B., Mellalieu, S. D., James, N., and Shearer, D. A. (2008). The influence of match location, quality of opposition, and match status on technical performance in professional association football. *J. Sports Sci.* 26, 885–895. doi: 10.1080/02640410701836887

Vales-Vázquez, Á., Casal-López, C., Gómez-Rodríguez, P., Blanco-Pita, H., and Serra-Olivares, J. (2017). Competitive profile differences between the best-ranked European football championships. *Hum. Mov.* 18, 97–105. doi: 10.5114/hm.2017.73619

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The football championship is won when playing away: difference in match statistics between the winner and the second-place team in LaLiga

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The football championship is won when playing away: difference in match statistics between the winner and the second-place team in LaLiga

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ABSTRACT

The aim of this study was to identify match statistics that best explained the differences between the first- and the second-placed teams in the Spanish National football championship (LaLiga). For this aim, the number of wins, draws, losses, distribution of scored/received goals, and accumulated attack, and defensive match statistics were obtained of the 1st and 2nd place teams for eight seasons (from 2010–2011 to 2017–2018). In comparison to the championship winner, the second-place team obtained a similar number of victories at home but a lower number of away wins (effect size [ES] = moderate). The goal-based variables with the highest effect size between the first- and second-place teams were a higher number of goals scored while playing away and a lower number of goals received while playing away (ES = moderate). A higher shooting accuracy along with less conceded shots and conceded corners (ES = moderate), were the match statistics with the highest effect size between the investigated teams. A higher number of wins when playing away was the best indicator of performance to differentiate between the championship winner and the second-place team. Increased shooting accuracy and conceding less shots from corners might also aid in obtaining victory in LaLiga.

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Soccer; match analysis; performance; elite football

1. Introduction

Succeeding in elite football (soccer) is a complex architype that is influenced by a myriad of intrinsic and extrinsic elements of the game. For example, physical conditioning, match-play movements, technical aptitudes and team tactics are considered as the main intrinsic factors affecting football performance but different contextual factors might also contribute to the success of a football team, especially in high-performance teams. The influence of these factors on football success has been recently reviewed and analysed (Hartmann et al., 2015; Lepschy et al., 2018; Mackenzie & Cushion, 2013; Sarmento, Anguera et al., 2018; Sarmento et al., 2014), and the understanding of successful key

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indicators in elite football is now more clear than ever. Although the outcome of a football match is not always free of chance, the knowledge of football performance indicators that can regulate success is critical for coaches and performance analysts (Lepschy et al., 2020).

The aforementioned reviews mainly included investigations in which the keys for football success were established by comparing match statistics between winners and losers (Broich et al., 2014; Castellano et al., 2012; Lago-Peñas et al., 2011; Mao et al., 2016; Szwarc, 2007) or high-ranked and low-ranked teams (Lago-Ballesteros & Lago-Peñas, 2010; Pappalardo & Cintia, 2018; Rampinini et al., 2009). While these investigations are useful in broadly defining success in elite football, they failed to address the subtle differences within top-ranked teams that compete in a national football league for the championship.

The analysis of higher vs lower performance football teams implies that almost all match statistics are associated to football performance (Lepschy et al., 2018; Sarmento, Clemente et al., 2018). To this regard, match statistics may contribute more (Brito Souza et al., 2019) than match running performance to explain the number of points obtained in a national league (Brito Souza et al., 2020). Nevertheless, the high number of variables that differentiate between winners and losers and between better-ranked and least-ranked teams in all European national leagues (Pappalardo & Cintia, 2018) difficults the understanding of what actions are more important for succeeding in football championships. This confuses the work of coaches and performance analysts, especially those that work for highly ranked teams because there is no clear scientific background to prioritise game actions over others. Specifically, previous literature shows a very similar number of offensive and defensive match statistics within highly ranked teams (Brito de Souza et al., 2019) while the running actions with and without ball possession in the winner of a national league are very similar to those of teams classified for the Champions League (Brito Souza et al., 2020). In contrast, research that compares 1st and 2nd-ranked teams in a football championship is scarce. Szwarc (2007) analysed match statistics between the teams that won/lost the final game of the Champions League from 1997 to 2003. This author found that the number of shots on goal and an effective goalkeeper were the main factors in obtaining a victory in the final match. However, unlike the Champions League, where victory is obtained through KO-rounds, triumph in a national football league is obtained by the sum of the points scored throughout the season. Thus, the factors that explain success in weekly competitions of a national football league might differ from the Champions League.

To the authors' opinion, the explanation of key performance indicators that aid to obtain victory in a football league should be made by comparing match-play variables among high-performance teams, instead of interpolating the information of previous investigations that compared high vs low performance teams (Lago-Peñas et al., 2010). For this reason, the aim of the current research was to identify match statistics that best explained the differences between the first (1st)- and second-place (2nd) teams in the Spanish National football championship (LaLiga). The intention of this analysis is to define what characteristics differentiate a high-performance team between other teams with comparable performance in order to obtain a championship win. Because no previous investigation has analysed football performance in a national league at this level of (i.e., 1st vs 2nd- ranked teams), we do not have a hypothesis.

2. Methods

2.1. Design and procedures

The current research presents a descriptive and comparative analysis for main end-season match statistics obtained by the first-two ranked teams in the Spanish Professional Football League (LaLiga; from 2010/11 to 2017/18 seasons). The investigation does not included information that allows the identification of football players to keep LaLiga ethical guidelines. The investigation was approved by the University Institutional Review Board (Camilo José Cela University).

2.2. Measures

This analysis has been based on the suggestions made by Mackenzie and Cushion (2013) and includes a sample of three different elite football teams – across eight complete seasons teams are included in the 1st/2nd place cluster according to their end-season ranking – that won the championship or ended in second place; teams competing in the same championship and against the same rivals; and operational definitions of the investigated variables. Table 1 contains information about the end-season ranking points of the teams included in the analysis.

The end-season accumulated match statistics of the 1st and 2rd-ranked teams were obtained from LaLiga during the 8 years. The data were extracted by the match statistics software Media Coach®, based on the track analysis tool OPTA Sportsdata (Spain). The reliability of this current tracking system to assess match statistics has been tested with an intra-class correlation coefficient that ranges from 0.88 to 1.00 (Liu et al., 2013). In addition, the validity of this software to assess movement demands during match play has been obtained through high agreement of the track analysis with the data obtained with GPS (Felipe et al., 2019; Pons et al., 2019). In the analysis, we included the number of home and away wins, the number of home and away draws and the number of home and away losses for each team, and information about the obtained/received goals during

Table 1. Ranking points and name of the elite football teams included in the analysis.

Season	1st place (points)	2nd place (points)
2010–2011	F.C. Barcelona (96)	Real Madrid C.F. (92)
2011–2012	Real Madrid C.F. (100)	F.C. Barcelona (91)
2012–2013	F.C. Barcelona (100)	Real Madrid C.F. (91)
2013–2014	Atlético de Madrid (90)	F.C. Barcelona (87)
2014–2015	F.C. Barcelona (94)	Real Madrid C.F. (92)
2015–2016	F.C. Barcelona (91)	Real Madrid C.F. (90)
2016–2017	Real Madrid C.F. (93)	F.C. Barcelona (90)
2017–2018	F.C. Barcelona (93)	Atlético de Madrid (79)

each season. In addition, we selected standard match statistics measured by Media Coach® with their operational definitions which are defined in Table 2. The selection of these variables has been based on previous studies (Lago-Peñas et al., 2010; Liu et al., 2016; Rampinini et al., 2009). The accumulated match statistics were divided by offensive and defensive actions to improve the applicability of this study's results to professional football.

2.3. Statistical analysis

All variables are presented as average ± standard deviation for the 1st and 2nd-ranked teams. To determine the magnitude of the differences in match statistics, the effect size was calculated through pairwise comparisons (Hopkins et al., 2009). The Cohen's d statistic ± 90% confidence intervals (CI) were used on log-transformed data to reduce bias due to any non-uniformities of error. The smallest significant standardised effect threshold was set as 0.2. Effect sizes were interpreted according to the following ranges: <0.2, trivial; 0.2–0.6, small; 0.6–1.2, moderate; 1.2–2.0, large; 2.0–4.0, very large and; >4.0, extremely large. All of these calculations were made in spreadsheets to compare the means of the two groups provided by Hopkins (Hopkins, 2020).

Table 2. Operational definitions of the match statistics and events used for the investigation.

Attacking variables	Specifications
Goal	Score obtained by the attacking team
Shot	Attempt to score a goal of the attacking team
Shooting accuracy	Goals/shots
Pass	Attempted exchange of the ball between two players of the attacking team
Successful pass	Successful exchange of the ball between two players of the attacking team
Passing accuracy	Successful passes/passes
Cross	Action made by a player with the objective of introducing the ball within the opposition team
Penalty kick	Single shot on the goal while it is defended only by the opposing team's goalkeeper
Turnover	Loss of ball possession to the opposing team
Foul received	Infringement committed by the opposing the team
Corner	Ball crosses the end line of opponent's side and the last person in contact with the ball was an opponent
Free kick goal	Goal scored for the attacking team as the result of a direct or indirect free kick
Offside	Infringement committed by the attacking team as a result of a player being offside
Defensive variables	
Goal received	Score obtained by the opposing team
Shot conceded	Attempt to score a goal made by the opposing team
Effectiveness against conceded shooting	Goals received/shots conceded
Foul committed	Infringement committed by the defending team
Penalty kick conceded	Single shot on the goal while it is defended only by the defending team's goalkeeper
Corner against	Ball crosses the end line of defending team's side and the last person in contact with the ball was an opponent
Yellow cards	Sanction by the referee to one of the players of the defending team
Red cards	Sanction by the referee to one of the players of the defending team that ends in player expulsion
Free kick goals received	Goal received as the result of a direct or indirect free kick
Recovery	Obtaining the ball possession due to a defensive action

3. Results

Figure 1 depicts the distribution of wins, draws, and losses – both at home and away – for 1st- and 2nd-placed teams in the last eight seasons of LaLiga. In comparison to the championship winner, the second-place team obtained a similar number of victories at home but a lower number of away wins (ES = large). As a result, the total number of wins at the end of the season was inferior in the 2nd place vs the 1st place team (ES = large). On the contrary, the 2nd place team obtained a higher number of away draws (ES = moderate) and away loses (ES = moderate), resulting in a higher total number of draws (ES = small) and losses (ES = moderate) at the end of the season. Interestingly, the number of draws and losses at home was not different between the 1st and 2nd place teams.

Table 3 includes information about the differences in the distribution of goals between 1st and 2nd place teams. A higher number of goals scored while playing away, a lower number of goals received while away, and a lower number of received free-kick goals were the variables with the highest effect size on the 1st vs. 2nd place teams' comparison (ES ≥ 0.6 and moderate). A higher number of goals scored in the second half and a lower number of goals received in the second half were other variables that differentiated between the 1st and 2nd place teams (ES = small). Table 4 depicts data about differences in match statistics between the champion and the second-place team at the end of the season. A higher shooting accuracy differentiated the championship winner from the second-place team (ES = moderate), even when the winner shot less (ES = small). The winner also performed a higher number of passes and successful passes with a lower proportion of crosses (ES = small). In the defensive variables, a lower amount of conceded shots, penalty kicks, corners, and yellow cards likely differentiated between the teams (ES ≥ 0.5 and from small-to-moderate).

Figures 2 and 3 depict an overview of the magnitude of effect size identified for each variable analysed in this investigation. Away wins, the total number of wins and shooting accuracy were variables with the largest effect in the comparison of 1st vs 2 place teams. On the contrary, losses and draws away, the total number of losses and the number of conceded corners were variables in which the 2nd place team obtained higher numbers than the championship winner.

4. Discussion

This investigation was thoroughly tailored to determine the match statistics that best differentiated between 1st and 2nd place teams in the Spanish National Championship of football. This information is key at understanding which differences in match-play result in in a championship winner, and it uses information from the football league with the more remarkable international prestige and competitive quality (Vales-Vázquez et al., 2018). The main outcomes of this investigation were: a) while the number of home wins, draws, and losses were similar for the 1st and 2nd place teams, the championship winner obtained more victories while away at the expense of less away draws and away losses (Figure 1). b) a higher number of scored goals and lower number of received goals while playing away also distinguished the championship winner from the 2nd place team. However, the between-team differences in goals scored/received at home had a lower

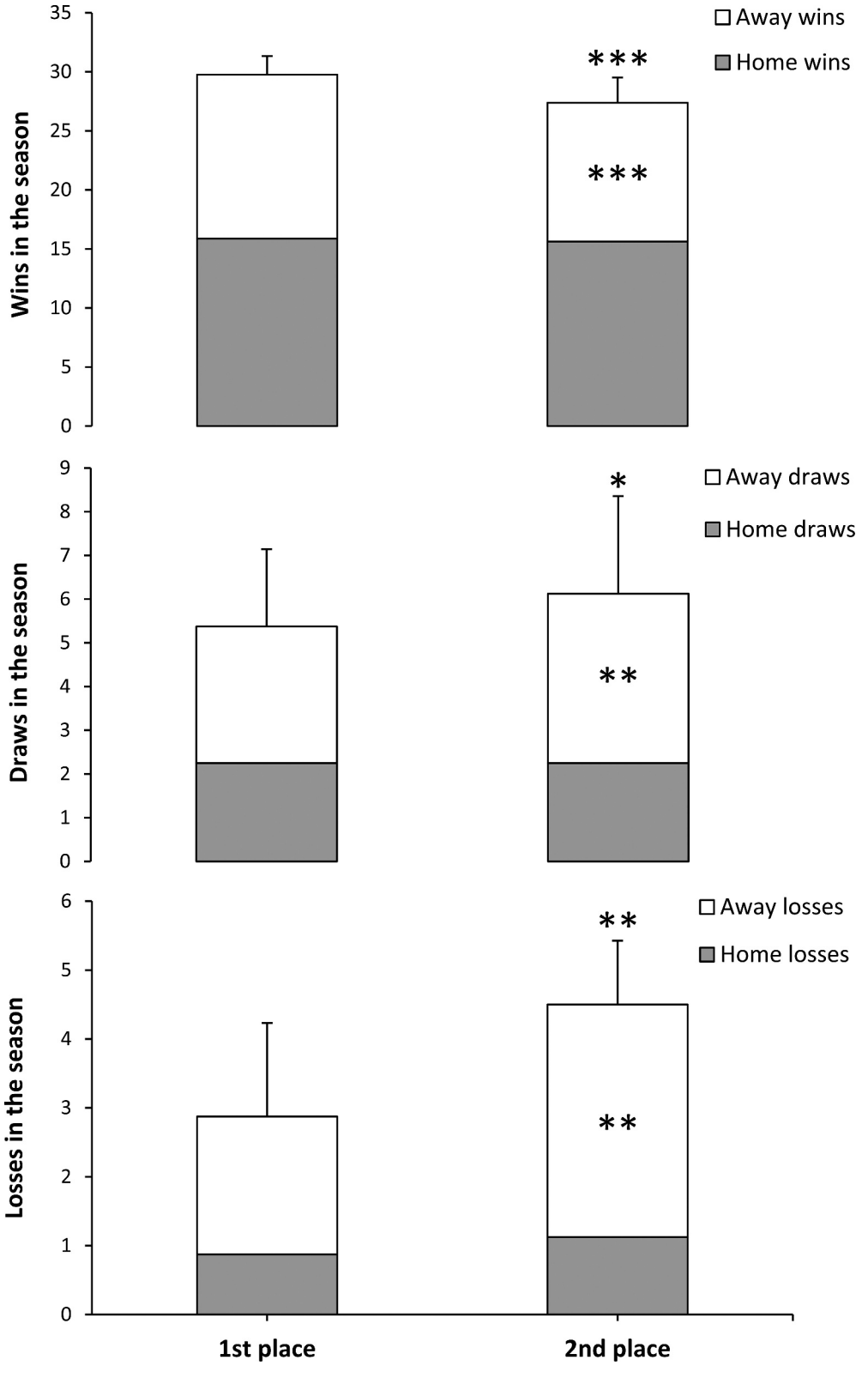

Figure 1. Distribution of wins, draws, and losses in the first and second place teams during the last 8 seasons of LaLiga. * = small; ** = moderate. *** = large

Table 3. Distribution of goals in the first and second place teams during the last eight seasons of LaLiga.

Variable	1st place	2nd place	ES±CI
Goals	103 ± 14	102 ± 20	−0.2 ± 1.1
Goals at home	58 ± 10	62 ± 13	0.3 ± 1.1
Goals away	46 ± 9	40 ± 8	−0.6 ± 1.1
Goals first half	44 ± 9	47 ± 12	0.2 ± 1.1
Goals second half	59 ± 10	54 ± 12	−0.5 ± 0.9
Goals in extra-time	5 ± 2	5 ± 2	−0.5 ± 1.2
Free kick goals	15 ± 4	16 ± 6	0.1 ± 1.1
In-game goals	88 ± 15	85 ± 15	−0.1 ± 0.8
Goals received	30 ± 8	33 ± 7	0.4 ± 0.7
Goals received at home	14 ± 4	14 ± 4	0.1 ± 0.8
Goals received away	16 ± 5	19 ± 3	0.6 ± 0.6
Goals received first half	13 ± 4	14 ± 6	0.2 ± 1.1
Goals received second half	17 ± 4	19 ± 3	0.5 ± 0.7
Goals received in extra-time	1 ± 1	2 ± 2	0.4 ± 0.9
Free kick goals received	5 ± 2	8 ± 3	0.8 ± 0.7
In-game goals received	25 ± 7	25 ± 5	0.1 ± 0.7

ES, effect size; CI, confidence interval

Table 4. Distribution of match statistics in the first and second place teams during the last eight seasons of LaLiga.

Variable	1st place	2nd place	ES±CI
Shots	598 ± 75	642 ± 105	0.4 ± 1.0
Shooting accuracy (%)	17.5 ± 2.1	16.0 ± 1.6	−0.7 ± 0.7
Passes	25113 ± 4367	23115 ± 3565	−0.4 ± 0.7
Successful passes	21396 ± 4590	19347 ± 3704	−0.4 ± 0.7
Passing accuracy (%)	84.6 ± 4.4	83.3 ± 3.3	−0.2 ± 0.7
Crosses	690 ± 185	745 ± 165	0.3 ± 0.7
Penalty kicks	9 ± 5	10 ± 3	0.3 ± 0.7
Turnovers	4757 ± 248	4701 ± 233	−0.2 ± 0.8
Fouls received	560 ± 21	570 ± 44	0.4 ± 1.3
Corners	235 ± 17	246 ± 33	0.5 ± 1.4
Offsides	131 ± 10	126 ± 18	0.3 ± 1.1
Shots conceded	354 ± 45	389 ± 62	0.6 ± 0.9
Effectiveness against conceded shooting (%)	8.4 ± 1.7	8.8 ± 1.7	0.2 ± 0.9
Fouls committed	427 ± 63	454 ± 56	0.4 ± 0.7
Penalty kicks conceded	3 ± 2	2 ± 2	0.5 ± 0.6
Corners against	144 ± 14	158 ± 28	0.8 ± 1.2
Yellow cards	76 ± 15	87 ± 12	0.6 ± 0.7
Red cards	2 ± 2	2 ± 2	0.4 ± 0.8
Recoveries	2016 ± 108	2005 ± 138	−0.1 ± 0.9

ES, effect size; CI, confidence interval.

magnitude of effect. c) a higher shooting accuracy while attacking and less conceded shots, corners, free kick goals, and penalty kicks while defending were differentiated the championship winner and the second-place team. This analysis clearly determines that the key determinant to winning the Spanish football championship was obtaining match wins while playing away because 1st and 2nd place teams obtain similar results while playing at home. With this in mind, drawing with the rival while playing away is not enough to winning the championship because the second-place team obtained more draws in total and while playing away. This information suggests that football teams fighting for the victory in a national football league must play offensively with the aim of obtaining victory in away games. An overall higher shooting accuracy and a lower

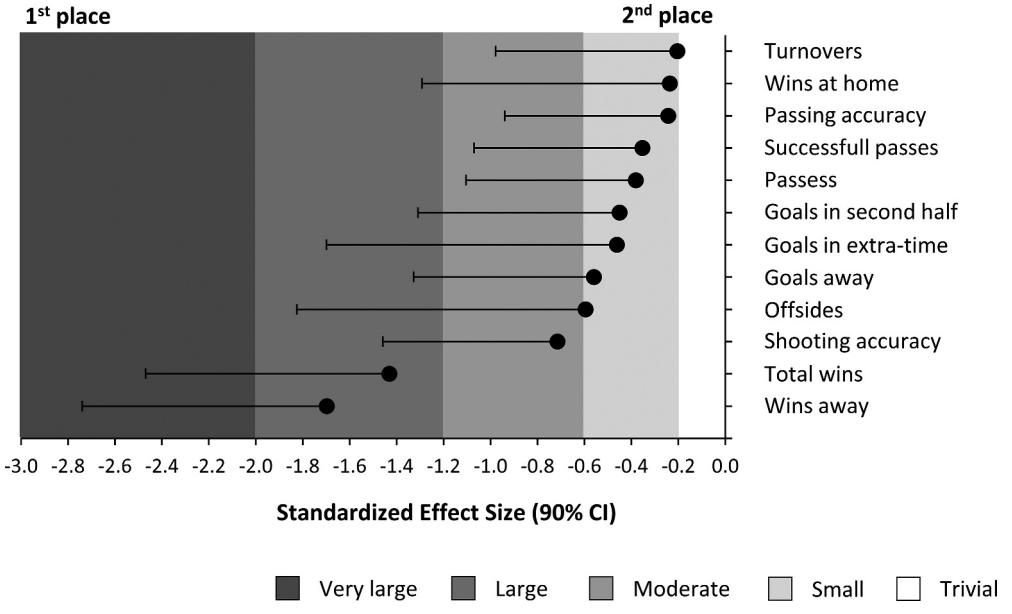

Figure 2. Standardised effect size (−90% CI) of game statistics where the first place team obtained higher numbers than the second place team in the last 8 seasons of LaLiga. Only game statistics with ≥ small effect size have been included.

number of conceded shooting, particularly from corners and free-kicks, are also factors that might be essential in winning the football championship.

This investigation is novel because it is the first analysis that establishes differences in the teams that are competing for a national football championship (1st and 2nd ranked teams). In addition, despite the low number of teams that fulfilled this definition, it includes accumulated values obtained at the end of eight complete seasons in LaLiga for a total of 592 matches. The identification of match statistics that differ between match winner vs match losers (Castellano et al., 2012; Lago-Peñas et al., 2011; Mao et al., 2016; Szwarc, 2007) and better-ranked vs worse-ranked teams (Brito de Souza et al., 2019; Lago-Ballesteros & Lago-Peñas, 2010; Pappalardo & Cintia, 2018; Rampinini et al., 2009) have been the topic of previous investigations. This previous information helps to understand key variables that define high-performance football teams and low performance teams. However, it is unable to explain the subtle and diverse differences between the teams competing for a championship. While a myriad of match statistics (e.g., number of shots, shooting accuracy, ball possession, number of passes, passing accuracy, etc.) have been identified as key football performance indicators when comparing successful and less-successful football teams (Lago-Ballesteros & Lago-Peñas, 2010; Lepschy et al., 2020; Pappalardo & Cintia, 2018; Rampinini et al., 2009), most of these variables were very comparable between the 1st and 2nd place teams (Tables 3 and 4).

Figures 2 and 3 depict an overview of the magnitude of effect size identified for each variable of this investigation. Game statistics with trivial effect sizes have not been included in these figures. In Figure 2, variables in which the championship winner obtained higher measures than the 2nd place team are depicted with 90% confidence intervals. Away wins

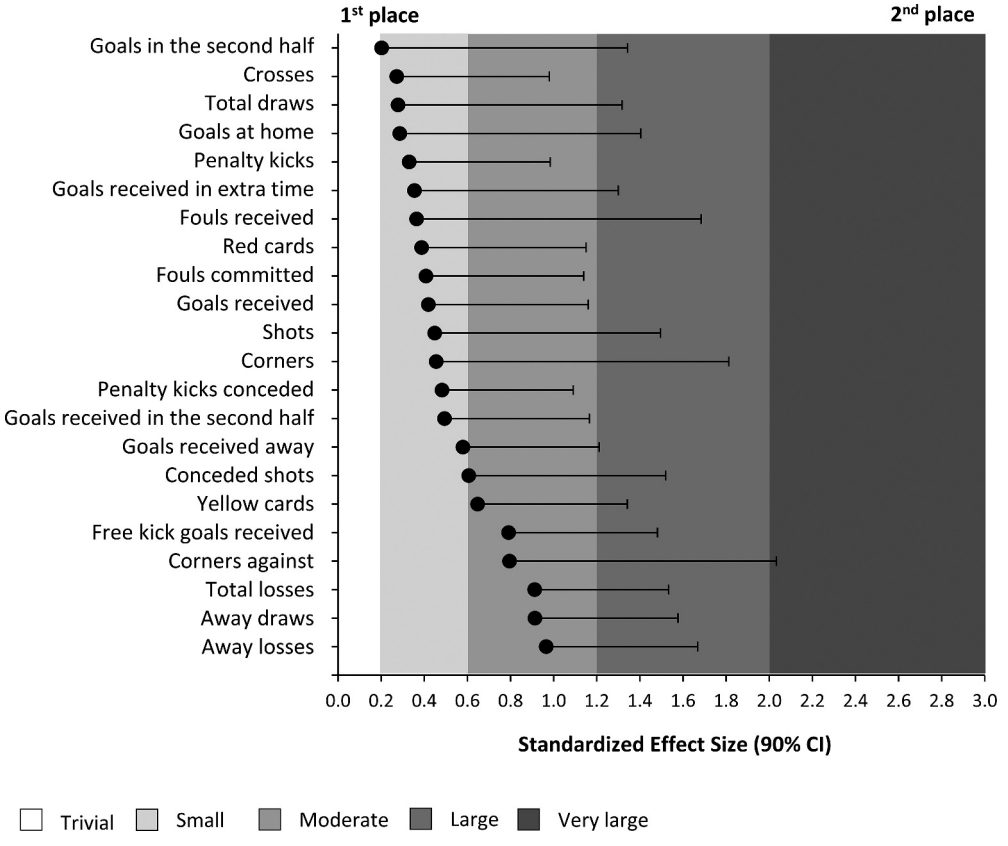

Figure 3. Standardised effect size (+90% CI) of game statistics where the first place team obtained lower numbers than the second place team in the last 8 seasons of LaLiga. Only game statistics with ≥ small effect size has been included.

and the total number of wins were variables had large effects in winning the football championship. This was then followed by shooting accuracy (moderate effect size). Although other match statistics presented small effect sizes when comparing the 1st and 2nd place teams, the extent of the confidence intervals impedes the categorisation of these variables as key performance indicators. While passing accuracy and ball possession have been previously identified as football performance indicators (Luhtanen et al., 2001; Rampinini et al., 2009), also in LaLiga (Liu et al., 2016), all match statistics related to passing had small effect sizes between the teams. As previously suggested (Collet, 2013; Harrop & Nevill, 2014), it seems that a high numbers of passes or a high efficacy in passing have limited influence in overall football success and it might not be a definitory variable to win a nation football championship. To this regard, it is probable that successful passing may be a key aspect in soccer performance only if it provides a source of attacking plays culminating in shots at goal (Oberstone, 2009). In fact, the models that concede a key role for shooting and shooting accuracy among all the match statistics can fairly predict football success (Brito Souza et al., 2019; Pappalardo & Cintia, 2018). All this information together suggests that, in addition to its role to define a high-ranked team vs low-ranked teams, shooting performance is also definitive to win the championship.

As opposed to Figure 2, Figure 3 includes variables in which the championship winner obtained lower ratings than the 2nd place team. Following the same criteria, lower number of total losses (particularly away), less draws while playing away, and less conceded shots (particularly from corner and free kicks) had moderate effect sizes in winning the championship. Interestingly, although the number of corners is relatively low (around five corners per match and per team; (Castellano et al., 2012)), the number of corners against was the match statistic with the highest effect size between 1st and 2nd place teams (excluding the ones related to match results; Figure 2). This contrasts with findings of previous investigations were the number of corners was similar in winning and losing teams in World Cup tournaments (Castellano et al., 2012) and in the UEFA Champions League (Lago-Peñas et al., 2011). As the teams included in the current investigation were the top-two teams in LaLiga, and they are potentially characterised by conceding a low number of occasions to the rival (Brito de Souza et al., 2019), it is probable conceding a corner has higher impact in highly ranked teams because this game action can be one of the few manner of approaching to the rival's goal area and obtaining an opportunity of shooting in low-ranked teams. A low number of yellow cards and goals received while away also had a moderate-to-small effect size. Thus, although several match statistics were identified as having a small effect in differentiating between the two teams with the highest ranking at the end of the season, only a few were presented moderate influence on the classification at the end of the season. Avoiding clear shooting of the opposing team, especially from rivals' free kick actions close to the area, might also be a key performance variable in winning the championship (Lepschy et al., 2018). Although evading rivals' shooting is more difficult during away games (Sarmento et al., 2014; Taylor et al., 2008), this might be crucial in obtaining victories in away games.

All this information might be useful in modulating match plays for teams pursuing the national football championship. The advantage of playing at home (Goumas, 2017) produced wins in ~84% of the matches played at home (~16 home wins from 19 possible home wins in one complete season). However, the championship winner obtains 73% of victories while playing away (~14 away wins from 19 possible away wins). For the second-place team, this value is reduced to 62%. Drawing away seems to not be enough to obtain the football championship since the 2nd ranked teams obtained 20% of away draws vs 16% of away draws for the 1st place team. Thus, the use of an offensive style of play and tactical approaches in the teams that are fighting for a championship should be maintained while playing away.

The current investigation presents some limitations that should be discussed in order to improve the applicability of the results. First, due to the nature of this study's aims, the analysis included a comparison of only two teams for eight complete seasons. For this reason, we have used an analysis based on the magnitude of effect size instead of the most traditional null-hypothesis significance testing. However, this approach may have high rates of type I errors (Sainani, 2018) and thus, the current investigation may incorrectly identify differences between 1st and 2nd place teams (i.e., false positives). Furthermore, the analysis of end of season data rather than match data does not account for unbalanced matches especially if the championship winner has won the title early. To this regard, the differences in the number of points at the end of the season between the 1st and 2nd place teams varied from 1 point (2015–2016) to 14 points (2017–2018). Consequently, the outcomes of this investigation should only be applied to high

ranking-teams competing for championship victory to create training routines and to prepare tactics and strategies, in correlation to the rival's level, that help to increase their likelihood of winning away matches while maintaining home victories. Second, this analysis was conducted on a national football championship where 2–3 teams competed until the last "playing days" of the league. Thus, these outcomes cannot be extrapolated to other national or international competitions were the ranking is not tied until the end of the season. Finally, other key indicators of football performance such as physical variables and movement patterns during match-play, football-specific technical aptitudes, and team tactics have not been included in this analysis (Sarmento, Clemente et al., 2018). Despite these limitations, the authors of this investigation believe that its results can better aid professionals to understand success in football.

In summary, although numerous match statistics had small effect sizes between the 1st-ranked and 2nd-ranked teams at the end of the season, the variables with moderate effect sizes were scarce and subtle. A higher number of wins while playing away, instead of drawing or losing while away, was the best performance indicator of differentiating between the championship winner and the second-place team. Increased shooting accuracy and conceding less shots from corners and free kicks also aided to winning the Spanish National football championship. An offensive style of play might be crucial in winning the championship, although conceding fewer clear shots might also help in obtaining away wins. Although the means of obtaining an effective offensive style while keeping high ratings in defensive variables may be different depending on the team's characteristics, the use of training exercises based on a direct style that assures the finalisation of the play with a shot may be an strategy to achieve this objective. In addition, exercises that promote aggressive pressing after losing the ball may be also recommended as one of the best manners to reduce the number of rival's shots. Coaches should consider that high physical challenges that this style of play entails (Castellano et al., 2014) in order to assure appropriate physical conditioning during training, players' substitutions during the match and players' rotation between matches. From a practical perspective, high-ranking football coaches and players aiming for the national football championship should focus on increasing their likelihood of winning away matches while maintaining home victories.

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Disclosure statement

Roberto López Del Campo, Hugo Blanco-Pita and Ricardo Resta were LaLiga employees during the preparation of this work. The remaining authors declare that there is no potential conflict of interest.

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References

Brito de Souza, D., López-Del Campo, R., Blanco-Pita, H., Resta, R., & Del Coso, J. (2019). An extensive comparative analysis of successful and unsuccessful football teams in LaLiga. *Frontiers in Psychology*, *10*(1), 2566. https://doi.org/10.3389/fpsyg.2019.02566

Brito Souza, D., López-Del Campo, R., Blanco-Pita, H., Resta, R., & Del Coso, J. (2019). A new paradigm to understand success in professional football: Analysis of match statistics in LaLiga for 8 complete seasons. *International Journal of Performance Analysis in Sport*, *19*(4), 543–555. https://doi.org/10.1080/24748668.2019.1632580

Brito Souza, D., López-Del Campo, R., Blanco-Pita, H., Resta, R., & Del Coso, J. (2020). Association of match running performance with and without ball possession to football performance. *International Journal of Performance Analysis in Sport*, *20*(3), 483–494. https://doi.org/10.1080/24748668.2020.1762279

Broich, H., Mester, J., Seifriz, F., & Yue, Z. (2014). Statistical analysis for the first bundesliga in the current soccer season. *Progress in Applied Mathematics*, *7*(2), 1–8. https://doi.org/10.3968/4886

Castellano, J., Alvarez-Pastor, D., & Bradley, P. S. (2014). Evaluation of research using computerised tracking systems (amisco® and prozone®) to analyse physical performance in elite soccer: A systematic review. *Sports Medicine*, *44*(5), 701–712. https://doi.org/10.1007/s40279-014-0144-3

Castellano, J., Casamichana, D., & Lago, C. (2012). The use of match statistics that discriminate between successful and unsuccessful soccer teams. *Journal of Human Kinetics*, *31*(1), 137–147. https://doi.org/10.2478/v10078-012-0015-7

Collet, C. (2013). The possession game? A comparative analysis of ball retention and team success in European and international football, 2007-2010. *Journal of Sports Sciences*, *31*(2), 123–136. https://doi.org/10.1080/02640414.2012.727455

Felipe, J. L., Garcia-Unanue, J., Viejo-Romero, D., Navandar, A., & Sánchez-Sánchez, J. (2019). Validation of a video-based performance analysis system (mediacoach®) to analyze the physical demands during matches in LaLiga. *Sensors*, *19*(19), 4113. https://doi.org/10.3390/s19194113

Goumas, C. (2017). Modelling home advantage for individual teams in UEFA Champions League football. *Journal of Sport and Health Science*, *6*(3), 321–326. https://doi.org/10.1016/j.jshs.2015.12.008

Harrop, K., & Nevill, A. (2014). Performance indicators that predict success in an English professional league one soccer team. *International Journal of Performance Analysis in Sport*, *14*(3), 907–920. https://doi.org/10.1080/24748668.2014.11868767

Hartmann, H., Wirth, K., Keiner, M., Mickel, C., Sander, A., & Szilvas, E. (2015). Short-term periodization models: Effects on strength and speed-strength performance. *Sports Medicine*, *45*(10), 1373–1386. https://doi.org/10.1007/s40279-015-0355-2

Hopkins, W. G. (2020). *A spreadsheet for deriving a confidence interval, mechanistic*. Retrieved June 20, 2020, from https://www.sportsci.org/2007/wghinf.htm

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise*, *41*(1), 3–13. https://doi.org/10.1249/MSS.0b013e31818cb278

Lago-Ballesteros, J., & Lago-Peñas, C. (2010). Performance in team sports: Identifying the keys to success in soccer. *Journal of Human Kinetics*, *25*(1), 85–91. https://doi.org/10.2478/v10078-010-0035-0

Lago-Peñas, C., Lago-Ballesteros, J., Dellal, A., & Gómez, M. (2010). Game-related statistics that discriminated winning, drawing and losing teams from the Spanish soccer league. *Journal of Sports Science and Medicine*, *9*(2), 288–293. https://doi.org/10.1080/09168451.2014.878218

Lago-Peñas, C., Lago-Ballesteros, J., & Rey, E. (2011). Differences in performance indicators between winning and losing teams in the UEFA Champions League. *Journal of Human Kinetics*, *27*(1), 135–146. https://doi.org/10.2478/v10078-011-0011-3

Lepschy, H., Wäsche, H., & Woll, A. (2018). How to be successful in football: A systematic review abstract. *The Open Sports Sciences Journal*, *11*(1), 3–23. https://doi.org/10.2174/1875399X01811010003

Lepschy, H., Wäsche, H., & Woll, A. (2020). Success factors in football: An analysis of the German Bundesliga. *International Journal of Performance Analysis in Sport*, *20*(2), 150–164. https://doi.org/10.1080/24748668.2020.1726157

Liu, H., Gómez, M. A., Gonçalves, B., & Sampaio, J. (2016). Technical performance and match-to-match variation in elite football teams. *Journal of Sports Sciences*, *34*(6), 509–518. https://doi.org/10.1080/02640414.2015.1117121

Liu, H., Hopkins, W., Gómez, M. A., & Molinuevo, J. S. (2013). Inter-operator reliability of live football match statistics from OPTA Sportsdata. *International Journal of Performance Analysis in Sport*, *13*(3), 803–821. https://doi.org/10.1080/24748668.2013.11868690

Luhtanen, P., Belinskij, A., Hayrinen, M., & Vanttinen, T. (2001). A comparative tournament analysis between the EURO 1996 and 2000 in soccer. *International Journal of Performance Analysis in Sport*, *1*(1), 74–82. https://doi.org/10.1080/24748668.2001.11868250

Mackenzie, R., & Cushion, C. (2013). Performance analysis in football: A critical review and implications for future research. *Journal of Sports Sciences*, *31*(6), 639–676. https://doi.org/10.1080/02640414.2012.746720

Mao, L., Peng, Z., Liu, H., & Gómez, M. A. (2016). Identifying keys to win in the chinese professional soccer league. *International Journal of Performance Analysis in Sport*, *16*(3), 935–947. https://doi.org/10.1080/24748668.2016.11868940

Oberstone, J. (2009). Differentiating the top english premier league football clubs from the rest of the pack: Identifying the keys to success. *Journal of Quantitative Analysis in Sports*, *5*(3), 1–27. https://doi.org/10.2202/1559-0410.1183

Pappalardo, L., & Cintia, P. (2018). Quantifying the relation between performance and success in soccer. *Advances in Complex Systems*, *21*(3n4), 3–4. https://doi.org/10.1142/S021952591750014X

Pons, E., García-Calvo, T., Resta, R., Blanco, H., Del Campo, R. L., García, J. D., & Pulido, J. J. (2019). A comparison of a GPS device and a multi-camera video technology during official soccer matches: Agreement between systems. *PLoS ONE*, *14*(8), 1–13. https://doi.org/10.1371/journal.pone.0220729

Rampinini, E., Impellizzeri, F. M., Castagna, C., Coutts, A. J., & Wisløff, U. (2009). Technical performance during soccer matches of the Italian Serie A league: Effect of fatigue and competitive level. *Journal of Science and Medicine in Sport*, *12*(1), 227–233. https://doi.org/10.1016/j.jsams.2007.10.002

Sainani, K. L. (2018). The Problem with "magnitude-based Inference.". *Medicine and Science in Sports and Exercise*, *50*(10), 2166–2176. https://doi.org/10.1249/MSS.0000000000001645

Sarmento, H., Anguera, M. T., Pereira, A., & Araújo, D. (2018). Talent identification and development in male football: A systematic review. *Sports Medicine*, *48*(4), 907–931. https://doi.org/10.1007/s40279-017-0851-7

Sarmento, H., Clemente, F. M., Araújo, D., Davids, K., McRobert, A., & Figueiredo, A. (2018). What performance analysts need to know about research trends in association football (2012–2016): A systematic review. *Sports Medicine*, *48*(4), 799–836. https://doi.org/10.1007/s40279-017-0836-6

Sarmento, H., Marcelino, R., Anguera, M. T., CampaniÇo, J., Matos, N., & LeitÃo, J. C. (2014). Match analysis in football: A systematic review. *Journal of Sports Sciences*, *32*(20), 1831–1843. https://doi.org/10.1080/02640414.2014.898852

Szwarc, A. (2007). Efficacy of successful and unsuccessful soccer teams taking part in finals of champions league. *Research Yearbook*, *13*(2), 221–225. https://scholar.google.com/scholar_lookup?title=Efficacy+of+successful+and+unsuccessful+soccer+teams+taking+part+in+finals+of+champions+league%2E&journal=Res%2E+Yearb%2E&author=Szwarc+A.&publication_year=2007&volume=13&pages=221%E2%80%93225

Taylor, J. B., Mellalieu, S. D., James, N., & Shearer, D. A. (2008). The influence of match location, quality of opposition, and match status on technical performance in professional association football. *Journal of Sports Sciences*, *26*(9), 885–895. https://doi.org/10.1080/02640410701836887

Vales-Vázquez, Á., Casal-López, C., Gómez-Rodríguez, P., Blanco-Pita, H., & Serra-Olivares, J. (2018). Competitive profile differences between the best-ranked European football championships. *Human Movement*, *2017*(5), 97–105. https://doi.org/10.5114/hm.2017.73619

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Association of match running performance with and without ball possession to football performance

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Association of match running performance with and without ball possession to football performance

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ABSTRACT

The aim of this study was to determine the relationship between match running patterns with and without ball possession and the number of points earned at the end of the Spanish football league (*La Liga*). Running distance covered with and without ball possession at speeds ≥21 and <21 km/h were analysed from 4 consecutive seasons (2015–2016 to 2018–2019). The league champion ran a shorter distance per match than the teams that classified for the Champions League ($P = 0.05$), than the teams ranked in the middle of the ranking ($P = 0.02$), and the teams that were relegated to the second division ($P = 0.04$). However, the league champion and the teams that classified for the Champions League ran a greater distance with ball possession than teams in the middle of the ranking ($P < 0.01$) and relegation teams ($P < 0.01$). A stepwise multiple regression analysis was able to explain only 37.9% of the total variance in the number of points with match running variables. In conclusion, the best football teams cover a greater distance with the ball than the less successful teams but the contribution of match running performance to overall football success is limited.

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Soccer; match analysis; team sport performance; physical performance

1. Introduction

It is well recognised that success in elite football is based on the interaction of multiple physical, technical and tactical capacities of players and of team squads (Sarmento et al., 2018). To ensure that elite players are optimally prepared for the high intensity demands imposed during competitive match play, it is imperative that players are exposed to comparable demands under controlled training conditions (Harper et al., 2019). For this reason, several investigations have analysed the match statistics and running patterns that were best associated with victory in a match and a better ranking in a tournament (Brito de Souza, López-Del Campo, Blanco-Pita, Resta & Del Coso, 2019; Lago-Ballesteros & Lago-Peñas, 2010; Rampinini et al., 2009). These investigations and subsequent systematic review have established that shooting accuracy, the number of shots when attacking,

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and a low number of shots conceded when defending are within the most recurrent match statistics used to differentiate better-ranked and worse-ranked teams (Lepschy et al., 2018; Sarmento et al., 2014). These investigations have helped to tailor football training programmes focused on improving variables related to a more vertical style of playing where shooting is the key factor of the team's attacking strategy, perhaps to the detriment of enhancing variables related with passing and organising (Brito de Souza et al., 2019). However, despite the importance conceded to developing optimal physical conditioning in elite football players, information about the influence of match running performance on football success is scarce and contradictory.

In the Italian Serie A League, the worse-ranked teams (15th-20th of the ranking) ran a greater total distance per match than the more successful teams (1st-5th of the ranking (Rampinini et al., 2009). Interestingly, completing > 8% of the total running distance at >16 km/h might increase the likelihood of attaining one of the first positions in the Serie A League (Longo et al., 2019) while the running activities at lower speeds might be unrelated to ranking. Furthermore, the distance covered with the ball was greater in the more successful teams in the Serie A League, particularly when running with the ball at > 14 km/h (Rampinini et al., 2009). When analysing the German Bundesliga, the total distance covered during matches, as well the number of running activities <18 km/h, were unrelated to the final points accumulated at the end of the season (Hoppe et al., 2015). Again, the running distance and the number of activities performed with ball possession were positively associated with ranking points and the running distance covered with the ball explained 60% of the variance in the final number of points accumulated. In contrast, in the Spanish LaLiga, both successful and unsuccessful teams presented the same running requirements at > 21 km/h and the running distance with ball possession was similar in teams classified for the Champions League and teams that relegated to an inferior category (Asian Clemente et al., 2019). While these investigations infer the importance of running with ball possession, the true influence of this action on overall football success is still unknown.

All previous investigations on this topic (Asian Clemente et al., 2019; Hoppe et al., 2015; Longo et al., 2019; Rampinini et al., 2009) have always analysed match running performance and its association with ranking points during one season. Thus, the outcomes of these investigations might be influenced by the effect produced by the running performance of extraordinary football players, in-season players' injuries, the signing of new players or even by the physical conditioning training by the teams' staff (Kattuman et al., 2019). Accordingly, the aim of this study was to determine the association between match running performance variables, with and without ball possession, and the number of points earned at the end a professional football league by using data on 4 complete seasons. We hypothesised that the teams with a higher number of ranking points would have higher values for all running performance variables performed when in possession of the ball.

2. Methods

This investigation is a descriptive correlational analysis to determine the importance of running with and without the ball in overall football performance. It includes a sample of 20 high-performance teams across 4 seasons (2015–2016 and 2018–2019) for a total of 1,520

Table 1. Points obtained by the teams competing in the last 4 seasons in the Spanish professional football league (*La Liga*).

Season	Champion	Champions League	Europa League	Middle	Relegation
20152016	91	≥ 64	≥ 60	≥ 39	≤ 38
20162017	93	≥ 72	≥ 64	≥ 35	≤ 31
20172018	93	≥ 73	≥ 60	≥ 43	≤ 29
20182019	87	≥ 61	≥ 59	≥ 41	≤ 37

matches. Overall football performance during the season was defined as the number of points earned during the season once the championship had finished (i.e. ranking points), a variable that has been previously used for this purpose (Brito Souza et al., 2019). Data were obtained from the Spanish Professional Football League (*La Liga*), which authorised the use of the variables included in this investigation. In accordance with *La Liga*'s ethical guidelines, this investigation does not include information that identifies football players. The Institutional Review Board of the Camilo José Cela University approved this investigation.

Table 1 contains information about the average ranking points obtained at the end of each season. It also highlights points obtained by the league champion (1^{st}), teams classified for the Champions League (2^{nd} – 4^{th}) and Europa League (5^{th} and 6^{th}), and the relegated teams (18^{th} – 20^{th}). Teams that did not fulfil these criteria were categorised as middle teams, because their points classified them in the middle of the ranking (7^{th} – 17^{th}). Seeking high applicability of the research outcomes to the real context in a professional football league, the variables used for this analysis were running distances covered with and without ball possession. For both situations, running distance covered at ≥ 21 km/h and at < 21 km/h were analysed. The data were extracted by the match statistics software Mediacoach®, a multicamera tracking system that can accurately assess player's running distances at different speeds while discriminating when the players are in possession of the ball. Briefly, Mediacoach® obtains information through a stereo camera system which is based on two multi-camera units placed at either side of the midfield line. Each multicamera is composed of three cameras with a resolution of 1920 × 1080 pixels and they are synchronised to provide a stitched panoramic picture, which is then used to create the stereoscopic view for triangulating the players and ball . It should be noted that optical tracking data might introduce errors in the analysis by occlusions, which is why one human operator is required to correct these errors during measurement. The validity of this semi-automatic software to assess movement demands during match play has been obtained through high agreement of the multicamera tracking analysis with the data obtained with GPS (Felipe et al., 2019; Pons et al., 2019) and with data obtained from a reference camera systems (i.e. VICON motion capture system (Linke et al., 2020)). Data on each variable was normalised as team's running distance per match to obtain easier-to-use information for coaches and physical conditioning staff. Because we used the accumulated match statistics and ranking points, we were required to use 80 comparative data points (20 teams per season and 4 seasons).

3. Statistical analysis

We set the significance level for the statistical analysis at $P < 0.05$ and all analysis and calculations were performed using the SPSS v.20 software package (SPSS Inc., USA).

Initially, we used the Levene test to verify sample homogeneity, and the Shapiro-Wilk test to verify normality in each variable (i.e. total running distance and running distance covered at ≥ 21 km/h and at < 21 km/h with and without ball possession). Descriptive means and standard deviations were calculated for all these variables within each group (Table 1). We used a one-way ANOVA to compare the means between groups (Champion vs. teams classified for the Champions League vs. teams classified for the Euro League vs. Middle teams vs. Relegation teams). After a significant F value was obtained in the ANOVA, the differences between groups were identified by performing pairwise comparisons and using Tukey post-hoc test. Afterwards, we used Pearson's correlation coefficient (r) to assess the association between all running variables of each team and the points obtained at the end of the season. Then, we performed a multiple regression analysis in a stepwise interactive mode to assess the influence that each running variable had on the points obtained at the end of the league. In the regression analysis, all match statistics were introduced based on their correlation with the residual ($p < 0.1$) and their intercorrelation with variables that already existed in the equation. By using a threshold of 3.5 points in the variance inflation factor (VIF), redundant variables were excluded to avoid multicollinearity. The produced regression equation was accepted at a significance level of $P < 0.01$. The r^2 values were adjusted for the number of cases and parameters in the analysis. Using the standardised regression coefficients, the relative contribution of each of the different variables in relation to the explained variances was calculated as follows (Puente et al., 2015).

Partial contribution r^2 adjusted = ([Standardised regression coefficient for parameter]/ Σ [of all standardised regression coefficients in equation]).

4. Results

Figure 1 depicts teams' total running distances per match according to their ranking position at the end of the competitive season. The ANOVA analysis revealed a main effect of the ranking position on total running distance ($P = 0.040$). On average, the league champion (105.6 ± 1.7 km/match) ran a shorter distance than the teams that classified for the Champions League (109.3 ± 2.5 km/match, $P = 0.05$), than the teams ranked in the middle of the classification (109.4 ± 2.3 km/match, $P = 0.02$), and the teams that were relegated to the second division (109.3 ± 2.3 km/match, $P = 0.04$). The differences in running distance between the league champion and the teams that classified for the Europa League (108.9 ± 1.7 km/match, $P = 0.15$) did not reach statistical significance. A similar main effect of ranking position was found on running distance at speeds <21 km/h ($P = 0.03$), where the league champion ran less distance than the Champions League teams ($P = 0.05$), Middle teams ($P = 0.01$) and Relegation teams ($P = 0.03$). However, all teams ran a similar distance at speeds >21 km/km ($P = 0.65$: Figure 1).

Figure 2 depicts teams' running distances per match with ball possession. The ANOVA analysis revealed a main effect of the ranking position on teams' total running distances with ball possession ($P < 0.01$). On average, the league champion and the teams classified for the Champions League ran a greater distance with possession than Middle teams ($P < 0.01$) and Relegation teams ($P < 0.01$). Regarding the running distance with ball possession at ≥ 21 km/h (ANOVA; $P < 0.01$), again the league champion and the

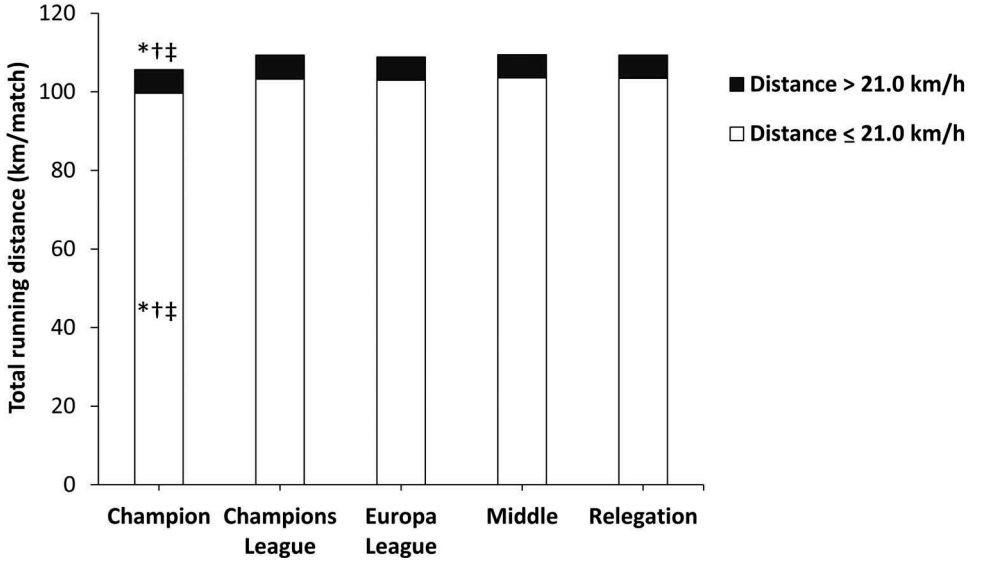

Figure 1. Total running distance per match in teams with different ranking categories in *La Liga*. (*) Different from champions league teams at $P < 0.05$; (†) Different from middle teams at $P < 0.05$; (‡) Different from relegation teams at $P < 0.05$.

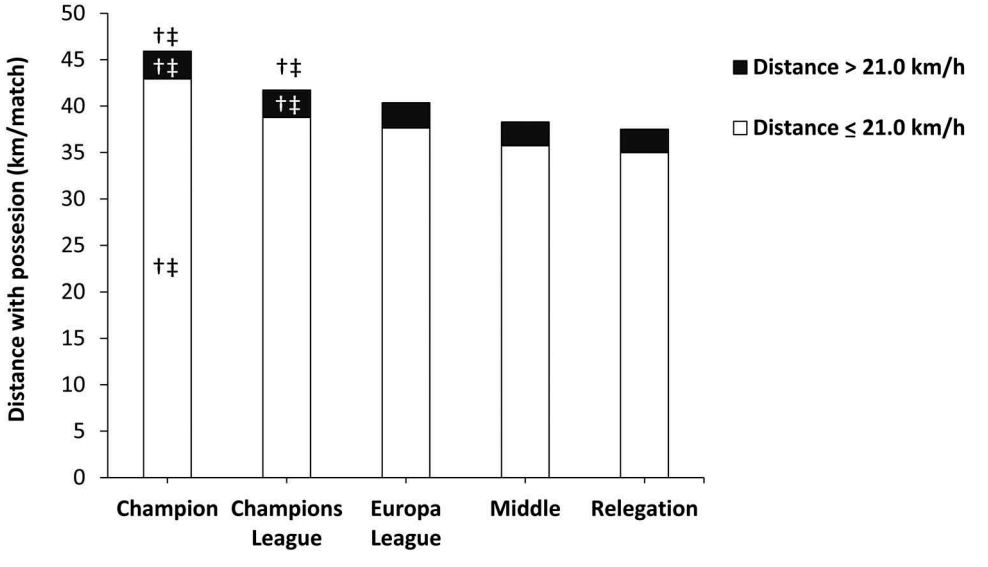

Figure 2. Running distance per match with ball possession in teams with different ranking categories in *La Liga*. (†) Different from middle teams at $P < 0.05$; (‡) Different from relegation teams at $P < 0.05$.

teams classified for the Champions League ran a greater distance than Middle teams ($P < 0.01$) and Relegation teams ($P < 0.01$) but only the league champion also ran a greater distance with the ball at < 21 km/h than Middle teams ($P < 0.01$) and Relegation teams ($P < 0.01$).

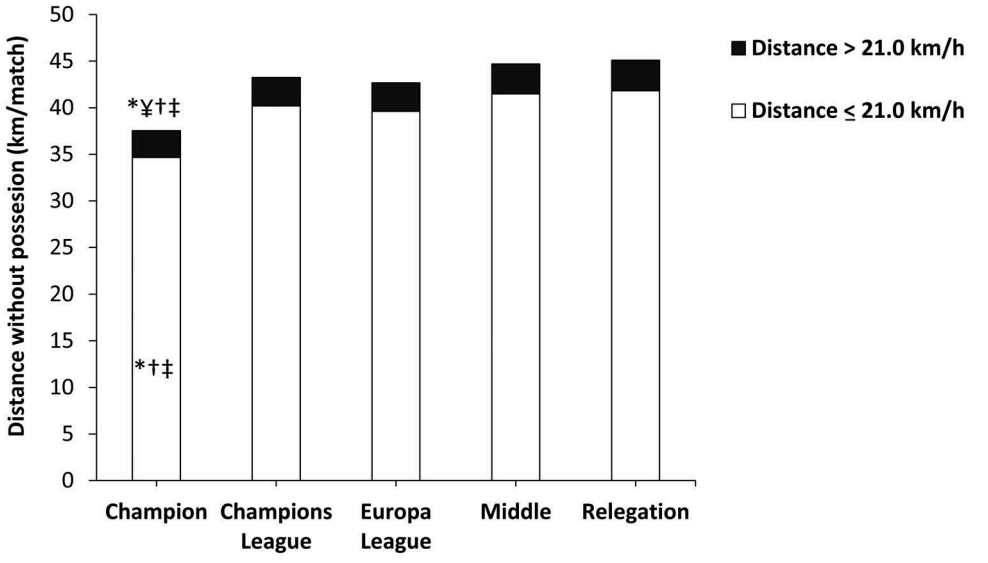

Figure 3. Running distance per match without ball possession in teams with different ranking categories in *La Liga*. (*) Different from champions league teams at $P < 0.05$; (¥) Different from Europa league teams at $P < 0.05$; (†) Different from middle teams at $P < 0.05$; (‡) Different from relegation teams at $P < 0.05$.

Figure 3 depicts teams' running distances per match without ball possession. The ANOVA analysis revealed a main effect of the ranking position on the running distance without ball possession ($P < 0.01$). Specifically, the league champion ran less distance that all the remaining teams ($P < 0.01$). This difference was due to a lower running distance at < 21 km/h in the league champion when compared to Champions League ($P = 0.04$), Middle ($P < 0.01$). and Relegation ($P < 0.01$) teams. In contrast, there was not any between-group difference in the distance covered without the ball at ≥ 21 km/h ($P = 0.06$).

Table 2 contains Pearson's correlation coefficients of the analysed variables with the ranking points at the end of the season. Neither total running distance nor distances above and below 21 km/h correlated to the points obtained at the end of the season. However, the distances covered with possession positively correlated with ranking points while the distances covered without possession negatively correlated to ranking points. Figure 4 depicts the variance in the points obtained as explained by the variables analysed. Overall, the multiple regression analysis explained 37.9% of the total variance in the number of points at the end of the seasons. The running distance with possession at ≥ 21 km/h was the variable that best explained the variance of the ranking points (18.1%), followed by distance with possession at < 21 km/h (13.9%). The running distances without possession explained less than 4% each.

5. Discussion

Previous investigations have found that match running performance poorly correlated with the final points accumulated during a national football league (Asian Clemente et al., 2019; Hoppe et al., 2015; Longo et al., 2019; Rampinini et al., 2009; Di Salvo et al., 2009).

Table 2. Pearson correlation coefficients (r) for the association between the points obtained at the end of the season and running distance with and without the ball.

Match running variables	R
Distance	−0.11
Distance ≥ 21 km/h	0.22
Distance < 21 km/h	−0.14
Distance with possession	0.52*
Distance with possession ≥ 21 km/h	0.57*
Distance without possession ≥ 21 km/h	−0.27*
Distance with possession < 21 km/h	0.50*
Distance without possession < 21 km/h	−0.36*

(*) The correlation was statistically significant at $P < 0.05$.

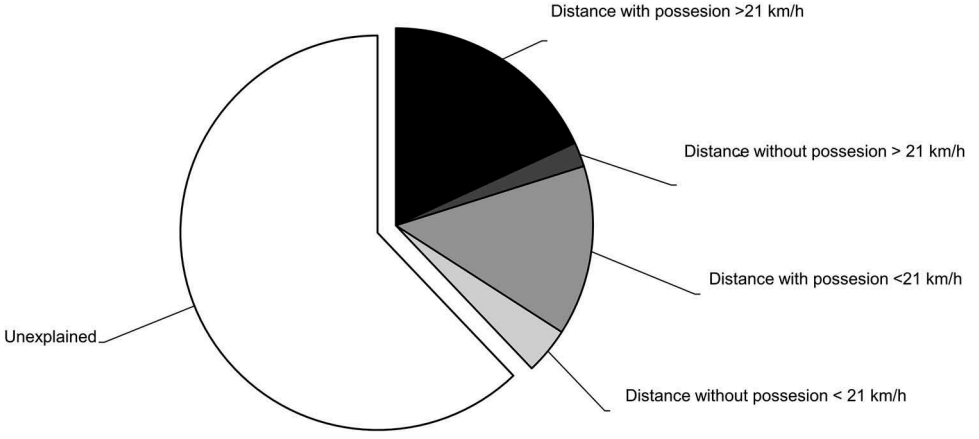

Figure 4. Percentage of variance in the number of points obtained at the end of the season as explained by running distances with or without ball.

In contrast, the running distance with ball possession and the number of football actions with the ball were positively associated with the ranking position at the end of the league, although this is not always the case (Asian Clemente et al., 2019). Overall, recent research points towards a positive association between match running actions with ball possession and success in football (Hoppe et al., 2015). The current investigation is innovative because it has analysed running patterns with and without ball possession according to the ranking points, to the classification for European competitions, and to the positions that led to relegation to an inferior category. The champion was the team with the lowest running distance per match (total and < 21 km/h; Figure 1) while the running distances was similarly high in teams classified for the Champions League, teams classified for the Europa League, teams in the Middle of the classification and Relegation teams. In contrast, both the league winner and the Champions League teams ran a greater distance with ball possession at both ≥21 and <21 km/h (Figure 2). In fact, the proportion of running distance with ball possession was the highest in the league champion (43.5% of the total running distance) followed by Champions League teams (38.2% of the total running distance) with ~36% of the running distance with the ball in the remaining

teams. These data indicate that more successful teams cover a high proportion of the total distance performed when they are in possession of the ball, so the running distance with ball possession might be a definitive variable to win the league, with less influence in the remaining positions of the ranking.

In recent years, the investigations aiming to detect successful playing patterns in football through the analysis of match statistics have proliferated along with the increasing popularity of this sport. Among them, one of the most sought factors has been ball possession (Casal et al., 2019). Evidence shows that successful teams in a national league normally have longer possession times than less successful teams (Carling, 2007; Jones et al., 2004). In addition, successful teams regain ball possession after losing it more quickly than worse-ranked teams (Vogelbein et al., 2014). However, high ball possession does not guarantee better football performance because there is evidence suggesting that ball possession might feature in teams that are either losing or trying to tie the match (Bradley et al., 2014; Lago-Peñas & Dellal, 2010). In addition, when accounting for the opponent team's quality and the home advantage, ball possession is no longer a predictor of success (Collet, 2013).

The current investigation, by including the analysis of 3 complete seasons, adds new information to this topic because it indicates that running actions at ≥ 21 km/h when in possession of the ball might be important to win the league or to classify for the Champions League while the relevance of running with the ball is lower in the remaining football teams. This finding is contrary to outcomes of Asian Clemente et al. (2019) when examining LaLiga 2013–2014 season. In that season, LaLiga was won by Atlético de Madrid while in the last 16 competitions the winners have been either Real Madrid or Barcelona. The difference between these two investigations might indicate that the influence of running with the ball on football success is a general outcome that might not apply to certain teams with distinct game styles. In addition, it raises the necessity of investigating several seasons when trying to determine the influence of running patterns on football success, to avoid the bias of running performance of unusual football players or teams (Kattuman et al., 2019). The higher running distance with the ball in the more successful teams, particularly at ≥ 21 km/h, might be related to technic-tactic components of the match play, indicating that players are prone to run fast when their teams are in possession of the ball to offer clear ways of passing or high-intensity actions to loss their marks. Interestingly, this might indicate that an effective manner of maintaining possession with constant player's movement rather than "keeping possession of the ball" is a characteristic of more successful teams in LaLiga. Although the running distance with the ball positively correlated with the points obtained at the end of the season (Table 2), the distance covered with ball possession in teams ranked from 5th to 20th positions was similar (Figure 2). Thus, it seems that ball possession, particularly when performing high-speed actions, might be a contributor to football success but it might be subjected to other technical and tactical skills more associated with victory such as shooting (Lepschy et al., 2018).

Match running performance variables only explained 37.9% of the variance in the points earned at the end of the season (Figure 4). Interestingly, the distances covered with ball possession (above and below 21 km/h) were the main contributors to the explained variance while the running distance without ball possession had minimal influence in the analysis. The variance explained for the number of ranking points with the current model was lower than the variance explained by including only the distance covered with ball

possession in the Bundesliga (i.e. 60% of variance; (Hoppe et al., 2015)). While the current investigation included the data on 4 complete seasons (2015–2016 to 2018–2019), the investigation by Hoppe et al. (2015) only analysed the Bundesliga season 2012/2013. It is probable that the game style of the teams that were successful in that particular season in the Bundesliga influenced the high variance explained by match running performance with ball possession in this investigation. In fact, a recent analysis of the influence of match statistics on teams' success in *La Liga* over a period of 8 years (Brito Souza et al., 2019) has found that 84.1% of the total variance in the number of points at the end of the seasons was explained by offensive statistics (high shooting accuracy and number of shots were the primary attacking match statistics) while 73.5% of the variance in the number of points was explained by defensive statistics (conceding a low number of the rival's shots and a low proportion of goals per shot conceded were the primary defensive match statistics). Together, all this information suggests that the match running activities might be associated with only one third of the ranking points obtained during a football league while almost two thirds of the variance in the ranking points are associated with football actions not directly related to match running. From a practical perspective and considering that football success might only be achieved with the optimal interaction of physical, technical and tactical capacities, these outcomes might indicate training of those match actions more associated with victory (e.g. shooting) should be prioritised over the training of physical conditioning variables. This is just speculation, and further research is necessary to confirm this suggestion.

The present investigation has some limitations that should be discussed to improve the applicability of its outcomes. A limitation of this study was that it was impossible to investigate match running performance with ball possession by using a more precise categorisation of running speeds. At this stage, Mediacoach software only categorises running actions with the ball above and below 21 km/h. To facilitate the comparison, we have also presented running actions without ball possession in these same two categories. In any case, this and previous investigations that have used different running speed categorisations (Hoppe et al., 2015; Rampinini et al., 2009) coincide in that the most important factor associated with ranking points at the end of the season is overall running distance with ball possession (irrespective of the velocity). Secondly, previous investigations have indicated that the quality of the opposing team and match location might also be important contributors to football success during a competitive league (Lago, 2009; Liu et al., 2016; Sarmento et al., 2014; Taylor et al., 2008). While these factors were not directly included in the analysis, the influence of these variables in the current investigation was minimal because the use of the end-season accumulated data for match running performance statistics and ranking points meant that all teams competed against the same rivals with an equal number of games played at home and away. Lastly, we did not obtain information about the sectors of the playing field where the running actions were developed. Future investigations should be geared to determining running actions, with and without the ball, in a specific area of the football pitch that might be more associated with football performance.

In conclusion, the league champion is the squad with the lowest running distance per match and the running distance per match was a poor contributor to the points earned during the league. Although it is often postulated that a high value of match running performance is important for achieving victory in a football competition, this

data indicates that running performance during matches was not associated with the ranking position at the end of the league. In contrast, the most successful football teams covered a greater distance with ball possession – particularly at ≥21 km/h – than less successful teams and the running distance with the ball positively correlated with the points at the end of the season. Still, the variance explained by including all match running performance variables was only 37.9% which means that the running actions during a match explain a low portion of the number of points available during a national league. From a practical perspective, these results suggest the convenience of focusing on training routines to improve high speed running actions with the ball. In particular, football teams should have a general playing style but also the capacity to modulate the team's style in depending on the quality of the rival, match location and match status (Aquino et al., 2017). Training methodologies that include physical conditioning exercises with the ball might be chosen over traditional physical training without the ball. Nevertheless, the low contribution of running with and without ball possession to the variance explained in the ranking points might point towards conceding more importance to the training of other technical and tactical skills than to the physical conditioning. As recently suggested, periodisation training emphasising technical-tactical content should be used to improve match running performance, especially at young ages (Palucci Vieira et al., 2019).

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Aquino, R., Munhoz Martins, G. H., Palucci Vieira, L. H., & Menezes, R. P. (2017). Influence of match location, quality of opponents, and match status on movement patterns in Brazilian professional football players. *Journal of Strength and Conditioning Research*, *31*(8), 2155–2161. https://doi.org/10.1519/JSC.0000000000001674

Asian Clemente, J., Requena, B., Jukic, I., Nayler, J., Santalla-Hernández, A., & Carling, C. (2019). Is physical performance a differentiating element between more or less successful football teams? *Sports*, *7*(10), 216. https://doi.org/10.3390/sports7100216

Bradley, P. S., Lago-Peñas, C., Rey, E., & Sampaio, J. (2014). The influence of situational variables on ball possession in the English Premier League. *Journal of Sports Sciences*, *32*(20), 1867–1873. https://doi.org/10.1080/02640414.2014.887850

Brito de Souza, D., López-Del Campo, R., Blanco-Pita, H., Resta, R., & Del Coso, J. (2019). An extensive comparative analysis of successful and unsuccessful football teams in LaLiga. *Frontiers in Psychology*, *10*, 2566. https://doi.org/10.3389/fpsyg.2019.02566

Brito Souza, D., López-Del Campo, R., Blanco-Pita, H., Resta, R., & Del Coso, J. (2019). A new paradigm to understand success in professional football: Analysis of match statistics in *LaLiga*

for 8 complete seasons. *International Journal of Performance Analysis in Sport*, *19*(4), 543–555. https://doi.org/10.1080/24748668.2019.1632580

Carling, C., Williams, A.M., Reilly, T. (2007). *Handbook of Soccer Match Analysis*: A Systematic Approach to Improving Performance. Routledge. New York, USA. pp. 164 . https://doi.org/10.4324/9780203448625

Casal, C. A., Anguera, M. T., Maneiro, R., & Losada, J. L. (2019). Possession in football: More than a quantitative aspect - A mixed method study. *Frontiers in Psychology*, *10*, 1–12. https://doi.org/10.3389/fpsyg.2019.00501

Collet, C. (2013). The possession game? A comparative analysis of ball retention and team success in European and international football, 20072010. *Journal of Sports Sciences*, *31*(2), 123–136. https://doi.org/10.1080/02640414.2012.727455

Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in premier league soccer. *International Journal of Sports Medicine*, *30*(3), 205–212. https://doi.org/10.1055/s-0028-1105950

Felipe, J. L., Garcia-Unanue, J., Viejo-Romero, D., Navandar, A., & Sánchez-Sánchez, J. (2019). Validation of a video-based performance analysis system (Mediacoach®) to analyze the physical demands during matches in LaLiga. *Sensors (Switzerland)*, *19*(19), 19. https://doi.org/10.3390/s19194113

Harper, D. J., Carling, C., & Kiely, J. (2019, December 1). High-intensity acceleration and deceleration demands in elite team sports competitive match play: A systematic review and meta-analysis of observational studies. *Sports Medicine*, *49*(12), 1923–1947. https://doi.org/10.1007/s40279-019-01170-1

Hoppe, M. W., Slomka, M., Baumgart, C., Weber, H., & Freiwald, J. (2015). Match running performance and success across a season in German Bundesliga soccer teams. *International Journal of Sports Medicine*. *36*(7): 563-6. https://doi.org/10.1055/s-0034-1398578

Jones, P. D., James, N., & Mellalieu, S. D. (2004). Possession as a performance indicator in soccer. *International Journal of Performance Analysis in Sport*, *4*(1), 98–102. https://doi.org/10.1080/24748668.2004.11868295

Kattuman, P., Loch, C., & Kurchian, C. (2019). Management succession and success in a professional soccer team. *Plos One*, *14*(3), e0212634. https://doi.org/10.1371/journal.pone.0212634

Lago, C. (2009). The influence of match location, quality of opposition, and match status on possession strategies in professional association football. *Journal of Sports Sciences*, *27*(13), 1463–1469. https://doi.org/10.1080/02640410903131681

Lago-Ballesteros, J., & Lago-Peñas, C. (2010). Performance in team sports: Identifying the keys to success in soccer. *Journal of Human Kinetics*, *25*(1), 85–91. https://doi.org/10.2478/v10078-010-0035-0

Lago-Peñas, C., & Dellal, A. (2010). Ball possession strategies in elite soccer according to the evolution of the match-score: The influence of situational variables. *Journal of Human Kinetics*, *25*(1), 93–100. https://doi.org/10.2478/v10078-010-0036-z

Lepschy, H., Wäsche, H., & Woll, A. (2018). How to be successful in football: A systematic review abstract. *The Open Sports Sciences Journal*, *11*(1), 3–23. https://doi.org/10.2174/1875399X01811010003

Linke, D., Link, D., & Lames, M. (2020). Football-specific validity of TRACAB's optical video tracking systems. *PLoS ONE*, *15*(3), 3. https://doi.org/10.1371/journal.pone.0230179

Liu, H., Gómez, M. A., Gonçalves, B., & Sampaio, J. (2016). Technical performance and match-to-match variation in elite football teams. *Journal of Sports Sciences*, *34*(6), 509–518. https://doi.org/10.1080/02640414.2015.1117121

Longo, U. G., Sofi, F., Candela, V., Dinu, M., Cimmino, M., Massaroni, C., Schena, E., & Denaro, V. (2019). Performance activities and match outcomes of professional soccer teams during the 2016/2017 serie A season. *Medicina (Kaunas, Lithuania)*, *55*(8): 469. https://doi.org/10.3390/medicina55080469

Palucci Vieira, L. H., Carling, C., Barbieri, F. A., Aquino, R., & Santiago, P. R. P. (2019, February 14). Match running performance in young soccer players: A systematic review. *Sports Medicine*, *49*(2), 289–318. https://doi.org/10.1007/s40279-018-01048-8

Pons, E., García-Calvo, T., Resta, R., Blanco, H., López Del Campo, R., Díaz García, J., & Pulido, J. J. (2019). A comparison of a GPS device and a multi-camera video technology during official soccer matches: Agreement between systems. *PloS One*, *14*(8), e0220729. https://doi.org/10.1371/journal.pone.0220729

Puente, C., Del Coso, J., Salinero, J. J., & Abián-Vicén, J. (2015). Basketball performance indicators during the ACB regular season from 2003 to 2013. *International Journal of Performance Analysis in Sport*, *15*(3), 935–948. https://doi.org/10.1080/24748668.2015.11868842

Rampinini, E., Impellizzeri, F. M., Castagna, C., Coutts, A. J., & Wisløff, U. (2009). Technical performance during soccer matches of the Italian Serie A league: Effect of fatigue and competitive level. *Journal of Science and Medicine in Sport*, *12*(1), 227–233. https://doi.org/10.1016/j.jsams.2007.10.002

Sarmento, H., Anguera, M. T., Pereira, A., & Araújo, D. (2018). Talent identification and development in male football: A systematic review. *Sports Medicine*, *48*(4), 907–931. https://doi.org/10.1007/s40279-017-0851-7

Sarmento, H., Marcelino, R., Anguera, M. T., CampaniÇo, J., Matos, N., & LeitÃo, J. C. (2014). Match analysis in football: A systematic review. *Journal of Sports Sciences*, *32*(20), 1831–1843. https://doi.org/10.1080/02640414.2014.898852

Taylor, J. B., Mellalieu, S. D., James, N., & Shearer, D. A. (2008). The influence of match location, quality of opposition, and match status on technical performance in professional association football. *Journal of Sports Sciences*, *26*(9), 885–895. https://doi.org/10.1080/02640410701836887

Vogelbein, M., Nopp, S., & Hökelmann, A. (2014). Defensive transition in soccer - are prompt possession regains a measure of success? A quantitative analysis of German Fußball-Bundesliga 2010/2011. *Journal of Sports Sciences*, *32*(11), 1076–1083. https://doi.org/10.1080/02640414.2013.879671

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Influence of Players' Maximum Running Speed on the Team's Ranking Position at the End of the Spanish *LaLiga*

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Abstract: The maximum running speed that a football player can attain during match play has become one of the most popular variables to assess a player's physical talent. However, the influence of a player's maximum running speed on football performance has not yet been properly investigated. The aim of this study was to determine the influence of a player's peak/maximum running speed on the team's ranking position at the end of a national league. A second aim was to investigate differences in maximum running speed among playing positions. To fulfil this aim, the peak/maximum running speeds of 475 male professional football players were recorded for 38 fixtures of the Spanish first-division league (*LaLiga*) from the 2017–2018 season (7838 data points). Players' peak running speeds in each match were assessed with a validated multicamera tracking system and associated software (Mediacoach®). Players' maximum running speed was established as the fastest running speed they attained during the entire season. Most players (53.5% of the total) had a maximum running speed in the range of 32.0–33.9 km/h, with only three players (0.6%) with a maximum running speed of over 35.0 km/h. Overall, forwards were faster than defenders and both types of players were faster than midfielders (33.03 ± 1.35 > 32.72 ± 1.32 > 32.08 ± 1.63 km/h; $p < 0.001$). There was no association between teams' maximum running speed and ranking position at the end of the league ($r = -0.356$, $p = 0.135$). The correlations between teams' maximum speeds and ranking position were low for defenders ($r = -0.334$, $p = 0.163$), midfielders ($r = 0.125$, $p = 0.610$), and forwards ($r = -0.065$, $p = 0.791$). As a result, the variance in the ranking position at the end of the season explained by a team's maximum speed was of only 7.5%. Finally, as an average for all teams, players' peak running speeds remained stable at ~30.7 ± 0.6 km/h throughout the whole season. These results suggest that successful and less successful football teams have squads with players able to obtain similar maximum running speeds during match play throughout the season. Hence, players' maximum running speeds have a poor association with the team's ranking position at the end of the Spanish professional national league.

Keywords: soccer; match analysis; team sports performance; exercise training; velocity

1. Introduction

Modern professional football (soccer) is a highly demanding team sport characterized by a succession of high intensity actions performed intermittently. These actions, particularly the ones

performed in close proximity to the ball, require high values of speed, strength, power, and agility [1]. However, football performance also depends on a variety of individual technical and tactical skills, and on constant interaction with teammates. Therefore, several physical, technical, and tactical capabilities must be well developed to become a successful professional player [2]. In the last few years, research has shifted the focus of the physical determinants in football, conceding more relevance to anaerobic-based actions instead of the traditional view of football as an aerobic-based team sport. In this regard, high intensity running and sprinting account for only ~10% of the total distance covered during a match [3,4], but high-intensity running is a key element to discriminate between elite football players and players of a lower competitive level [5]. Professional football players have become faster over time [2], with a greater capacity to cover a large volume of running at high intensity during matches [6]. On the other hand, players' aerobic capacity has slightly decreased over the time [7]. Additionally, through the use of principal component analysis (PCA), a technique to discriminate the physical performance variables which are more relevant for football performance, it has been demonstrated that high speed running is within the variables that best describe the profile of the physical demands during an official match [8,9]. Overall, this information suggests that a player's capacity to cover a high volume of running at high intensity is a crucial determinant of modern football success.

During a competitive match, football players perform a high intensity action every 30 to 90 s, and each high-intensity action lasts, on average, from 2 to 4 s [10]. Hence, from a physical perspective, players perform short-term but continuous high intensity actions interspersed with recovery periods that may vary depending on the evolution of the game. In elite football, players can perform more than 150 intense actions during a match [4], but most of them are not performed at maximum speed. The number of these actions increases with the level of play [2], varies with the playing position on the field [5] with a higher number of sprints and distance at sprint velocity in wide midfielders than in other positions [11], and rises over the course of a season [12]. Interestingly, straight sprinting is the most frequent action prior to scoring a goal [13] and the possession of a high value of maximum running speed is key for overtaking opponents and winning disputed balls. Furthermore, high values of maximum running speed may also reduce the relative neuromuscular load during a match [14] as any action at a given running speed will represent a lower fraction of a player's maximum speed. Still, it is important to note that the distance covered at high intensity during the competition is not a unique factor associated to football success. In fact, some researchers have suggested that the contribution of the distance covered at high intensity to overall performance is very limited [15], while the distance covered with the possession of the ball is more relevant [16]. Last, the relevance of high intensity running for performance may vary from match to match due to contextual variables such as match location, match outcome, or the level of the opponent [9].

Match-play situations requiring maximum or near-to-maximum running speeds are rarely produced during the game, although they are performed at critical moments. For this reason, the maximum running speed that a football player can attain during match play has become one of the most popular variables to assess a player's physical performance. Overall, the mean of maximum sprinting velocity of professional football players is normally between 31 and 32 km/h [5], but there are professional players with running speeds ranging from 29 to 33 km/h [17]. However, the majority of high intensity runs in football are shorter than 20 m, which precludes reaching maximum running speeds. Hence, the value of maximum running speed and the distance that a player could cover at high intensity are sometimes unrelated. For example, wide midfielders and external defenders perform more high-intensity running and sprinting [10], but the fastest players are usually the forwards [18]. To date, the influence of players' maximum running speed on the overall team's football performance has not yet been properly investigated. As mentioned above, it is clear that the possession of a high running speed and the capacity to repeat sprints over the time during a competitive match are both potentially beneficial factors for football performance. Nevertheless, to date, it is unknown if it is better to direct players' physical conditioning to obtain formidable high maximum speeds or to direct training

to obtain players able to produce sprints of lower/submaximal velocity but with a higher capacity of repeating them over time. For this reason, the aim of this study was to determine the influence of players' maximum running speed on the team's ranking at the end of a national league. This objective was intended to evaluate the relevance of players' maximum speed on football performance during a national football league. A second aim was to investigate differences in maximum running speed among playing positions. We hypothesized that more successful football teams (i.e., the ones in the first ranking positions at the end of the season) would have squads with the fastest players in all field positions, in comparison to worse-ranked teams. Additionally, forwards will be faster than any other field position.

2. Materials and Methods

2.1. Participants

The study sample was composed of 475 football players competing in the Spanish first-division football league (*LaLiga*) during the 2017–2018 season. This corresponds to the entire population of professional football players that competed at least for 30 min in the 2017–2018 season. From the total, 175 players were defenders, 196 were midfielders, and 105 were forwards (36.8/41.3/21.9%, respectively). The number of players per team and per playing position in the field, in addition to their maximum running speeds during the season, are detailed in Table 1. Of note, data from the players competing in the team classified in 13th position were not used in this investigation, as none of the matches played in its stadium reported data on running actions during the 2017–2018 season. In accordance with *LaLiga*'s ethical guidelines, this investigation does not include information that identifies football players. The Institutional Review Board of the Camilo José Cela University approved this study, which is in accordance with the latest version of the Declaration of Helsinki.

Table 1. Number of players and players' maximum running speed according to the team's ranking in the 2017–2018 season of *LaLiga* championship.

Ranking	Total	Defender	Midfielder	Forward
1st	22 32.8 ± 1.2	9 33.1 ± 1.0	8 32.0 ± 1.3	5 33.5 ± 1.0
2nd	23 32.8 ± 1.6	8 33.1 ± 1.1	9 31.8 ± 2.0	6 33.8 ± 0.7
3rd	21 33.4 ± 1.5	8 34.1 ± 1.0	9 32.8 ± 1.5	4 33.1 ± 1.8
4th	23 33.0 ± 1.2	9 33.0 ± 0.5	11 32.9 ± 1.5	3 33.9 ± 1.4
5th	27 32.0 ± 1.6	9 32.2 ± 1.5	12 31.5 ± 1.7	6 32.9 ± 1.3
6th	24 32.7 ± 1.3	9 33.2 ± 0.8	7 32.5 ± 0.8	8 32.4 ± 1.9
7th	28 32.1 ± 1.7	10 32.0 ± 1.3	13 31.9 ± 2.0	5 32.8 ± 1.4
8th	26 32.1 ± 1.6	10 32.1 ± 1.5	9 31.0 ± 1.4	7 33.5 ± 1.2
9th	23 32.8 ± 1.6	8 32.8 ± 1.4	11 32.6 ± 2.0	4 33.1 ± 0.9
10th	20 32.8 ± 1.3	8 33.0 ± 1.5	8 32.3 ± 1.4	4 33.3 ± 0.8
11th	23 32.4 ± 1.4	8 32.4 ± 1.7	11 32.0 ± 1.2	4 33.4 ± 1.0
12th	22 32.3 ± 1.7	9 32.2 ± 2.1	7 32.4 ± 1.2	6 32.4 ± 1.9
14th	27 32.5 ± 1.5	8 32.8 ± 1.4	12 32.1 ± 1.7	7 32.6 ± 1.3

Table 1. *Cont.*

Ranking	Total	Defender	Midfielder	Forward
15th	29 32.6 ± 1.4	9 33.3 ± 0.7	11 32.5 ± 1.8	9 31.9 ± 1.1
16th	23 32.6 ± 1.2	11 32.9 ± 1.1	8 31.9 ± 1.1	4 33.3 ± 1.1
17th	23 32.8 ± 1.7	9 32.9 ± 1.1	10 32.2 ± 2.1	4 34.3 ± 0.7
18th	27 32.2 ± 1.8	11 32.1 ± 1.7	13 31.8 ± 1.8	3 34.1 ± 0.2
19th	33 32.5 ± 1.3	11 32.6 ± 1.0	15 31.9 ± 1.4	7 33.4 ± 0.8
20th	31 32.3 ± 1.5	11 32.3 ± 1.2	12 32.0 ± 1.8	8 32.6 ± 1.7

Note: There were no data for the team classified in 13th position.

2.2. Procedures

This investigation is a descriptive and comparative analysis to determine the importance of players' maximum/peak running speeds on football performance. Data were obtained from *LaLiga*, which authorized the use of the variables included in this investigation. The Spanish national first-division football league is composed of 20 teams competing in a total of 38 fixtures (for a total of 380 matches for season). Data from the matches of the team classified in 13th position were excluded from the investigation because the multicamera tracking system was not installed in its stadium during the season under investigation. Hence, this investigation contains data on 361 matches played across 38 fixtures. In each fixture, players' peak running speed, defined as the highest running speed attained in a particular match, was obtained and recorded for all the field players, for a total of 7838 values across the season. Only peak running speeds of players competing during at least 30 min in the match were considered for analysis to ensure that the players had time to produce a football action at high/peak intensity. Maximum running speed was defined as the highest running speed obtained by a player during the entire season, using all the values recorded by this player during all the matches he participated in for at least 30 min. The data on goalkeepers were excluded due to the different nature of their movement patterns during the game. To determine the influence of players' peak/maximum running speeds on football performance, a comparison was made of the individual and team average running speeds (1) according to the ranking position at the end of the season and (2) according to ranking categories as follows: the league champion (1st); teams classified for the Champions League (2nd–4th); teams classified for the Europa League (5th and 6th); teams in the middle of the ranking (7th–17th); and the relegated teams (18th–20th). An analysis of teams' maximum speeds depending on the playing position was also performed by using three positions: defenders, midfielders, and forwards.

2.3. Instrument

Data on peak/maximum running speeds were extracted using the match statistics software Mediacoach® (*LaLiga*, Madrid, Spain), a multicamera tracking system that can accurately assess the instantaneous running speed of all the players on the field. Briefly, Mediacoach® records the position of each player at 25 frames per second using a stereo multicamera system composed of two multicamera units placed at either side of the midfield line. Each multicamera unit contains three cameras with a resolution of 1920 × 1080 pixels, which are synchronized to provide a stitched panoramic picture. The panoramic picture is then employed to create the stereoscopic view that allows triangulating of all the players on the field and the ball. In the case of a lack of location of a player due to occlusions by another player, an experienced operator manually corrected the position during measurement. This correction is common in corners and fouls but rarely occurs during actions where players obtained their peak/maximum running speeds. Hence, the manual corrections had minimal relevance for the

objectives of this investigation. The validity of this software to assess movement demands during match play has been obtained through high agreement with the data obtained with GPS [19,20] and with data obtained from a reference camera system (i.e., VICON motion capture system [21]).

2.4. Statistical Analysis

We set the significance level for the statistical analysis at $p < 0.05$ and all analyses and calculations were performed using the SPSS v.20 software package (IBM, Armonk, NY, USA). Initially, we used the Levene test to verify sample homogeneity and the Kolmogorov–Smirnov test to verify the normality of peak/maximum running speeds. Descriptive means and standard deviations were calculated in each team and for each playing position (Table 1). We used a one-way analysis of variance (ANOVA) of repeated measures to compare peak running speeds among the 38 fixtures that comprised the championship. We used a two-way ANOVA (fixture x ranking category) to determine differences in the evolution of maximum running speed across the season among the ranking groups. The number and distribution of players according to their maximum running speeds were calculated using 1.0 km/h intervals. A two-way ANOVA (playing position x ranking) was used to search for differences among teams in the maximum running speed for any playing position. In the case of a significant F value in the ANOVAs, the differences between groups were identified by Tukey post hoc tests. For the differences in maximum running speed between playing positions, the effect size was calculated in Cohen's *d* units [22]. Pearson's correlation coefficients (*r*) were used to assess the association between a team's maximum running speed and ranking position at the end of the season. The size of a correlation coefficient was evaluated following Hinkle et al. [23]. Then, a multiple regression analysis was carried out in a stepwise interactive mode to assess the influence that a team's maximum running speed had on the ranking position the end of the league. In the regression analysis, all match statistics were introduced based on their correlation with the residual ($p < 0.1$) and their intercorrelation with variables that already existed in the equation. The r^2 values were adjusted for the number of cases and parameters included in the analysis [24].

3. Results

Figure 1 depicts the peak running speeds obtained by the football teams during the season. In the upper panel, the data include the mean of all teams competing in *LaLiga* in each of the 38 fixtures that comprised the championship, and the one-way ANOVA revealed no statistically significant differences in the values of peak running speed among the different fixtures ($F = 1.282$; $p = 0.372$). In the lower panel, peak running speeds are presented according to different ranking groups. The two-way ANOVA revealed no main effect of the ranking group in the maximum running speeds obtained during the season ($F = 2.191$; $p = 0.134$).

The number of players distributed according to their maximum running speeds during the 2017–2018 season is presented in Figure 2. Most players (53.5%) were in the range of 32.0–33.9 km/h, with 71 players (14.9%) surpassing 34.0 km/h and only 3 players (0.6%) with maximum running speeds of over 35.0 km/h. Still, there were 27 players (5.7%) who did not reach 30.0 km/h during the competitive season. Nevertheless, teams' maximum speeds were unrelated to the end of season ranking position obtained, as the one-way ANOVA revealed no differences in the maximum running speed values among the different teams competing in *LaLiga* ($F = 1.308$; $p = 0.177$). Additionally, the correlation coefficient between teams' maximum speeds and ranking position was low ($r = -0.356$, $p = 0.135$).

There was a main effect of the playing position on maximum running speed ($F = 18.765$; $p < 0.001$). Overall, forwards were the fastest players (33.03 ± 1.35 km/h) with a higher maximum running speed than defenders (32.72 ± 1.32 km/h; $p = 0.025$, $d = 0.23$) and midfielders (32.08 ± 1.63 km/h; $p < 0.001$, $d = 0.63$). Defenders were also faster than midfielders (Figure 3; $p < 0.001$, $d = 0.43$). However, there was not any interaction between the ranking position of the team and the playing position (Table 1; $F = 0.897$; $p = 0.643$). The correlation coefficient between teams' maximum speeds and ranking position was low for defenders ($r = -0.334$, $p = 0.163$) and small for midfielders ($r = -0.125$, $p = 0.610$) and forwards

(r = −0.065, $p = 0.791$). Finally, the variance in the ranking position obtained at the end of the league as explained by the team's maximum speed was of only 7.5% (contribution r^2 adjusted = 0.075, $p = 0.427$).

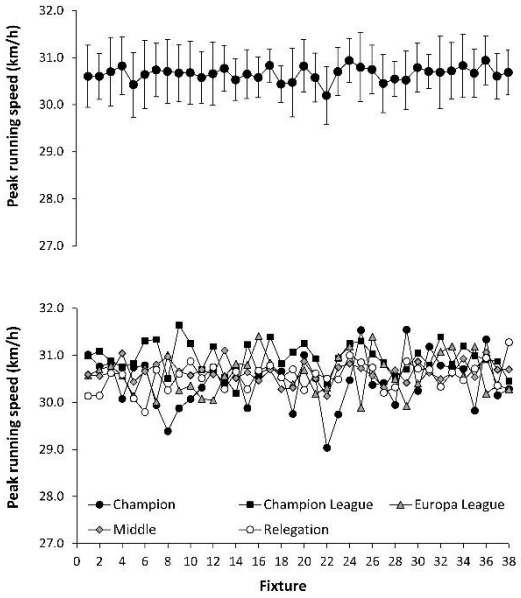

Figure 1. Peak running speed (**upper panel**) and peak running speed in teams with different ranking categories (**lower panel**) across *LaLiga* 2017–2018.

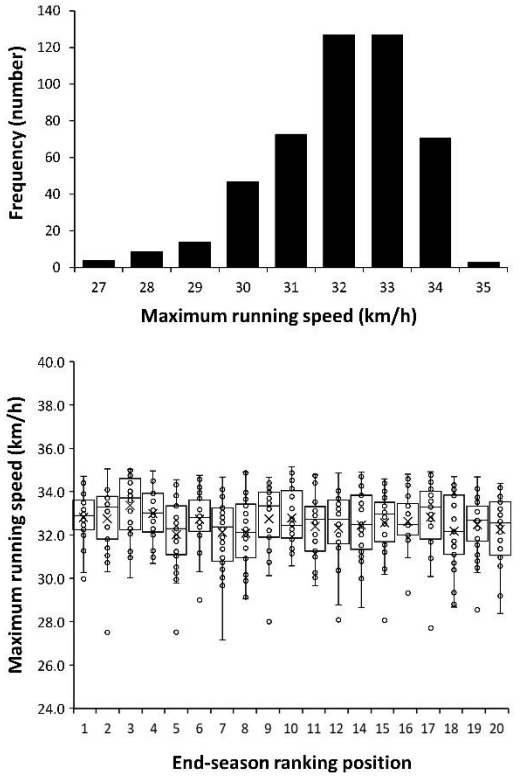

Figure 2. Number of players according to their maximum running speed (**upper panel**) and individual maximum running speed according to the end-season ranking position of the teams competing in *LaLiga* 2017–2018 (**lower panel**). Data represent the maximum running speed obtained by each player in the 2017–2018 season. Note: There were no data for the team classified in 13th position.

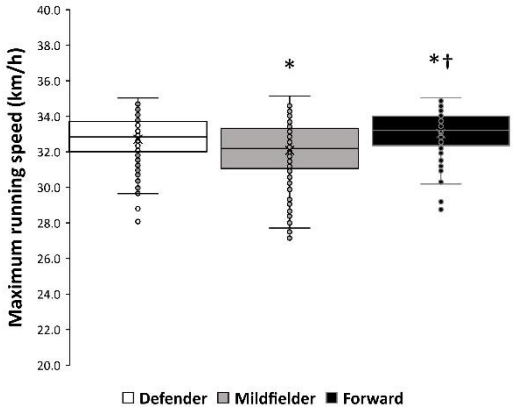

Figure 3. Individual maximum running speed according to the playing position in the field in *LaLiga* 2017–2018. (*) Different from defender at $p < 0.05$. (†) Different from midfielder at $p < 0.05$.

4. Discussion

With the incorporation of microtechnology into elite football (mainly, the use of Global Positioning System devices and multicamera tracking systems), sport scientists and physical trainers are now analyzing a high number of physical and physiological variables that may have the potential to contribute to overall football performance. This represents, in most cases, an excess of data that complicates the understanding of what variables are important for the game [8]. Additionally, the existence of a high number of variables may lead to oversimplification of the game by using them to categorize players. In this regard, the maximum running speed that a player can obtain during a match has become a widely used variable to assess a player's physical talent, despite the evidence to argue that this variable is important for a player's and team's performance being scarce. Peak/maximum running speed represents one single action during the match, while professional football players perform more than 150 intense actions during match play [4]. Hence, the potential evaluation of a player's physical talent, by using only one action during match play, may lead to incorrect assumptions, at least in elite football. Despite the popularity of this performance variable, we are not aware of any previous investigations that have aimed to determine the influence of players' peak/maximum running speeds on the team's overall football performance. The current investigation presents an analysis of the fluctuations of peak running speeds obtained during matches throughout a complete season of *LaLiga*. In addition, the players' maximum running speeds have been compared to the ranking obtained at the end of the championship, while differences in maximum running speed among playing positions have been analyzed. Overall, the current investigation demonstrates that peak running speed was maintained relatively constant throughout the championship, a characteristic shared by the Champion, the teams classified for the Champions League, the teams classified for the Europa League, middle teams, and the relegated teams (Figure 1). Additionally, all teams competing in *LaLiga* had squads with comparable maximum running speeds, irrespective of their ranking position at the end of the championship (Figure 2). The similarity in maximum running speeds among teams was equally present in defenders, midfielders, and forwards (Table 1), although forwards were the fastest players in each team (Figure 3). In addition, the correlation coefficient between teams' maximum speed and ranking position was low and the variance in the ranking position obtained at the end of the league explained by team's maximum speed was of only 7.5%. Together, this information points towards a poor association between players' maximum/peak running speeds and the team's overall football performance during a national league. This notion does not dispute the importance of covering high volumes at high intensity for football performance but suggests that most, if not all, professional teams in *LaLiga* possess players able to reach over 30 km/h, limiting the discriminatory utility of maximum running speeds to distinguish between better- and worse-ranked teams.

Recently, it has been found that football teams competing in a national football league needed 8–10 fixtures from the beginning of the season until they reached a plateau in match running performance [12]. The necessity of competing in 8–10 matches before reaching a steady-state physical performance was evident for the running distance at over 24 km/h and for the number of running actions performed above this threshold. However, the current analysis indicates that on average for all the teams competing in *LaLiga*, players' peak running speeds were 30.6 ± 0.7 km/h for the first fixture, and a comparable value was obtained throughout the competition (Figure 1). This result suggests that professional football players are able to reach maximum or near-to-maximum running velocities from the first competitive match, even when they are not ready to perform a large volume of high intensity running. While maximum running speed during a match is mainly related to mechanical determinants aimed to produce great vertical ground reaction forces per unit of body mass [25,26], the capacity to produce a high amount of running actions at high intensity is more related to metabolic parameters such as the capacity to supply energy from different pathways during the running action and during the recovery, and the ability to reduce the intramuscular accumulation of metabolic by-products [27,28]. Therefore, it seems that professional football players possess the mechanical capacity to perform at least one running action at very high speed from the beginning of the championship, but they need several fixtures to obtain the physiological adaptations to produce high values of running distance at high intensity and sprinting velocities.

Peak running speed and the amount of running performed at high intensity are physical variables that represent different performance outcomes during a match [17]. Peak running speed is normally obtained during an offensive or defensive football action without the ball and in a field position that allows the distance necessary to obtain appropriate acceleration and maximum velocity. Players obtain their peak running speed during a critical action of the game but this represents only one of the hundreds of high intensity actions and dozens of sprints performed during a match [2,4]. Accordingly, while several previous investigations have coincided in establishing the importance of high intensity running during a match for overall football performance [2,4,5], the current investigation suggests that players' peak/maximum running speeds are comparable in all teams competing in *LaLiga*, irrespective of their ranking and competitive level.

In this regard, the distance covered at over 21 km/h during a national league has a modest capacity to discriminate between successful and less successful teams, especially if the distance is covered with the ball [16]. However, the utility of the physical demands during a match to predict football performance is lower when compared to match statistics such as shooting accuracy, the number of shots performed, and the capacity to prevent the rival from shooting [29,30]. All this information points towards a poor capacity of teams' maximum running speeds to anticipate the football performance of a squad. From a practical perspective, this information also suggests the convenience of focusing training on more useful determinants of football performance like the development of a high capacity to repeat sprints during a match and tactical and strategic interventions to enhance shooting efficacy, reducing the time devoted to improving players' maximum running speeds.

The upper panel in Figure 2 indicates that 94.3% of players (448 out of 475) competing in *LaLiga* are capable of running at over 30.0 km/h. Only three players were able to run at over 35.0 km/h, while the fastest players reached 35.2 km/h. Overall, most players were able to obtain sprinting velocities between 32 and 33 km/h (Figure 2). Although these values of maximum running speed are excellent for football players [5,17], they are much lower than the peak velocity obtained by elite-level athletes during sprint events [2]. Furthermore, the presence of this high number of players running at over 30 km/h hinders the capacity of using maximum speed actions to overcome rivals during match play. Midfielders and defenders perform more high-intensity running and sprinting [10] but, as previously suggested, the fastest players are usually the forwards [18]. This pattern was found in most teams in the present investigation (Table 1) and suggests that the playing field position of a defender has evolved to become a position with fast players to increase their aptitude to defend against fast forward players, and vice versa.

The current investigation presents some limitations that should be discussed to improve the applicability of its outcomes to overall football performance. First, this investigation contains a notational analysis of peak/maximum running speed in a sample of professional football players competing in a national league (*LaLiga*). By using different statistics (e.g., simple and multiple correlations and groups comparison), we have contrasted team peak/maximum running speed of successful and less successful football teams in *LaLiga*. While this analysis is useful to understand the relevance of players' maximal running speed on the ranking position obtained in the competition, football performance is a complex construct that is influenced by a myriad of intrinsic and extrinsic factors, the one analyzed here being only one of them. In fact, it may be argued that the current analysis is reductionist because it omits the "why", "where", and "how" of the actions that lead to peak/maximum running speed [31]. In this regard, football actions requiring maximum or peak running speeds represent a low portion of the total number of high-intensity actions executed during a match, but the context in which they are performed is critical because it demands the player to obtain his/her maximal effort. Future investigations with more ecological approaches should be carried out to establish the relevance of peak/maximum running speeds in a more complex dynamic environment [32], including the cause of the sprint action, the location on the pitch of the sprint action, the main outcome of the sprint action, and the interactions of the player performing the sprint action with his/her teammates and rivals.

From a practical perspective, and of the opinion of the authors of the current research, physical training in elite football should be more focused on enhancing the ability to repeat sprints of sub-maximum intensity (e.g., between 21 and 30 km/h) to obtain high volumes of running distance at >24 km/h, rather than on improving players' maximum running speed. This is important as the training routines used for such objectives may be substantially different. Additionally, a key portion of physical and conditioning training should be devoted to increasing a player's capacity to accelerate/decelerate in short distances as they perform four times as many accelerations as reported sprints per match [33]. Lastly, the physical training devoted to developing maximum running speed could be focused on ensuring that players obtain at least 30–32 km/h of peak velocity during match play, as this is the peak running speed that most players produce during a game. The obtaining of higher velocities will likely impact on a few actions during the game, but as suggested by the results of this study, they will have low influence on the overall team performance at the end of the league. Of note, the utility of possessing a team squad with players able to obtain high peak/maximum running speeds may depend on the playing style. It is probable that teams with direct play when attacking and exerting high pressure while defending may benefit from faster players.

5. Conclusions

In summary, successful and less successful football teams competing in *LaLiga* have squads with players able to obtain similarly high maximum running speeds during match play. In addition, players of successful and less successful teams are capable of obtaining peak running speeds from the first fixture of the competition and maintain it across the season. Although football is a sport with a relatively low number of goals, and the goals are habitually preceded by power and speed actions [13], players' maximum running speeds had minimal impact on the team's ranking position at the end of the Spanish national league. In fact, the variance in the ranking position obtained at the end of the season explained by the team's maximum speed was of only 7.5%.

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References

1. Ade, J.; Fitzpatrick, J.; Bradley, P.S. High-intensity efforts in elite soccer matches and associated movement patterns, technical skills and tactical actions. Information for position-specific training drills. *J. Sports Sci.* **2016**, *34*, 2205–2214. [CrossRef] [PubMed]
2. Haugen, T.A.; Tønnessen, E.; Hisdal, J.; Seiler, S. The role and development of sprinting speed in soccer. *Int. J. Sports Physiol. Perform.* **2014**, *9*, 432–441. [CrossRef] [PubMed]
3. Suarez-Arrones, L.; Torreño, N.; Requena, B.; Sáez De Villarreal, E.; Casamichana, D.; Barbero-Alvarez, J.C.; Munguía-Izquierdo, D. Match-play activity proile in professional soccer players during oficial games and the relationship between external and internal load. *J. Sports Med. Phys. Fitness* **2015**, *55*, 1417–1422. [PubMed]
4. Mohr, M.; Krustrup, P.; Bangsbo, J. Match performance of high-standard soccer players with special reference to development of fatigue. *J. Sports Sci.* **2003**, *21*, 519–528. [CrossRef] [PubMed]
5. Rampinini, E.; Coutts, A.J.; Castagna, C.; Sassi, R.; Impellizzeri, F.M. Variation in top level soccer match performance. *Int. J. Sports Med.* **2007**, *28*, 1018–1024. [CrossRef]
6. Bush, M.; Barnes, C.; Archer, D.T.; Hogg, B.; Bradley, P.S. Evolution of match performance parameters for various playing positions in the English Premier League. *Hum. Mov. Sci.* **2015**, *39*, 1–11. [CrossRef]
7. Tønnessen, E.; Hem, E.; Leirstein, S.; Haugen, T.; Seiler, S. Maximal aerobic power characteristics of male professional soccer players, 1989–2012. *Int. J. Sports Physiol. Perform.* **2013**, *8*, 323–329. [CrossRef]
8. Casamichana, D.; Castellano, J.; Gomez Diaz, A.; Martín-García, A. Looking for complementary intensity variables in different training games in football. *J. Strength Cond. Res.* **2019**, in press. [CrossRef]
9. Oliva-Lozano, J.M.; Rojas-Valverde, D.; Gómez-Carmona, C.D.; Fortes, V.; Pino-Ortega, J. Impact of contextual variables on the representative external load profile of Spanish professional soccer match-play: A full season study. *Eur. J. Sport Sci.* **2020**. [CrossRef]
10. Vigne, G.; Gaudino, C.; Rogowski, I.; Alloatti, G.; Hautier, C. Activity profile in elite Italian soccer team. *Int. J. Sports Med.* **2010**, *31*, 304–310. [CrossRef]
11. Oliva-Lozano, J.M.; Fortes, V.; Krustrup, P.; Muyor, J.M. Acceleration and sprint profiles of professional male football players in relation to playing position. *PLoS ONE* **2020**, *15*, e0236959. [CrossRef]
12. De Souza, D.B.; González-García, J.; Campo, R.L.-D.; Resta, R.; Buldú, J.M.; Wilk, M.; Coso, J. Players' physical performance in LaLiga when the competition resumes after COVID-19: Insights from previous seasons. *Biol. Sport* **2021**, *38*, 3–7.
13. Faude, O.; Koch, T.; Meyer, T. Straight sprinting is the most frequent action in goal situations in professional football. *J. Sports Sci.* **2012**, *30*, 625–631. [CrossRef] [PubMed]
14. Mendez-Villanueva, A.; Buchheit, M.; Simpson, B.; Bourdon, P.C. Match play intensity distribution in youth soccer. *Int. J. Sports Med.* **2013**, *34*, 101–110. [CrossRef] [PubMed]
15. Gomez-Piqueras, P.; Gonzalez-Villora, S.; Castellano, J.; Teoldo, I. Relation between the physical demands and success in professional soccer players. *J. Hum. Sport Exerc.* **2019**, *14*, 1–11. [CrossRef]
16. Brito Souza, D.; López-Del Campo, R.; Blanco-Pita, H.; Resta, R.; Del Coso, J. Association of match running performance with and without ball possession to football performance. *Int. J. Perform. Anal. Sport* **2020**. [CrossRef]
17. Rampinini, E.; Bishop, D.; Marcora, S.M.; Ferrari Bravo, D.; Sassi, R.; Impellizzeri, F.M. Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. *Int. J. Sports Med.* **2007**, *28*, 228–235. [CrossRef]
18. Haugen, T.A.; Breitschädel, F.; Seiler, S. Sprint mechanical properties in soccer players according to playing standard, position, age and sex. *J. Sports Sci.* **2020**, *38*, 1070–1076. [CrossRef]
19. Pons, E.; García-Calvo, T.; Resta, R.; Blanco, H.; López Del Campo, R.; Díaz García, J.; Pulido, J.J. A comparison of a GPS device and a multi-camera video technology during official soccer matches: Agreement between systems. *PLoS ONE* **2019**, *14*, e0220729. [CrossRef]
20. Felipe, J.L.; Garcia-Unanue, J.; Viejo-Romero, D.; Navandar, A.; Sánchez-Sánchez, J. Validation of a video-based performance analysis system (Mediacoach®) to analyze the physical demands during matches in LaLiga. *Sensors* **2019**, *19*, 4113. [CrossRef]
21. Linke, D.; Link, D.; Lames, M. Football-specific validity of TRACAB's optical video tracking systems. *PLoS ONE* **2020**, *15*, e0230179. [CrossRef] [PubMed]

22. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed.; Lawrence Erlbaum Associates: Mahwah, NJ, USA, 1988.
23. Hinkle, D.E.; Wiersma, W.; Jurs, S.G. *Applied Statistics for the Behavioral Sciences*; Houghton Mifflin College Division: Boston, MA, USA, 2003.
24. Puente, C.; Del Coso, J.; Salinero, J.J.; Abián-Vicén, J. Basketball performance indicators during the ACB regular season from 2003 to 2013. *Int. J. Perform. Anal. Sport* **2015**, *15*, 935–948. [CrossRef]
25. Weyand, P.G.; Sandell, R.F.; Prime, D.N.L.; Bundle, M.W. The biological limits to running speed are imposed from the ground up. *J. Appl. Physiol.* **2010**, *108*, 950–961. [CrossRef] [PubMed]
26. Buchheit, M.; Samozino, P.; Glynn, J.A.; Michael, B.S.; Al Haddad, H.; Mendez-Villanueva, A.; Morin, J.B. Mechanical determinants of acceleration and maximal sprinting speed in highly trained young soccer players. *J. Sports Sci.* **2014**, *32*, 1906–1913. [CrossRef] [PubMed]
27. Girard, O.; Mendez-Villanueva, A.; Bishop, D. Repeated-sprint ability part I: Factors contributing to fatigue. *Sport. Med.* **2011**, *41*, 673–694. [CrossRef]
28. Mendez-Villanueva, A.; Edge, J.; Suriano, R.; Hamer, P.; Bishop, D. The Recovery of Repeated-Sprint Exercise Is Associated with PCr Resynthesis, while Muscle pH and EMG Amplitude Remain Depressed. *PLoS ONE* **2012**, *7*, e51977. [CrossRef]
29. Brito de Souza, D.; López-Del Campo, R.; Blanco-Pita, H.; Resta, R.; Del Coso, J. An Extensive Comparative Analysis of Successful and Unsuccessful Football Teams in LaLiga. *Front. Psychol.* **2019**, *10*, 2566. [CrossRef]
30. Brito Souza, D.; López-Del Campo, R.; Blanco-Pita, H.; Resta, R.; Del Coso, J. A new paradigm to understand success in professional football: Analysis of match statistics in LaLiga for 8 complete seasons. *Int. J. Perform. Anal. Sport* **2019**, *19*, 543–555. [CrossRef]
31. Vilar, L.; Araújo, D.; Davids, K.; Button, C. The role of ecological dynamics in analysing performance in team sports. *Sport. Med.* **2012**, *42*, 1–10. [CrossRef]
32. Araújo, D.; Davids, K.; Hristovski, R. The ecological dynamics of decision making in sport. *Psychol. Sport Exerc.* **2006**, *7*, 653–676. [CrossRef]
33. Ingebrigtsen, J.; Dalen, T.; Hjelde, G.H.; Drust, B.; Wisløff, U. Acceleration and sprint profiles of a professional elite football team in match play. *Eur. J. Sport Sci.* **2015**, *15*, 101–110. [CrossRef] [PubMed]

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Players' physical performance in LaLiga across the season: insights for competition continuation after COVID-19

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ABSTRACT: Due to the COVID-19 outbreak, professional football players competing in LaLiga were confined at home for ~8 weeks and then they were allowed to train to prepare the first competitive match for 4 weeks. As the duration of summer break in the prior four seasons of LaLiga (from 2015-2016 to 2018-2019) was of similar length to the suspension of the championship due to COVID-19 (~12 weeks), we have analysed the running performance of teams competing in LaLiga in these four seasons to anticipate players' physical performance after the resumption of the competition. The analysis includes the average running distance per game for each of the 38 matchdays that compose LaLiga. One-way ANOVA revealed that there was a main effect of the matchday on total running distance per match ($p = 0.001$), and in the distance covered between 14.0 and 20.9 km/h ($p < 0.001$), between 21.0 and 23.9 km/h ($p < 0.001$) and at above 24.0 km/h ($p < 0.001$). Overall, the post-hoc analysis revealed that the running patterns progressively increased during the first 8-10 matchdays and then reached a plateau which was significantly different to matchday-1 ($p < 0.05$). This analysis reveals that, in the prior four competitive seasons of LaLiga, players' physical performance was lower at the beginning of the season and the teams needed approximately 8-10 matchdays to reach a steady state running performance. These data suggest that football players will progressively increase their performance across the 11 matchdays remaining to complete LaLiga.

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INTRODUCTION

The pandemic of coronavirus disease-19 (COVID-19), an acute respiratory syndrome caused by the coronavirus SARS-CoV2, entailed the suspension of sports competition worldwide and, in most territories, home confinement and quarantine. These exceptional measures were adopted by the majority of health authorities in European countries, especially after the World Health Organization characterized COVID-19 as a pandemic on 11 March, 2020 [1]. Home confinement was included within a battery of limitations that governments set to diminish the spread of the virus, while the restrictions were particularly restraining with professional sports competitions due to the high risk of virus infection when bringing together thousands of people in a sport arena. Although the length of home isolation due to the COVID-19 outbreak varied substantially among European countries, in the case of Spain, it entailed a strict quarantine that prohibited all individuals from practising any form of exercise outside of their own residence from 14 March, 2020. During quarantine, professional athletes and sportspeople used several forms of home training, attempting to maintain their physical conditioning and lifestyles, ultimately reducing the harmful physiological and psychological effects of home isolation. In this regard, the staffs of Spanish professional football teams provided to their players personalized training programmes to reduce the detraining effects of home isolation, by using video-based activities that primarily included strength exercise with body loads, and intermittent exercise routines performed within a low range of displacement. However, the critical movements and actions of football, including accelerations/decelerations, sprints

with and without changes of direction, and kicking the ball were difficult to replicate in the conditions for most players and it was speculated that players would need several weeks of football-specific retraining to recover their physical and technical performance [2]. The COVID-19 outbreak occurred when most of the European professional football leagues were unfinished, disrupting the competition. The great economic incomes associated with professional football in Europe increased the pressure to resume football competition as soon as possible once the pandemic was under control [3]. The German Bundesliga was the first major European football league to successfully return to play, resuming its football competition on 16 May, 2020. The English Premier League returned on 17 June, 2020 while the Italian Serie A resumed competition on 17 June, 2020. In contrast, the organisers of other leagues, as the French Ligue 1, decided to bring a premature close to avoid football matches until the next season. Due to the uneven evolution of the COVID-19 in each country, the return to football training and competition were tailored taking into account the characteristics of the pandemic in each country [4]. In Spain, on 11 May, 2020, the home isolation measures were alleviated, and professional football players competing in LaLiga, the top Spanish football league, were allowed to attend the club's facilities. From that date, players were allowed to train first by using football-specific training routines with a 1–2 m "social" distance (for 1 week) and by using training groups of an increasing number of players afterwards. Due to the positive evolution of the pandemic in Spain, and after adopting a strict protocol to minimize infection during football matches, football and medical authorities authorized resuming LaLiga on 8 June, 2020 [5] to complete the 11 matchdays remaining to finish the competition. Hence, in the case of Spain, professional football players competing in LaLiga were confined at home for ~8 weeks and they were allowed to train to prepare the first competitive match for 4 complete weeks, for a total suspension of the competition lasting ~12 weeks. Although much has been hypothesised about the potential effect of home isolation on players' physical performance when the competition was resumed after COVID-19 [4, 6–8], a potential answer may be obtained by analysing the data of previous seasons in LaLiga. The end of LaLiga normally occurs in the third week of May, and the start of the following season normally occurs in the third week of August. This means that the first division of professional football in Spain is suspended by ~12 weeks every year for the summer break. During this period, professional football players perform a transition period which may have different characteristics for those players competing in international football events (i.e., international football players competing with their national teams), while for most players it entails active recovery. During the transition period, there have been found several detraining effects such as changes in body composition, declines in sprint running performance and reduction in muscle power [9]. Afterwards, professional football teams perform a preseason period lasting ~4–6 weeks [10] to offset the detraining effects of the transition period and to start football competition with the best possible level of fitness. Although the main objective of the preseason period is to adapt players to the efforts, movements and physical challenges of competition and it usually entails high volumes of training and friendly matches [11], players usually need several weeks of official football competition to achieve a steady state of physical performance, as it has been previously found in the Bundesliga [12].

MATERIALS AND METHODS

This study is a descriptive analysis of the running performance of teams competing in LaLiga across the last 4 seasons (from 2015–2016 to 2018–2019). The analysis includes the average running distance per game for each of the 38 matchdays that compose LaLiga, for a total of 1,520 matches analysed. Data were obtained from La Liga, which authorised the use of the variables included in this investigation. Data were extracted by a valid multicamera tracking system and associated software (Mediacoach, Spain) that measures players' running distances at different speeds [13, 14].

RESULTS

By using a one-way analysis of variance of repeated measures (LSD post-hoc), and by using a significance level to determine meaningful differences at $p < 0.05$, we have found the following outcomes: there was a main effect of the matchday on total running distance per match ($F = 2.44$, $p = 0.001$). In comparison to matchday-1, the total running distance covered during the game in several fixtures after matchday-10 was significantly longer (Figure 1A). There was also a main effect of the matchday on the distance covered at < 14.0 km/h ($F = 1.63$, $p = 0.010$). However, in this case, the running distance at this speed threshold was progressively decreased from matchday-1 and it was significantly lower than matchday-1 at several matchdays after matchday-8 (Figure 1B). Regarding the distance covered between 14.0 and 20.9 km/h ($F = 5.76$, $p < 0.001$), between 21.0 and 23.9 km/h ($F = 3.22$, $p < 0.001$) and at above 24.0 km/h ($F = 2.50$, $p < 0.001$), there was a main effect of the matchday on the running performance at these speed thresholds, and the post-hoc analysis revealed that the running patterns progressively increased during the first 8–10 matchdays and then reached a plateau which was significantly different to matchday-1 (Figure 1C, 1D and 1E). A similar pattern was found for the number of sprints performed at ≥ 24.0 km/h ($F = 2.78$, $p < 0.001$; Figure 1F). In all running variables, there was a progressive decrease in the last four matchdays.

DISCUSSION

This analysis reveals that, in the prior four competitive seasons of LaLiga, players' physical performance was lower at the beginning of the season and the teams needed approximately 8–10 matchdays to reach a steady state running performance. As the durations of the transition period and the preseason period in these prior four seasons were of similar length to the duration of home confinement due to COVID-19 (8 weeks) and similar to the time allowed to prepare

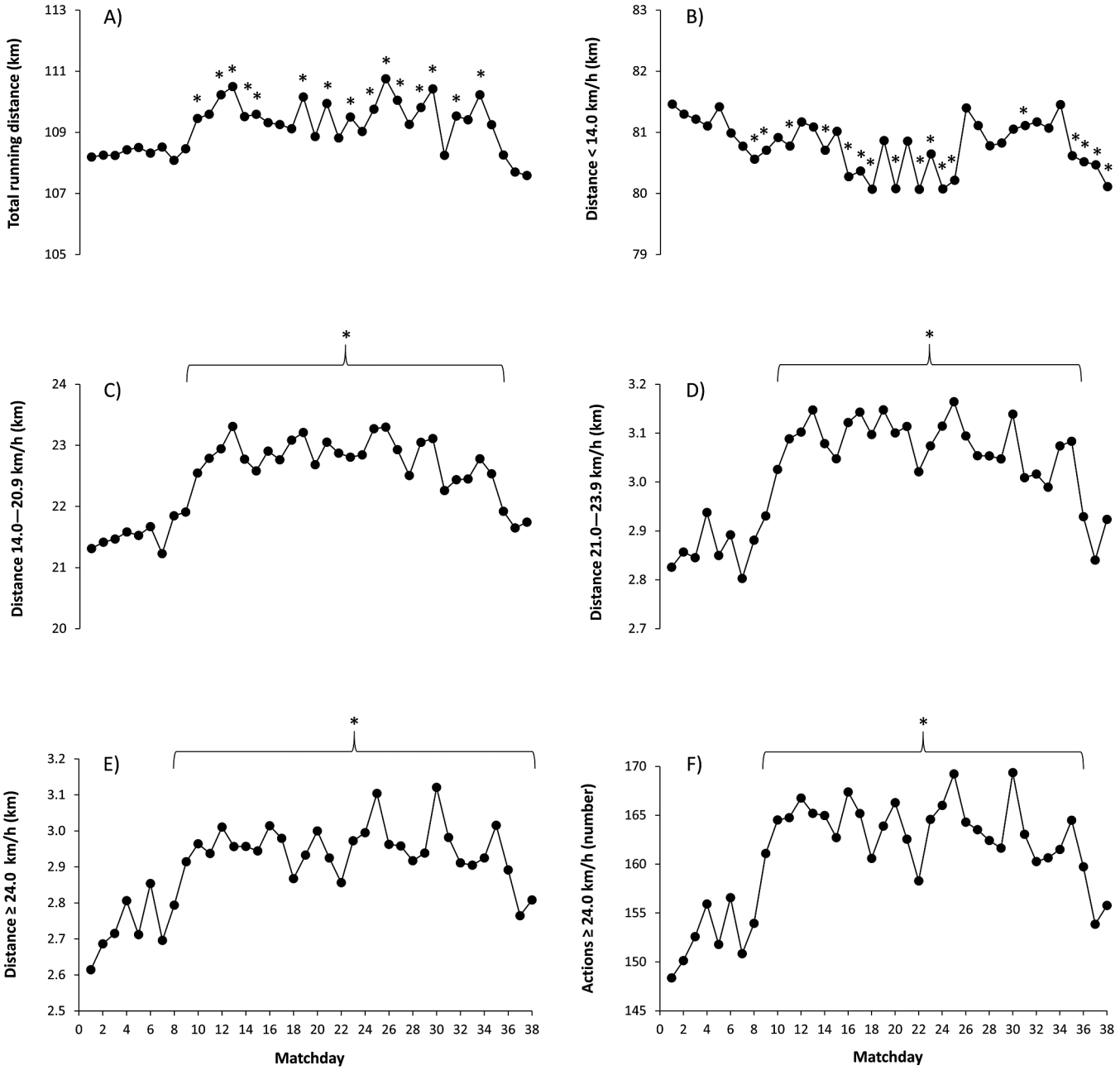

FIG. 1. Total running distance per match, distance at different speed thresholds and number of sprints across the 38 matchdays that composed *LaLiga*.
A) Total running distance, B) running distance covered at < 14.0 km/h, C) running distance covered between 14.0 and 20.9 km/h, D) running distance covered between 21.0 and 23.9 km/h, E) running distance covered at ≥ 24.0 km/h, F) number of sprints covered at ≥ 24 km/h. Each dot represents mean running distance on each matchday in the last four seasons (from 2015/16 to 2018/19). (*) Different from matchday-1 at $p < 0.05$

players before resuming football competition in Spain (4 weeks), these data suggest that football players will progressively increase their performance across the 11 matchdays remaining to complete the championship. The similarities in the length of the competition disruption due to COVID-19 in Spain and the summer break between football seasons indicate that players will face a scenario with resemblances to the onset of a football season. Furthermore, Spanish football authorities have included other measures to alleviate the physical strain induced by the official matches as the increase in the number of player substitutions up to 5 per match, in-game refreshment pauses and schedules to reduce the hours with higher ambient temperatures, all to promote a reduced physical load of the game.

CONCLUSIONS

In summary, when resuming competition after COVID-19, professional players of LaLiga will experience physical challenges similar to the ones they usually undergo during the first official matches of the season. This analysis might be useful for strength and physical conditioning coaches because it advocates that those teams that are better prepared, in physical and conditioning terms, to achieve high running performance from the first match after resuming the competition may increase their possibilities of succeeding [15], especially for those teams that are fighting to win the championship or to avoid relegation. In addition to football performance parameters, football practitioners should be aware of the potential higher injury risk [16] as the need to finish the season without affecting the start of the next championship will produce a congested calendar with lower-than-habitual recovery times. Although no research has been published to date with the injury incidence in professional football after COVID-19, informal and news media reports indicate that football players may have suffered a higher than usual number of injuries, especially muscle injuries, and with a particularly high incidence on the first matchdays after the resumption of competition [17]. However, this is not an unusual observation, as the preseason and the onset of the football season are periods with an increase in the incidence and prevalence of some type of injuries [8].

Once the 2019–2020 editions of the major European football leagues are finished, it will be necessary to investigate the effect of home isolation and quarantine on football performance by analysing running activity patterns and game statistics in the matches played after resuming football competition. As the duration of confinement and football competition interruption have been substantially different among the football leagues, future investigations will determine whether confinement length was associated with football performance decline or increased injury incidence in professional football. Finally, the study of football performance of the teams competing in the UEFA Champions League and Europa League, which will be resumed after the end of the European football leagues, will also be useful to determine how top European football teams managed a season that lasted over a year. French teams will merit special attention as they will have to compete in the last stages of these international football competitions after a period without official competitions longer than 4 months. All this information will be valuable not only to understand the impact of COVID-19 on current football performance, but potentially also to anticipate and lessen the impact of future disruptions of football competitions due to this disease, as the COVID-19 pandemic may spread cyclically and outbreaks may recur in large cities in autumn 2020 [18].

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Conflict of interest

The authors of this work declare no conflict of interest.

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REFERENCES

1. World Health Organization Archived: WHO Timeline – COVID-19 Available online: https://www.who.int/news-room/detail/27-04-2020-who-timeline---covid-19 (accessed on Jul 6, 2020).
2. Herrero-Gonzalez H, Martín-Acero R, Del Coso J, Lalín-Novoa C, Pol R, Martín-Escudero P, De la Torre AI, Hughes C, Mohr M, Biosca F, et al. Position statement of the Royal Spanish Football Federation for the resumption of football activities after the COVID-19 pandemic (June 2020). Br J Sports Med. 2020.
3. Corsini A, Bisciotti GN, Eirale C, Volpi P. Football cannot restart soon during the COVID-19 emergency! A critical perspective from the Italian experience and a call for action. Br J Sports Med. 2020.
4. Eirale C, Bisciotti G, Corsini A, Baudot C, Saillant G, Chalabi H. Medical recommendations for home-confined footballers' training during the COVID-19 pandemic: from evidence to practical application. Biol Sport. 2020;37(2):203–207.
5. Kirkland A. La Liga given green light to restart on June 8 by Spanish prime minister Available online: https://www.espn.com/soccer/spanish-primera-division/story/4098472/la-liga-given-green-light-to-restart-on-june-8-by-spanish-prime-minister (accessed on May 27, 2020).
6. Primorac D, Matišić V, Molnar V, Bahtijarević Z, Polašek O. Pre-season football preparation in the era of COVID-19: Croatian Football Association Model. JJ Glob Health. 2020;10(1):010352.
7. Carmody S, Murray A, Borodina M, Gouttebarge V, Massey A. When can professional sport recommence safely during the COVID-19 pandemic? Risk assessment and factors to consider. Br J Sports Med. 2020; bjsports-2020-102539.
8. Bisciotti GN, Eirale C, Corsini A, Baudot C, Saillant G, Chalabi H. Return to football training and competition after lockdown caused by the COVID-19 pandemic: medical recommendations. Biol Sport. 2020;37(3):313–319.
9. Silva JR, Brito J, Akenhead R, Nassis GP. The Transition Period in Soccer: A Window of Opportunity. Sports Med. 2016;46(3):305-13
10. Campos-Vazquez MA, Toscano-Bendala FJ, Mora-Ferrera JC, Suarez-Arrones LJ. Relationship between internal load indicators and changes on intermittent performance after the preseason in professional soccer players. J Strength Cond Res. 2017;31: 1477–1485.
11. Rago V, Silva J, Mohr M, Randers M, Barreira D, Krustrup P, Rebelo A. Influence of opponent standard on activity profile and fatigue development during preseasonal friendly soccer matches: a team study. Res Sport Med. 2018;26:413–424.
12. Chmura P, Konefał M, Wong DP, Figueiredo AJ, Kowalczuk E, Rokita A, Chmura J, Andrzejewski M. Players' physical performance decreased after two-thirds of the season: Results of 3 consecutive seasons in the German first bundesliga. Int J Environ Res Public Health. 2019;16(11):2044.

13. Pons E, García-Calvo T, Resta R, Blanco H, López Del Campo R, Díaz García J, Pulido JJ. A comparison of a GPS device and a multi-camera video technology during official soccer matches: Agreement between systems. PLoS One. 2019;14:e0220729.
14. Felipe JL, Garcia-Unanue J, Viejo-Romero D, Navandar A, Sánchez-Sánchez J. Validation of a video-based performance analysis system (Mediacoach®) to analyze the physical demands during matches in LaLiga. Sensors (Switzerland). 2019;19(19): 4113
15. Brito Souza D, López-Del Campo R, Blanco-Pita H, Resta R, Del Coso J. Association of match running performance with and without ball possession to football performance. Int. J Perform Anal Sport. 2020; 483-494.
16. Wollin M, Thorborg K, Pizzari T. Monitoring the effect of football match congestion on hamstring strength and lower limb flexibility: Potential for secondary injury prevention? Phys Ther Sport. 2018;29:14–18.
17. Marca Bundesliga | Coronavirus: Fourteen injuries in first weekend of Bundesliga restart | MARCA in English Available online: https://www.marca.com/en/football/international-football/2020/05/20/5ec5100be2704e1e318b457b.html (accessed on Jul 6, 2020).
18. Huang Z, Huang J, Gu Q, Du P, Liang H, Dong Q. Optimal temperature zone for the dispersal of COVID-19. Sci Total Environ. 2020;736:139487

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Running Patterns in *LaLiga* Before and After Suspension of the Competition Due to COVID-19

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In the first wave of the COVID-19 outbreak (spring 2020), the first division of professional soccer in Spain (*LaLiga*) was suspended for 12 weeks as part of the lockdown imposed by the Spanish health authorities. Professional soccer players were confined to home for 8 weeks and then a retraining period of 4 weeks was set before the first competitive match. When competition was resumed, professional soccer teams competed in a congested calendar (11 matchdays in 39 days) while some in-game regulations were altered (up to 5 substitutions, refreshment pauses). The current research presents an analysis of running patterns before suspension and after resumption of *LaLiga* to determine how the lockdown affected players' physical performance. To aid in this purpose, a pairwise comparison was performed of running patterns of the 2019–2020 vs. 2018–2019 season (i.e., control season). Using a two-way ANOVA (season x matchday), it was found that there was no main effect of the season on total running distance per match ($P = 0.288$) nor in the distances covered < 14.0 km/h ($P = 0.294$), at 21.0–23.9 km/h ($P = 0.266$), and at ≥ 24.0 km/h ($P = 0.112$). Only the distance at 14.0–20.9 km/h was affected by the season ($P = 0.019$) with a lower running distance on matchday 34 in the 2019–2020 vs. 2018–2019 season. The number of substitutions (from 2.9 to 4.5 substitutions per game; $P < 0.001$) and match duration (96 vs. 100 min; $P < 0.001$) significantly increased after resumption respect to the previous season. These data suggest that high-intensity running performance of professional soccer teams was maintained after the resumption of the competition while the alterations likely aided in the in-game regulations facilitated the maintenance of soccer physical performance.

Keywords: football, sports competition, elite athlete, professional athlete, sport performance

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INTRODUCTION

During the spring of 2020, the outbreak of the coronavirus disease (COVID-19) caused the suspension of sports competition worldwide, as their suspension was one of the several actions taken by most countries to reduce the spread of the virus. In most European countries, suspension of sports competition was accompanied by the lockdown of territories and home confinement.

In Spain, the first wave of COVID-19 impacted in March 2020 and national health authorities set a severe lockdown that entailed home confinement starting on March 14 (Castañeda-Babarro et al., 2020). At the beginning, the lockdown was set for a duration of two weeks and professional and elite athletes struggled to maintain their physical condition by training at home as it was believed that sports competitions would be resumed as soon as the lockdown finished (Sarto et al., 2020). However, at the end, home confinement lasted for 8 weeks and athletes had to perform multiple and innovative forms of home training in an attempt to mitigate the detraining effects of confinement on their physical conditioning.

In Spanish professional soccer, players tried to keep their training routines at their homes during home confinement, following individualized programs provided by the teams' strength and conditioning staff. The training programs mainly included strength-based activities with body loads, proprioception activities, exercise performed with low range displacements and some endurance-based exercises such as running on a treadmill or cycling on a stationary bike (Barca Innovation Hub, 2020). Despite the effort of the teams' staff, the inclusion of high-intensity running actions depended on the conditions of home confinement for each player. For this reason, the execution of soccer-specific displacements such as accelerations/decelerations, sprints, and changes of direction were difficult to perform at home for most players (Moreno-Pérez et al., 2020).

Due to the potential risks of infection and injury, most sports competition in Spain were not resumed after home confinement and they were concluded until the next season. However, the case of professional soccer was different to other sport competitions. Due to the economic revenues and the popularity of soccer, the suspension of the professional leagues was a matter of debate in health, social and sports forums. Most soccer governing bodies stood for the resumption of the competition to finish the championships after the lockdown was lifted, although there were calls to avoid an overly premature resumption of soccer competition in Spain and in other European countries (Corsini et al., 2020; Herrero-Gonzalez et al., 2020). In addition, there were statements that provided practical recommendations for the preparation of training sessions for professional soccerers when returning to competition after the lockdown (Bisciotti et al., 2020; Herrero-Gonzalez et al., 2020).

Spanish health and sports authorities set specific guidelines for the resumption of a few professional competitions (i.e., soccer, basketball). The guidelines for professional competition resumption were established keeping in mind athletes' health status after the confinement, the reduction of the likelihood of COVID-19 infection during training and competition and the development of strategies for injury prevention (Herrero-Gonzalez et al., 2020). In fact, recent data suggest that professional soccer training and competition could have been carried out safely after the first wave of the COVID-19 pandemic using strict hygiene measures, regular PCR testing (Buldú et al., 2020; Meyer et al., 2020) and systematic contact tracing following confirmed cases (Carmody et al., 2020).

Specifically, for the first division of professional soccer in Spain (*LaLiga*), a retraining period of 4 weeks was established after lockdown and then the competition was resumed on June 8 2020 and the 11 fixtures left to finish the championship were successfully completed without any infections. As new waves of COVID-19 are impacting again in Spain and in other European countries, the analysis of the data of the previous season may be very useful in the case of future lockdowns that entail sports competition suspension and posterior resumption. In this regard, the need of investigating the effect of lockdown on soccer performance has been suggested by analysing running activity patterns and game statistics in the matches played after soccer competition resumed (Souza et al., 2020). To this regard, although soccer is a complex team sport in which success is based on the interaction of multiple physical, technical and tactical capacities of players and of team squads (Sarmento et al., 2018), the analysis of running performance after the competition resumption may be useful to understand the outcomes of the 2019–2020 season of *LaLiga*, as running activities during the matches are related to end-season ranking in a national league (Longo et al., 2019). In addition, the analysis of running performance after the competition resumption in the 2019–2020 season may be helpful to set specific guidelines, based on precedents, that aid the return to play after lockdowns. Hence, the aim of this article is providing a comparative analysis of match running performance in teams competing in *LaLiga* before and after the lockdown due to COVID-19.

METHODS

Participants

The study sample was composed of 530 and 555 soccer players competing in *LaLiga* Santander for the 2018–2019 and 2019–2020 seasons, respectively. A total of 342 soccer players played on both seasons while the remaining 401 players only played on one of the two seasons under investigation. This sample corresponds to the entire population of professional soccer players that competed in *LaLiga* for these two seasons. The inclusion criteria were (a) being a soccer player competing in the first-division of soccer in Spain, (b) being professionally associated to one of the twenty teams competing in *LaLiga* and (c) playing at least one match in either the 2018–2019 and 2019–2020 seasons. In accordance with *La Liga*'s ethical guidelines, this investigation does not include information that identifies soccer players. The Institutional Review Board of the Camilo José Cela University approved this study, which is in accordance with the latest version of the Declaration of Helsinki.

Experimental Procedures

This study is a descriptive and comparative analysis of match running performance in all teams competing in *LaLiga* in the 2018–2019 and 2019–2020 seasons. To aid in determining the effect of lockdown in soccer running performance, a pairwise comparison of running patterns was performed between these two seasons. The 2018–2019 season was established as a "control" season while the 2019–2020 season was considered as the

"experimental" season because entailed normal competition for 27 matches, a suspension for12 weeks and resumption to finish the 11 fixtures remaining.

The analysis includes the average running distance per game for each of the 38 matchdays that compose the first division of professional soccer in Spain, for a total of 560 matches analysed (i.e., 380 matches per season). Data were obtained from *LaLiga*, which authorised the use of the variables included in this investigation. Data were extracted by a valid and reliable multicamera tracking system and associated software (Mediacoach®, Spain) that measures players' running distance in total and at different speeds (i.e., below 14.0 km/h, between 14.0 and 20.9 km/h, between and 21.0 and 23.9 km/h and above 24.0 km/h). The number of running actions above 24.0 km/h was also obtained in each match to assess the number of sprints performed. Mediacoach® records the position of each player on the pitch at 25 Hz using a stereo multi-camera system composed of two multi-camera units placed at either side of the midfield line. Each multi-camera unit contains three cameras with a resolution of 1920 × 1080 pixels which are synchronised to provide a stitched panoramic picture (Del Coso et al., 2020). The panoramic picture is then employed to create the stereoscopic view that allows triangulating all the players on the field to assess their position and to calculate running speed during the match. In the case of a lack of location of a player due to occlusions by another player, an experienced operator manually corrected the position during measurement. The validity of Mediacoach® to assess running distance during soccer match play has been obtained through high agreement with the data obtained with Global Positioning System units (Felipe et al., 2019; Pons et al., 2019) and with data obtained from a reference camera system (i.e., VICON motion capture system (Linke et al., 2020)). Data on each variable was normalised as team's running distance per match to obtain easier-to-use information for coaches and physical conditioning staff (Brito Souza et al., 2020). Additionally, the number of substitutions per match and match duration were also extracted to assess the effect of the in-game regulations introduced after the resumption of the competition.

Statistical Analysis

Statistical analyses were carried out using the software IBM SPSS Statistics for Macintosh, Version 26.0 (IBM Corp., Armonk, NY, United States). Data were normally distributed in all variables as determined by the Shapiro-Wilk test. Additionally, the sphericity assumption was checked with Mauchly's test. If this assumption presented a probability of $P < 0.05$, the Greenhouse-Geisser correction was used. To identify the effects of the lockdown on match running performance variables, we used a two-way analysis of variance (ANOVA) with within-between comparisons (season × matchday), and an LSD post-hoc analysis in those variables with a significant F test. To specifically examine the effect of lockdown on the fixtures performed after the resumption of the soccer competition, a sub-analysis comparing the last 11 fixtures (from the fixture 28 to the fixture 38) of the 2018–2019 and 2019–2020 seasons was performed. For this sub-analysis, we used unpaired t tests while the effect size was also calculated by using Cohen's *d* units (Cohen, 1988). The significance level was set at $P < 0.050$.

RESULTS

The two-way ANOVA revealed that there was no main effect of the season or season × matchday interaction on total running distance per match, in the distances covered < 14.0 km/h, in the distance covered between 21.0 and 23.9 km/h, and in the distance covered at ≥ 24.0 km/h (**Figure 1**; see **Table 1** for F and *P* values). Likewise, there was no main effect of the season nor season × matchday interaction in the number of sprints performed at ≥ 24.0 km/h. However, there was a main effect of the season on the distance covered at 14.0–20.9 km/h ($P = 0.019$) with the post-hoc analysis revealing lower distances in the 2019–2020 season vs. 2018–2019 season for matchdays 32, 34, and 35 ($P < 0.050$). Additionally, the distance covered at 14.0–20.9 km/h was lower on matchdays 32, 34, 35, 36, 37, and 37 with respect to matchday 27 of the 2019–2020 season ($P < 0.050$).

The two-way ANOVA also revealed main effects of the season, matchday and an interaction between these two factors in the number of players' substitutions that the teams used per match (**Table 1**). Specifically, the number of substitutions was higher in all pairwise comparisons between the 2018–2019 vs. 2019–2020 season from matchday 28 to matchday 38 (**Figure 1**; $P < 0.050$). Furthermore, the number of substitutions was higher from matchday 28 to matchday 38 when compared to matchday 27 of the 2019–2020 ($P < 0.050$). There was also a main effect of the season on match duration (**Table 1**), indicating that match duration was higher from matchday 28 to matchday 38 in the 2019–2020 season with respect to the previous season ($P < 0.050$) while match duration was higher from matchday 28 to matchday 38 when compared to matchday 27 within the 2019–2020 season ($P < 0.05$).

In the sub-analysis of the last 11 matchdays of each season, total running distance and the distance at < 14.0 km/h were higher in the 2019–2020 season when compared to the 2018–2019 season ($P < 0.050$; **Table 2**). Additionally, the number of substitutions and match duration was higher the 2019–2020 season when compared to the 2018–2019 season ($P < 0.050$). On the contrary, the distance covered between 14.0 and 20.9 km/h was lower in the 2019–2020 season when compared to the 2018–2019 season ($P = 0.034$). There were no other differences between seasons in the remaining running performance variables in the last 11 matchdays of the seasons under investigations.

DISCUSSION

This analysis reveals that, despite the lockdown imposed by the Spanish health authorities during spring 2020 to control the first wave of the COVID-19 pandemic, running performance in the professional soccer teams of *LaLiga* was well preserved after the resumption of the competition, which took place after 12 weeks of competition suspension. This maintenance of overall running performance during the match was evident when comparing

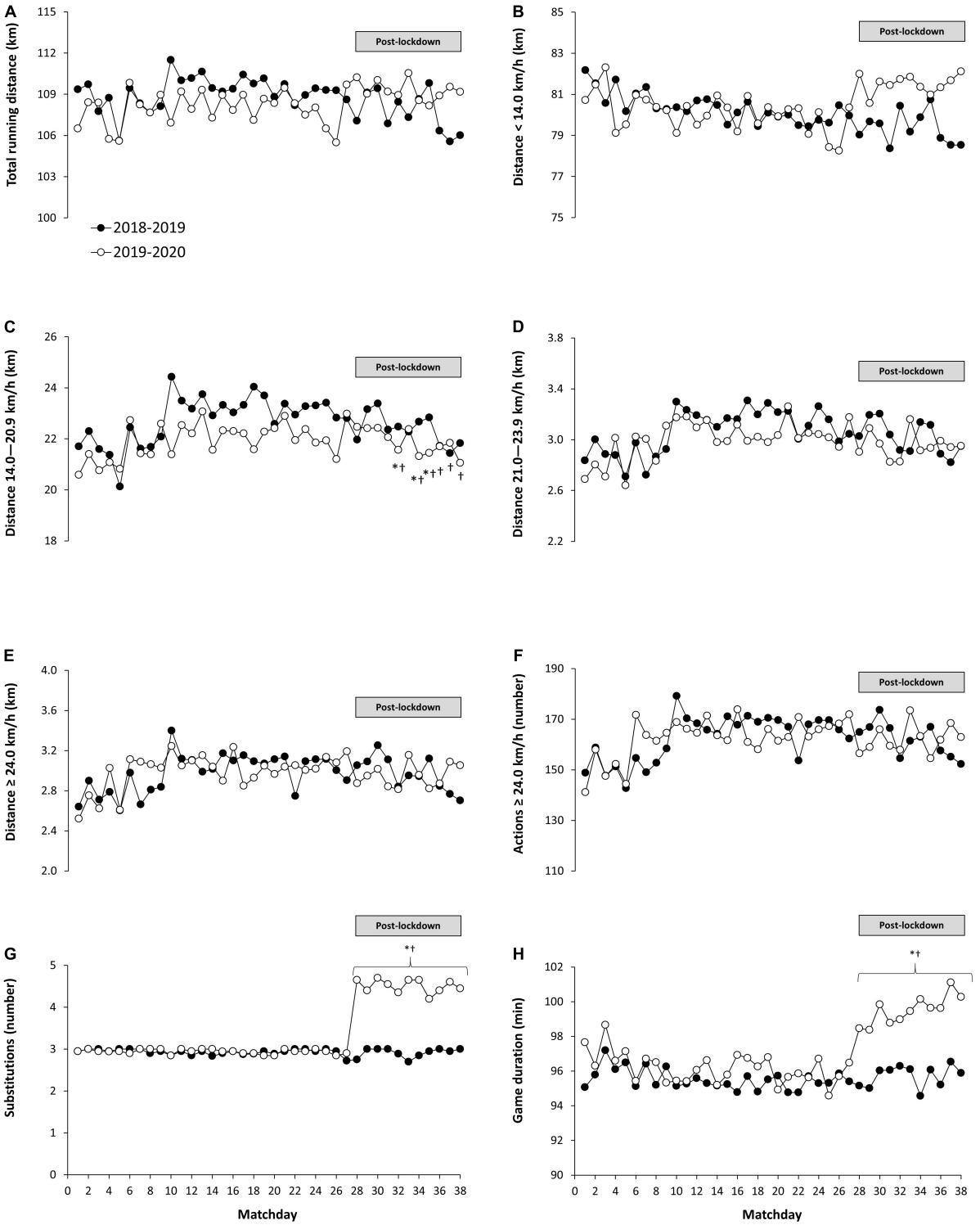

FIGURE 1 | Total running distance per match, distance at different speed thresholds, number of sprints, players' substitutions, and game duration in *LaLiga* in the 2018–2019 and 2019–2020 seasons. **(A)** Total running distance, **(B)** running distance covered at <14.0 km/h, **(C)** running distance covered between 14.0 and 20.9 km/h, **(D)** running distance covered between 21.0 and 23.9 km/h, **(E)** running distance covered at ≥24.0 km/h, **(F)** number of sprints covered at ≥24 km/h, **(G)** number of players' substitutions, **(H)** game duration. Each dot represents mean value for 20 teams on each matchday for each season (*) Different from the same matchday in the 2018–2019 season, $P < 0.05$. (†) Different from matchday 27 in the 2019–2020 season, $P < 0.05$. Note: In the 2019–2020 season, the competition was suspended after matchday 27 due to the COVID-19 pandemic. The competition was resumed after 12 weeks (8 weeks of lockdown and 4 weeks of retraining) to complete the 38 matchdays that comprised *LaLiga*.

TABLE 1 | Main effects (season × matchday) and interaction in running patterns of professional soccer teams in *LaLiga* when comparing the 2018–2019 and 2019–2020 seasons.

Variable	Season	Matchday	Interaction
Total running distance	F = 1.361 *P* = 0.288	F = 1.405 *P* = 0.254	F = 1.588 *P* = 0.193
Distance at <14.0 km/h	F = 1.321 *P* = 0.294	F = 0.751 *P* = 0.415	F = 0.893 *P* = 0.433
Distance at 14.0–20.9 km/h	F = 11.657 *P* = 0.019	F = 1.553 *P* = 0.234	F = 1.037 *P* = 0.414
Distance at 21.0–23.9 km/h	F = 1.564 *P* = 0.266	F = 2.079 *P* = 0.128	F = 1.588 *P* = 0.193
Distance at ≥24.0 km/h	F = 3.470 *P* = 0.112	F = 1.305 *P* = 0.294	F = 1.482 *P* = 0.220
Actions at ≥24.0 km/h	F = 2.077 *P* = 0.209	F = 0.981 *P* = 0.436	F = 1.151 *P* = 0.361
Number of substitutions	F = 308.197 *P* < 0.001	F = 19.603 *P* < 0.001	F = 22.890 *P* < 0.001
Match duration	F = 7.200 *P* < 0.001	F = 3.522 *P* = 0.385	F = 7.344 *P* = 0.110

In the 2019–2020 season, the competition was suspended at matchday 27 due to the COVID-19 pandemic. The competition was resumed after 12 weeks (8 weeks of lockdown and 4 weeks of retraining) to complete the 38 matchdays that comprised LaLiga.

TABLE 2 | Averaged running patterns of professional soccer teams in *LaLiga* in the last 11 fixtures of the 2018–2019 and 2019–2020 seasons.

Variable	2018–2019	2019–2020	*P* value	Effect size
Total running distance	107.7 ± 1.5	109.3 ± 0.7	0.015	1.10
Distance at <14.0 km/h	79.3 ± 0.8	81.5.3 ± 0.4	<0.001	2.75
Distance at 14.0–20.9 km/h	22.4 ± 0.6	21.9 ± 0.5	0.034	−0.81
Distance at 21.0–23.9 km/h	3.0 ± 0.1	3.0 ± 0.1	0.226	0.10
Distance at ≥24.0 km/h	3.0 ± 0.2	2.9 ± 0.1	0.759	−0.13
Actions at ≥24.0 km/h	162.1 ± 6.6	162.1 ± 5.6	0.994	0.00
Number of substitutions	2.9 ± 0.1	4.5 ± 0.2	<0.001	14.7
Match duration	95.7 ± 0.6	99.5 ± 0.8	<0.001	6.6

data of the season disrupted by the pandemic (2019–2020) to a control season (2018–2019), as running performance in all speed thresholds -except for some matchdays in the distance covered at between 14.0–20.9 km/h (**Figure 1C**) were maintained or even increased. The sub-analysis of the last 11 fixtures revealed that, both, the total running distance, and the distance covered at low running velocity (i.e., <14 km/h) were increased in the 2019–2020 season (**Table 2**) respect to the previous season. This increase in total running distance and in low-intensity running were likely facilitated by the longer match duration and the possibility of reaching up to five substitutions per match. Interestingly, the running distance at above 21 km/h, which represents the running actions more associated to soccer performance, particularly when in possession of the ball (Brito Souza et al., 2020) match, were well preserved in the 2019–2020 in comparison to the control season. It is probable that the maintenance of running distance at high speed and the number of sprints per match after the resumption of the competition was associated to the lower distance covered at 14.0–20.9 km/h (**Figure 1C** and **Table 2**). Although it remains as a speculation, the reduction of running activities of moderate intensity (i.e., 14.0–20.9 km/h) may represent an enhanced pacing strategy during matches to ultimately maintaining high-intensity running (i.e., > 21 km/h) despite a potential lower physical condition due to home confinement and the congested calendar. Collectively, all this information suggests that high-intensity running performance of professional soccer teams in *LaLiga,* was maintained after the resumption of the competition in the 2019–2020 seasons despite the competition was suspended for 14 weeks, including 8 weeks of severe home confinement.

These outcomes of the current investigation were likely assisted by management and regulations that Spanish health and soccer authorities established for professional soccer after the lockdown. In fact, it was predicted that, when resuming soccer competition after the lockdown, professional players of *LaLiga* would experience physical challenges similar to the ones they usually undergo during the first official matches of the season (i.e., a progressive increase in running performance during the first official matches (Souza et al., 2020)) because the lockdown was long enough to expect detraining effects (Pereira et al., 2020). This scenario was predicted with the data at that time which indicated muscle weakness induced by the lockdown (Moreno-Pérez et al., 2020) despite staff and soccer players trying to maintain their soccer-specific physical condition by training at home. However, this potential scenario did not materialise because the Spanish soccer authorities ensured players' health and safety and established regulations that avoided excessive fatigue while aiding soccer performance (Herrero-Gonzalez et al., 2020).

First, a retraining period of at least 4 weeks was set from the end of home confinement to the first competitive match. In this time, professional teams prepared their return to play following the recommendations of the Spanish Sports Council, in agreement with the Royal Spanish Soccer Federation (RSFF) and *LaLiga*, which established regulations to allow individual-only exercise routines for the first week of retraining with a progressive inclusion of small-group exercises until completing team trainings and 11-per side match simulation routines in the last weeks of the retraining period. Second, a minimum period of 72 h was set between matches as lower between-game recovery periods may entail accumulated fatigue and stress (Mohr et al., 2016) and could potentially lead to higher injury incidence (Bengtsson et al., 2014). Interestingly, the running patterns after the lockdown were preserved despite the teams completing the 11 matchdays remaining to finish the 2019–2020 season in ∼39 days (i.e., one game every 3.5 days). Of note, the previous year, the last 11 matchdays were completed in 63 days (i.e., one game every 5.7 days).

In the opinion of these authors, the specific modifications of the in-game regulations allowed after the lockdown were also key to maintaining players' physical running patterns (especially those above 21 km/h) and hence, the integrity of the competition. The RSFF and *LaLiga* agreed to permit two extra players' substitutions (for a total of up to 5 substitutions per match) although teams had to request substitutions in only three turns.

The current data indicate that most teams used this in-game allowance as the mean number of substitutions in the last 11 fixtures of the 2018–2019 season was 2.9 substitutions per game and it reached 4.5 substitutions per game in the 2019–2020 season (**Table 2**). Habitually, substitutes cover greater running distances than players who complete the entire match (Bradley et al., 2014) which points toward a favourable outcome of the allowance of up to 5 substitutions to preserve running performance after the lockdown. In this regard, some authors have recently proposed keeping the increase in substitutions from three to up to five permanently, with the aim of mitigating overall soccer physical demands (Mota et al., 2020). Interestingly, the time chosen for the first substitution did not vary after the lockdown (58 ± 3 min in 2018–2019 and 57 ± 2 min in 2019–2020 for the las 11 matchdays) and the time played by substitutes was similar (25 ± 2 min in 2018–2019 and 26 ± 1 min in 2019–2020 for the las 11 matchdays) suggesting that team managers do not anticipate substitutions despite possessing two more substitutions than before.

Additionally, a mandatory use of refreshment pauses at minute 30 and 75 of each match was established to allow enhanced in-game recovery as the game was stopped for ∼2 min in each half. As a result, game duration increased from 96 min in the last 11 fixtures of the 2018–2019 season to 100 min for the same period of the 2019–2020 season (**Table 1**). This likely produced that total running distance and distance at < 14 km/h were higher in the 2019–2020 vs 2018–2019 season (**Table 2**), as players usually moved at a low intensity running to the sideline for refreshment. To compensate for the time used for these pauses, referees increased game duration in each half as reflected in the current investigation, but the effective time of play was probably conserved. To date, there is no data to determine how effective these refreshment pauses are to help players' for in-game recovery, but the maintenance of the distance run at ≥ 21 km/h and the similar number of actions above 24 km/h in the post-lockdown period suggests that these drink breaks were be helpful to maintain running performance despite the congested calendar of the last 11 fixtures of the 2019–2020 season.

The current analysis describes an unusual situation produced by a virus pandemic and provides data on how health and soccer governing bodies were right about the proposition of new in-game regulations and by setting an appropriate time for retraining phase after home confinement. However, the analysis presents some limitations. First, the training routines performed at home during confinement and during the retraining period of 4 weeks were different between players and between teams. With the current data, we are unable to determine what teams selected the most optimal retraining strategies to maintain running performance after the resumption of competition. Additionally, the current analysis does not establish if those soccer teams that used a higher number of substitutions per game -up to five- were more able to maintain running performance after the resumption of competition. Last, the current analysis does not contain information about players' internal load during the matches or an evaluation of wellness before the matches. This information could have been useful to determine if players felt more fatigue before matches due to the congested calendar set for the resumption of the competition or if they presented a higher internal load in comparison to the 2018–2019 season. Despite these limitations, the authors of this brief report honestly believe that the information provided here can be useful for coaches and strength and conditioning staff to understand how running performance during soccer competition can be maintained after a detraining period induced by home confinement or other analogue measures.

In summary, running patterns in professional soccer teams competing in 2019–2020 *LaLiga* were maintained when the competition was resumed after lockdown due to the first wave of COVID-19, especially the distance covered at > 21 km/h. The 11 matchdays left to finish the championship were played with ∼3.5 days of recovery between matches but establishing 4 weeks of retraining, the authorisation for up to 5 player's substitutions during each match, and the mandatory use of refreshment pauses likely aided maintaining match running performance, at least when compared to that of the previous season. As the new wave of the COVID-19 pandemic are hitting most countries worldwide, it is expected that some sports competitions will have to be suspended to reduce the spread of the SARS-CoV2. The current data may be useful for sport's governing bodies to value the use of unusual regulations to reduce the stress of sports, particularly in those circumstances where athletes have been confined to home or when the competition has been suspended for several weeks. As the duration of lockdown and sports competition interruption may be substantially different among countries, future investigations should determine the best guidelines for sports competition resumption after suspension due to COVID-19. These best guidelines should include information about the length of retraining and modulation of some in-game regulations.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author. LaLiga is the owner of these data and this institution should approve any use of the data for further investigations.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Camilo José Cela University Ethics Committee. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

All the authors have equally contributed to the conception and preparation of this investigation. All authors have read and approved the final version of the manuscript and agreed with the order of presentation of the authors.

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REFERENCES

Barca Innovation Hub (2020). *COVID-19: How Fc Barcelona Trains During The Isolation Period. Barca Innov Hub*. Available online at: https://barcainnovationhub.com/covid-19-how-fc-barcelona-trains-during-the-isolation-period/ (accessed March 24, 2021).

Bengtsson, H., Ekstrand, J., Waldén, M., and Hägglund, M. (2014). Muscle injury rates in professional soccer increase with fixture congestion: an 11-year follow-up of the UEFA Champions League injury study. *Br. J. Sports Med.* 48, 566–567. doi: 10.1136/bjsports-2014-093494.19

Bisciotti, G. N., Eirale, C., Corsini, A., Baudot, C., Saillant, G., and Chalabi, H. (2020). Return to soccer training and competition after lockdown caused by the COVID-19 pandemic: medical recommendations. *Biol. Sport* 37, 313–319. doi: 10.5114/biolsport.2020.96700

Bradley, P. S., Lago-Peñas, C., and Rey, E. (2014). Evaluation of the match performances of substitution players in elite soccer. *Int. J. Sports Physiol. Perform.* 9, 415–424. doi: 10.1123/IJSPP.2013-0304

Brito Souza, D., López-Del Campo, R., Blanco-Pita, H., Resta, R., and Del Coso, J. (2020). Association of match running performance with and without ball possession to soccer performance. *Int. J. Perform. Anal. Sport* 20, 483–494. doi: 10.1080/24748668.2020.1762279

Buldú, J. M., Antequera, D. R., and Aguirre, J. (2020). The resumption of sports competitions after COVID-19 lockdown: the case of the Spanish soccer league. *Chaos Solitons Fractals* 138:109964. doi: 10.1016/j.chaos.2020.109964

Carmody, S., Ahmad, I., Gouttebarge, V., Malhotra, A., Glover, D., and Massey, A. (2020). Infographics. Soccer-specific strategies to reduce COVID-19 transmission. *Br. J. Sports Med.* 54, 1362–1364. doi: 10.1136/bjsports-2020-102693

Castañeda-Babarro, A., Coca, A., Arbillaga-Etxarri, A., and Gutiérrez-Santamaría, B. (2020). Physical activity change during COVID-19 confinement. *Int. J. Environ. Res. Public Health* 17, 1–10. doi: 10.3390/ijerph17186878

Cohen, J. (1988). *Statistical Power Analysis for The Behavioral Sciences*, Second Edn. Mahwah, NJ: Lawrence Erlbaum Associates.

Corsini, A., Bisciotti, G. N., Eirale, C., and Volpi, P. (2020). Soccer cannot restart soon during the COVID-19 emergency! A critical perspective from the Italian experience and a call for action. *Br. J. Sports Med.* 54, 1186–1187. doi: 10.1136/bjsports-2020-102306

Del Coso, J., de Souza, D. B., Moreno-Perez, V., Buldú, J. M., Nevado, F., Resta, R., et al. (2020). Influence of players' maximum running speed on the team's ranking position at the end of the Spanish Laliga. *Int. J. Environ. Res. Public Health* 17, 1–11. doi: 10.3390/ijerph17238815

Felipe, J. L., Garcia-Unanue, J., Viejo-Romero, D., Navandar, A., and Sánchez-Sánchez, J. (2019). Validation of a video-based performance analysis system (Mediacoach§) to analyze the physical demands during matches in LaLiga. *Sensors (Switzerland)* 19:4113. doi: 10.3390/s19194113

Herrero-Gonzalez, H., Martín-Acero, R., Del Coso, J., Lalín-Novoa, C., Pol, R., Martín-Escudero, P., et al. (2020). Position statement of the Royal Spanish Soccer Federation for the resumption of soccer activities after the COVID-19 pandemic (June 2020). *Br. J. Sports Med.* 54, 1133–1134. doi: 10.1136/bjsports-2020-102640

Linke, D., Link, D., and Lames, M. (2020). Soccer-specific validity of TRACAB's optical video tracking systems. *PLoS One* 15:e0230179. doi: 10.1371/journal.pone.0230179

Longo, U. G., Sofi, F., Candela, V., Dinu, M., Cimmino, M., Massaroni, C., et al. (2019). Performance activities and match outcomes of professional soccer teams during the 2016/2017 Serie A season. *Medicina (Kaunas)* 55:496. doi: 10.3390/medicina55080469

Meyer, T., MacK, D., Donde, K., Harzer, O., Krutsch, W., Rössler, A., et al. (2020). Successful return to professional men's soccer (soccer) competition after the COVID-19 shutdown: a cohort study in the German Bundesliga. . *Br. J. Sports Med.* 55, 1–6. doi: 10.1136/bjsports-2020-103150

Mohr, M., Draganidis, D., Chatzinikolaou, A., Barbero-Álvarez, J. C., Castagna, C., Douroudos, I., et al. (2016). Muscle damage, inflammatory, immune and performance responses to three soccer games in 1 week in competitive male players. *Eur. J. Appl. Physiol.* 116, 179–193. doi: 10.1007/s00421-015-3245-2

Moreno-Pérez, V., Del Coso, J., Romero-Rodríguez, D., Marcé-Hernández, L., Peñaranda, M., and Madruga-Parera, M. (2020). Effects of home confinement due to COVID-19 pandemic on eccentric hamstring muscle strength in soccer players. *Scand. J. Med. Sci. Sport* 30, 2010–2012. doi: 10.1111/sms.13768

Mota, G. R., Dos Santos, I. A., Arriel, R. A., and Marocolo, M. (2020). Is it high time to increase elite soccer substitutions permanently? *Int. J. Environ. Res. Public Health* 17, 1–13. doi: 10.3390/ijerph17197008

Pereira, L. A., Freitas, T. T., Pivetti, B., Alcaraz, P. E., Jeffreys, I., and Loturco, I. (2020). Short-Term detraining does not impair strength, speed, and power performance in elite young soccer players. *Sports* 8:141. doi: 10.3390/sports8110141

Pons, E., García-Calvo, T., Resta, R., Blanco, H., López Del Campo, R., Díaz García, J., et al. (2019). A comparison of a GPS device and a multi-camera video technology during official soccer matches: agreement between systems. *PLoS One* 14:e0220729. doi: 10.1371/journal.pone.0220729

Sarmento, H., Anguera, M. T., Pereira, A., and Araújo, D. (2018). Talent identification and development in male soccer: a systematic review. *Sport Med.* 48, 907–931. doi: 10.1007/s40279-017-0851-7

Sarto, F., Impellizzeri, F. M., Spörri, J., Porcelli, S., Olmo, J., Requena, B., et al. (2020). Impact of potential physiological changes due to COVID-19 Home confinement on athlete health protection in elite sports: a call for awareness in sports programming. *Sport Med.* 50, 1417–1419. doi: 10.1007/s40279-020-01297-6

Souza, D. B., de González-García, J., Campo, R. L.-D., Resta, R., Buldú, J. M., Wilk, M., et al. (2020). Players' physical performance in LaLiga when the competition resumes after COVID-19: insights from previous seasons. *Biol. Sport* 37, 2–7. doi: 10.5114/biolsport.2020.96856

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