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TESIS DOCTORAL / *DOCTORAL THESIS*

Análisis de la acción de juego de los equipos en las ligas profesionales del fútbol español desde 2011-12 hasta 2018-19 /

Performance analysis of the teams in the professional Spanish football leagues from 2011-12 to 2018-19

Presentado por / *Presented by*

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Declaración

Yo, Ibai Errekagorri Elezkano, declaro haber sido el autor del diseño de este proyecto de investigación y de la redacción de los artículos que componen esta tesis doctoral y de todos los apartados del documento final. Para ello, ha sido fundamental revisar la literatura científica relacionada con el tema del proyecto, plantear los objetivos y las hipótesis, diseñar el método de los estudios, extraer los datos para crear una matriz, realizar los análisis estadísticos correspondientes, interpretar los resultados y plantear las discusiones. Los datos para llevar a cabo esta tesis doctoral se obtuvieron desde la aplicación *Mediacoach*, perteneciente a *LaLiga* Española de Fútbol Profesional, que autorizó el uso de las variables incluidas en esta investigación. Me gustaría destacar que nada de esto hubiera sido igual sin las revisiones y los eternos consejos de mi director, Julen Castellano. Él tiene la culpa de mi formación como investigador.

El presente proyecto de investigación ha sido realizado con la ayuda Predoctoral de Formación de Personal Investigador no Doctor del Departamento de Educación del Gobierno Vasco entre 2020 y 2024 (números de referencia: PRE_2019_1_0210, MOD.: A; PRE_2020_2_0046, MOD.: A; PRE_2021_2_0077, MOD.: A; PRE_2022_2_0207, MOD.: A), y el centro de aplicación ha sido el Departamento de Educación Física y Deportiva de la Facultad de Educación y Deporte de la UPV/EHU. Además, esta tesis doctoral ha sido respaldada por el subproyecto del Gobierno de España *Mixed method approach on performance analysis (in training and competition) in elite and academy sport* [PGC2018-098742-B-C33] (2019-2021) [Ministerio de Ciencia, Innovación y Universidades (MCIU), la Agencia Estatal de Investigación (AEI) y el Fondo Europeo de Desarrollo Regional (FEDER)], que ha formado parte del proyecto coordinado *New approach of research in physical activity and sport from mixed methods perspective* (NARPAS_MM) [SPGC201800X098742CV0]. Durante este periodo, también he recibido una ayuda complementaria para realizar una estancia predoctoral de investigación de tres meses en el Departamento de Ciencias del Deporte de la Facultad de Ciencia y Tecnología de la Universidad Trent de Nottingham (Inglaterra, Reino Unido), la cual me ha permitido realizar la tesis con mención “Doctorado Internacional”.

Finalmente, declaro no haber tenido ningún conflicto de intereses a la hora de realizar la presente tesis doctoral.

Tesis por compendio de publicaciones

Esta tesis doctoral se presenta en formato de compendio de publicaciones, respetando el Capítulo XI de la Normativa de Gestión de las Enseñanzas de Doctorado de la UPV/EHU, cuya información se puede consultar en la página web https://www.ehu.eus/es/web/doktoregoa/tesis-doctoral/tesis-por-compendio-de-publicaciones.

La tesis está compuesta por cinco estudios publicados en revistas científicas que aparecen en la última relación publicada por el *Journal Citation Reports* (SCIE y/o SSCI). Estas son las referencias de los estudios:

- **Estudio 1:** Errekagorri, I., Castellano, J., Echeazarra, I., & Lago-Peñas, C. (2020). The effects of the Video Assistant Referee system (VAR) on the playing time, technical-tactical and physical performance in elite soccer. *International Journal of Performance Analysis in Sport*, *20*(5), 808–817. https://doi.org/10.1080/24748668.2020.1788350
- **Estudio 2:** Errekagorri, I., Castellano, J., Echeazarra, I., López-Del Campo, R., & Resta, R. (2022). A longitudinal analysis of technical-tactical and physical performance of the teams in the Spanish LaLiga Santander: An eight-season study. *Biology of Sport*, *39*(2), 389–396. https://doi.org/10.5114/biolsport.2022.105331
- **Estudio 3:** Errekagorri, I., López-Del Campo, R., Resta, R., & Castellano, J. (2024). Performance analysis of the teams that remained in the top-tier division of the Spanish LaLiga during eight consecutive seasons. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 1-10. https://doi.org/10.1177/17543371241232034
- **Estudio 4:** Errekagorri, I., Fernandez-Navarro, J., López-Del Campo, R., Resta, R., & Castellano, J. (2024). An eight-season analysis of the teams' performance in the Spanish LaLiga according to the final league ranking. *PLOS ONE*, *19*(2), e0299242. https://doi.org/10.1371/journal.pone.0299242

- **Estudio 5:** Errekagorri, I., López-Del Campo, R., Resta, R., & Castellano, J. (2023). Performance Analysis of the Spanish Men's Top and Second Professional Football Division Teams during Eight Consecutive Seasons. *Sensors*, *23*(22), 9115. https://doi.org/10.3390/s23229115

La tesis doctoral ha sido escrita en español, excepto los métodos y las conclusiones, que han sido redactadas en inglés, ya que se trata de una tesis con mención de "Doctorado Internacional". Los cinco artículos, por su parte, han sido redactados en inglés, siguiendo la normativa de las revistas donde han sido publicados.

Consejos para la lectura

Esta tesis doctoral está formada por varias secciones. La primera es la introducción, donde se ha llevado a cabo una presentación de la tesis y una justificación de la unidad temática. La segunda es el marco teórico, donde se abordan diferentes temas relacionados con la tesis, concretamente la aplicación de la tecnología y los datos en el fútbol profesional, el uso de diferentes variables e indicadores de rendimiento del fútbol, las variables contextuales y situacionales del fútbol y la evolución de la acción de juego del fútbol a lo largo de los años. La tercera sección tiene que ver con los objetivos y las hipótesis de los cinco estudios publicados en revistas que completan este proyecto. La cuarta está relacionada con los métodos utilizados en los cinco estudios. En la quinta sección se muestra el resumen de resultados y discusión de cada estudio. En la sexta sección se presentan las consideraciones finales, que está compuesta por las limitaciones, conclusiones y futuras líneas de investigación. En la séptima sección se han añadido las referencias utilizadas a lo largo del documento. Finalmente, en la octava sección, denominada como anexos, han sido añadidos los artículos publicados en formato revista con las referencias completas, el factor de impacto de la revista en el año de la publicación, su posición relativa en la categoría a la que pertenece, y otros indicios de calidad. Además, en esta sección también se ha incluido la resolución del Comité de Ética para las Investigaciones relacionadas con Seres Humanos de la UPV/EHU.

Abreviaturas

ALT = altura (en inglés, *height*)

AMP = amplitud (en inglés, *width*)

CEN = centros (en inglés, *crosses*)

COR = saques de esquina (en inglés, *corners*)

DT = distancia total recorrida

EPTS = sistemas de seguimiento electrónico del rendimiento

FAL = faltas (en inglés, *fouls*)

GNSS = sistemas globales de navegación por satélite

GPS = sistemas de posicionamiento global

GOL = goles (en inglés, *goals*)

Hz = hercios

IMU = unidad de medición inercial

IR = indicadores de rendimiento

km/h = kilómetros por hora

LaLiga = Primera División Española de Fútbol Masculino

LaLiga2 = Segunda División Española de Fútbol Masculino

LPS = sistemas de posicionamiento local

m = metros

min = minutos

PORDEF = distancia del portero respecto a su defensor más cercano

PRO = profundidad (en inglés, *length*)

PT = pases totales (en inglés, *total passes*)

PE = pases exitosos (en inglés, *successful passes*)

REG = regates (en inglés, *dribbles*)

s = segundos

TEJ = tiempo efectivo de juego

TIR = tiros (en inglés, *shots*)

TTJ = tiempo total de juego

UPV/EHU = Universidad del País Vasco/Euskal Herriko Unibertsitatea

VAR = árbitro asistente de vídeo

VAR0 = ninguna intervención del árbitro asistente de vídeo

VAR1 = una intervención del árbitro asistente de vídeo

VAR2 = dos o tres intervenciones del árbitro asistente de vídeo

Abbreviations

AIC = Akaike information criterion

EPT = effective playing time

EPTS = electronic performance and tracking systems

GKDEF = distance from the goalkeeper to his nearest defender

GNSS = global navigation satellite systems

GPS = global positioning systems

IMU = inertial measurement unit

km/h = kilometres per hour

KPI = key performance indicators

LaLiga = Spanish First Division of Men's Football

LaLiga2 = Spanish Second Division of Men's Football

LPS = local positioning systems

ML = maximum likelihood

REML = restricted maximum likelihood

TD = total distance covered

TD21 = total distance covered above 21 km/h

TPT = total playing time

RFID = radio frequency identification

UWB = ultra-wideband

VAR = Video Assistant Referee

VAR0 = no intervention by the Video Assistant Referee

VAR1 = one intervention by the Video Assistant Referee

VAR2 = two or three interventions by the Video Assistant Referee

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1. Introducción

Reep & Benjamin (1968) fueron pioneros en analizar las oportunidades de gol en el fútbol de rendimiento. Años más tarde, Reilly & Thomas (1976) analizaron la respuesta locomotriz de los futbolistas en competición. Estos dos estudios, de registro manual (observacional), fueron el punto de partida del análisis notacional (en inglés, *notational analysis*) y del análisis cinético (en inglés, *time-motion analysis*) en el fútbol. Años más tarde, el método observacional aplicado al deporte comenzó a forjarse en España (Anguera et al., 2000), siendo fundamental para describir y explicar objetivamente el comportamiento de los jugadores y equipos de fútbol durante un partido, principalmente mediante distribuciones de frecuencia de ciertos eventos del juego, proporcionando de esta manera información muy valiosa para mejorar el rendimiento futuro (Preciado et al., 2019).

La evolución tecnológica en el mundo del deporte en general, y en el fútbol en particular, ha experimentado un enorme auge en los últimos años (Rein & Memmert, 2016). Asimismo, el análisis del rendimiento tanto del entrenamiento como de la competición en el fútbol, especialmente en el profesional, ha desarrollado desde métodos de análisis tradicionales, concretamente cualitativos, hasta técnicas avanzadas de análisis de la acción de juego basadas en datos (Memmert & Rein, 2018). Hoy día existen sistemas de seguimiento electrónico del rendimiento (e.g., sistemas globales de navegación por satélite (GNSS), sistemas de posicionamiento local (LPS) y sistemas basados en cámaras con sensor óptico) que permiten realizar el análisis de variables cinemáticas (e.g., desplazamientos, aceleraciones), así como de variables individuales (e.g., mapas de calor) y tácticas colectivas de un equipo (e.g., posicionamiento promedio de los jugadores, distancias entre jugadores y/o espacios cubiertos por un grupo de jugadores) a partir de los datos de posicionamiento registrados (Low et al., 2020; Rico-González, Los Arcos, Nakamura, Moura, et al., 2020; Rico-González, Los Arcos, Rojas-Valverde, et al., 2020).

La dimensión física o condicional no ha sido la única beneficiada de las nuevas tecnologías, ya que estas ahora también permiten analizar el comportamiento colectivo de jugadores y equipos. Los sistemas de seguimiento electrónico del rendimiento, a través del dato posicional, permiten medir e identificar la acción de los jugadores individualmente, de los equipos y de la interacción de estos con mayor profundidad, y gracias a ello, ha sido posible llevar a cabo estudios más precisos y objetivos durante el entrenamiento y, especialmente, durante la competición. Además, disponer de más datos ayudará a que los investigadores puedan afrontar una limitación importante de pequeños tamaños de muestra que podían ser comunes en estudios previos (Coutts, 2014).

Cabe destacar que ha habido un aumento de estudios sobre el análisis de la acción de juego del fútbol, como por ejemplo las comparaciones de las demandas del juego entre diferentes ligas, el impacto de variables contextuales (ubicación del partido, nivel del rival, resultado momentáneo del partido, etc.) en la dimensión condicional y decisional de los equipos, o la evolución de la dimensión condicional y decisional de los jugadores y equipos a lo largo de los años en diferentes competiciones, entre otros (Sarmento et al., 2014). Respecto a este último punto, estudios anteriores han analizado la evolución del fútbol a lo largo de las temporadas, tanto en competiciones nacionales (Allen et al., 2023; Barnes et al., 2014; Bradley et al., 2016; Bush et al., 2015; González-Rodenas et al., 2023, 2024; Konefał et al., 2019; Lago-Peñas et al., 2022; Mićović et al., 2023; Pons et al., 2021) como en competiciones internacionales (Barreira et al., 2015; Wallace & Norton, 2014). No obstante, hasta el día de hoy son muy escasos o inexistentes los estudios que han analizado la evolución de la acción de juego de los equipos de la máxima categoría de una liga profesional doméstica teniendo en cuenta su comportamiento colectivo, es decir, el uso colectivo del espacio que hacen los equipos en el terreno de juego durante el partido. Tampoco se ha realizado ninguna investigación sobre la evolución de la acción de juego de ninguna liga profesional doméstica considerando únicamente los equipos que se mantuvieron en la máxima categoría a lo largo de los años, ni sobre la evolución de la acción de juego de los equipos de la segunda categoría de una liga profesional doméstica.

A consecuencia de ello, se decidió llevar a cabo diferentes estudios con los que ha sido configurada la presente tesis doctoral. Este proyecto de investigación lo configuran cinco artículos que tratan sobre el análisis de la acción de juego de los equipos pertenecientes a las ligas profesionales españolas de fútbol masculino durante ocho temporadas consecutivas, concretamente desde la temporada 2011-12 hasta la 2018-19.

En el primer estudio se analizó si la intervención del árbitro asistente de vídeo (VAR) provocó modificaciones en la dinámica del juego durante los partidos de la Primera División Española de Fútbol Masculino (*LaLiga*) en la temporada 2018-19. Para ello, se analizaron diferentes variables e indicadores de rendimiento (IR) relacionados con el tiempo de juego, con la dimensión tanto condicional como decisional y con el comportamiento colectivo en tres momentos diferentes: cuando el VAR no intervino ninguna vez en el partido, cuando intervino una vez y cuando intervino dos o tres veces. Cabe señalar que la temporada 2018-19 fue cuando se puso en funcionamiento el VAR en la Liga Nacional de Fútbol Profesional, y precisamente por ello, este estudio se realizó

para decidir si incluir o no esta temporada en la muestra de la investigación. Este trabajo ha sido el primero en evaluar el impacto del VAR en la dinámica del juego en una liga profesional doméstica.

En el segundo estudio se analizó la evolución de la acción de juego de todos los equipos que participaron en *LaLiga* desde la temporada 2011-12 hasta la 2018-19. Para ello, se analizaron diferentes variables e IR relacionados con la dimensión física y decisional. Aunque hasta la fecha haya varios estudios realizados sobre la evolución de la dimensión física y decisional tanto de los jugadores como de los equipos de *LaLiga* española, cabe indicar que cuando se realizó este trabajo solamente había sido publicado un estudio sobre la evolución de la dimensión física de las dos ligas profesionales del fútbol masculino español a lo largo de cuatro temporadas consecutivas (Pons et al., 2021). La información aportada en este estudio, especialmente por la gran muestra utilizada, permitirá disponer de valores de referencia que han caracterizado la acción de juego de los equipos de *LaLiga* en la dimensión tanto condicional como decisional y en el comportamiento colectivo.

En el tercer estudio se analizó la evolución de la acción de juego de aquellos equipos que permanecieron en *LaLiga* durante el periodo de ocho temporadas (desde 2011-12 hasta 2018-19). Para ello, también se analizaron diferentes variables e IR relacionados con la dimensión física y decisional. Cabe destacar que este trabajo ha sido el primero en analizar la evolución de la dimensión física y decisional de los equipos que se mantuvieron en *LaLiga* en el transcurso de un periodo de varias temporadas. La información aportada en este estudio, principalmente por la inclusión de un gran volumen de datos, también permitirá tener valores de referencia que han caracterizado la acción de juego de estos equipos en la dimensión tanto condicional como decisional y en el comportamiento colectivo.

En el cuarto estudio se analizó se analizó la evolución de la acción de juego de todos los equipos que participaron en *LaLiga* desde la temporada 2011-12 hasta la 2018-19 considerando la clasificación final liguera. Para ello, los equipos fueron divididos en cuatro grupos. En este trabajo también se analizaron diferentes variables e IR relacionados con la dimensión física y decisional, además del número de puntos acumulados por los equipos al finalizar cada temporada. A conocimiento del doctorando, este ha sido el primer trabajo que ha analizado la evolución de la dimensión física y decisional de los equipos según la clasificación final en *LaLiga*, donde se han incluido variables relacionadas con el comportamiento colectivo como la amplitud, profundidad,

altura y la distancia del portero respecto su defensor más cercano. La información aportada en este trabajo, especialmente por la inclusión de un gran volumen de partidos a lo largo de ocho temporadas, también permitirá disponer de valores de referencia que han caracterizado la acción de juego de los equipos de *LaLiga* en la dimensión tanto condicional como decisional y en el comportamiento colectivo en función del ranking liguero al final de cada temporada.

En el quinto y último estudio se analizó la evolución de la acción de juego de todos los equipos que participaron en la Segunda División Española de Fútbol Masculino (*LaLiga2*) a lo largo de ocho temporadas consecutivas, concretamente desde la temporada 2011-12 hasta la 2018-19. Para ello, también se analizaron diferentes variables e IR relacionados con la dimensión física y decisional. Este trabajo ha sido el primero en analizar la evolución de la dimensión física y decisional de los equipos de la segunda categoría de una liga profesional doméstica durante un periodo de varias temporadas. La información aportada en este estudio, principalmente por el uso de un gran volumen de partidos de *LaLiga2* en el transcurso de ocho temporadas, permitirá disponer de valores de referencia que han caracterizado la acción de juego de los equipos en la dimensión tanto condicional como decisional y en el comportamiento colectivo.

El presente proyecto de investigación comenzó en el curso 2018-19, cuando cursé el Máster Universitario en Ciencias de la Actividad Física y del Deporte de la UPV/EHU. Tras finalizar el máster y realizar una primera aproximación sobre la evolución la acción de juego de los equipos de *LaLiga* durante un largo periodo de tiempo, empecé a diseñar la presente tesis doctoral junto con mi director Julen Castellano, que gracias a su labor como asesor científico en el Deportivo Alavés y con la colaboración del Proyecto *Mediacoach* & Área de Investigación Deportiva de *LaLiga*, fue posible recopilar datos de partidos tanto de *LaLiga* como de *LaLiga2* de varias temporadas. Cabe señalar, por un lado, que la primera temporada de la muestra del presente proyecto, concretamente la 2011-12, es la temporada en la que se empezó a utilizar con regularidad el sistema basado en cámaras con sensor óptico *TRACAB*® en los campos de fútbol y, a facilitar a los equipos profesionales de *LaLiga* informes de los partidos con diferentes parámetros de la dimensión física y decisional tanto de jugadores como de equipos desde la aplicación *Mediacoach*. Por otro lado, la base de datos para este proyecto la creamos después de finalizar la temporada 2018-19, coincidiendo con el final del máster. La siguiente temporada (2019-20), la del COVID-19, fue la que determinó no seguir recopilando datos para este proyecto, porque entendemos que

habría marcado un sesgo importante en el análisis de la evolución de la acción de juego de los equipos del fútbol profesional masculino español.

Por último, me gustaría resaltar que en la estancia predoctoral de tres meses que realicé durante el curso 2022-23 en el Departamento de Ciencias del Deporte de la Facultad de Ciencia y Tecnología de la Universidad Trent de Nottingham (Inglaterra, Reino Unido), aprendí junto con mi tutor Javier Fernández Navarro análisis estadísticos más avanzados como los modelos lineales mixtos, motivo por el que se aplicaron este tipo de análisis estadísticos en los últimos tres estudios que componen esta tesis doctoral.

2. Marco teórico

2.1. La tecnología y los datos en el fútbol profesional

2.1.1. La tecnología en el fútbol profesional

La tecnología ha experimentado un crecimiento significativo en el deporte profesional y, especialmente en los deportes de equipo como el fútbol, permitiendo investigar con mayor precisión y objetividad sobre la acción de los jugadores y equipos (Rein & Memmert, 2016). Actualmente existen diferentes sistemas de seguimiento electrónico del rendimiento, conocidos como EPTS (en inglés, *electronic performance and tracking systems*), que se utilizan en el ámbito de la élite deportiva. Según la FIFA (2015), la tecnología EPTS permite llevar a cabo un seguimiento tanto de jugadores como de equipos con el propósito de objetivar su rendimiento en el entrenamiento y/o en la competición. Principalmente, estos sistemas realizan un seguimiento de las posiciones de los jugadores y del balón, pero también se pueden utilizar junto con una unidad de medición inercial (IMU; en inglés, *inertial measurement unit*), y con sistemas de conexión que miden parámetros fisiológicos. Cabe destacar que los EPTS más destacados en deportes colectivos como el fútbol son los GNSS (en inglés, *Global Navigation Satellite Systems*), LPS (en inglés, *Local Positioning Systems*) y sistemas basados en cámaras con sensor óptico (Oliva-Lozano & Rago, 2020; Torres-Ronda, Clubb, et al., 2022).

Los GNSS son los EPTS que más se utilizan en el fútbol tanto en los entrenamientos como en los partidos. Cabe destacar que estos sistemas no funcionan en instalaciones cerradas, solo en espacios abiertos. Por tanto, el hecho de que el fútbol se practique al aire libre permite que los dispositivos se conecten con los satélites sin requerir ninguna instalación adicional, como por ejemplo cámaras o antenas (Cummins et al., 2013). Los GNSS más conocidos son los sistemas de posicionamiento global (GPS; en inglés, *global positioning systems*), que proporcionan medidas de desplazamiento, velocidad y aceleración mediante el uso de una red satelital (Torres-Ronda, Clubb, et al., 2022). Cabe resaltar que los GPS fueron utilizados inicialmente por el Departamento de Defensa de los Estados Unidos de América y desde entonces ha sido validada para su uso en el deporte (Aughey, 2011). La diferencia de tiempo entre el satélite y el receptor GNSS se utiliza para calcular el tiempo de viaje de la señal y, por consiguiente, la distancia del satélite a cada receptor (Larsson, 2003). Se requiere un mínimo de cuatro satélites para obtener el posicionamiento exacto mediante trigonometría, registrado en coordenadas geográficas (i.e., latitud, longitud y altitud) (Malone et al., 2017). Una vez conocida la posición, el desplazamiento durante un periodo determinado se puede utilizar para calcular la velocidad de un movimiento (Aughey, 2011). La

velocidad es calculada mediante el efecto *Doppler*, que se refiere a un cambio en la frecuencia de las señales del satélite causado por el movimiento del receptor (Terrier & Schutz, 2005). Por su parte, la distancia se calcula aplicando la derivada matemática a la posición, y la aceleración a la velocidad (Varley et al., 2017). Sin embargo, por causa del clima o del entorno en el que se esté realizando la actividad, en alguna ocasión la calidad de la señal puede que no sea la mejor (Terrier & Schutz, 2005). Los GNSS pueden sincronizarse con otros sensores o dispositivos para obtener diferentes parámetros de carga interna (Cummins et al., 2013). Finalmente, cabe señalar que esta tecnología es algo invasiva, ya que hay que colocar al deportista el dispositivo en un chaleco interior para poder obtener los datos.

Los LPS funcionan mediante una instalación de varias antenas colocadas alrededor del espacio donde se va a realizar la actividad, que permiten recopilar información de la posición de los deportistas (Rico-González, Los Arcos, Rojas-Valverde, et al., 2020). Estos sistemas están basados en la tecnología *radio frecuency identification* (RFID), *ultra-wideband* (UWB), infrarrojos, ultrasónico, Zigbee, WIFI, celular y Bluetooth (Alarifi et al., 2016). Los LPS miden la posición de un objeto o persona en movimiento analizando el tiempo y/o ángulo de llegada de una señal entre anclajes fijos y una unidad receptora (Torres-Ronda, Clubb, et al., 2022). Los datos de ese posicionamiento se registran en coordenadas cartesianas (i.e., ejes X e Y); después, la distancia se calcula aplicando la derivada matemática a la posición, la velocidad a la distancia y la aceleración a la velocidad (Torres-Ronda, Clubb, et al., 2022). La precisión de los LPS es buena, ya que estos sistemas se pueden utilizar en espacios cubiertos, semicubiertos o abiertos, independientemente de las condiciones meteorológicas o de la disposición de los satélites (Oliva-Lozano & Rago, 2020). Sin embargo, cualquier fallo que puedan tener las antenas requiere la intervención de alguna persona. Los LPS, al igual que los GNSS, también pueden sincronizarse con otros sensores o dispositivos para obtener diferentes parámetros de carga interna (Rojas-Valverde et al., 2019). Por último, cabe señalar que esta tecnología también es algo invasiva, ya que hay que colocar al deportista el dispositivo en un chaleco interior para poder obtener los datos.

Los sistemas basados en cámaras con sensor óptico funcionan gracias a la instalación de cámaras especiales en la cancha deportiva (e.g., pabellón, estadio…), que graban el encuentro con el objetivo de detectar el posicionamiento de los deportistas y del balón (Carling et al, 2008). Cabe destacar que su instalación es compleja y costosa, debido al tiempo que requiere y a la cantidad de cámaras necesarias para que no existan puntos muertos y, de este modo, evitar localizaciones

ausentes de seguimiento (Oliva-Lozano & Rago, 2020). Mediante los sistemas basados en cámaras de seguimiento óptico es posible monitorizar todos los elementos dentro del espacio de juego, por lo que gracias a algoritmos matemáticos de reconocimiento un mismo sistema es capaz de registrar la actividad de jugadores, de árbitros y del balón (Linke, Link, & Lames, 2018). Sin embargo, no es posible obtener datos más allá de lo que ocurre en el terreno de juego (Oliva-Lozano & Rago, 2020). Los datos de posicionamiento se registran en coordenadas cartesianas (i.e., ejes X e Y) para después, a partir de las coordenadas y el tiempo, calcular la distancia y velocidad, mientras que la aceleración se calcula aplicando la derivada matemática a la velocidad (Torres-Ronda, Clubb, et al., 2022). Uno de los aspectos positivos de esta tecnología es que no es nada invasiva, ya que no es necesario que el deportista y/o el árbitro se coloque ningún dispositivo. Finalmente, cabe indicar que estos sistemas no pueden sincronizarse con otros sensores o dispositivos para obtener diferentes parámetros de carga interna.

A día de hoy, se pueden encontrar dispositivos que combinan GNSS y LPS, además de los IMU y otros sistemas de conexión (Torres-Ronda, Beanland, et al., 2022). Una unidad de medición inercial o IMU, es un dispositivo electrónico que normalmente está compuesto por acelerómetros, giroscopios y magnetómetros (uno por cada eje de movimiento), con el objetivo de obtener medidas de velocidad, rotación y fuerzas gravitacionales (Waegli & Skaloud, 2009). Por su parte, otra característica de los EPTS como los GNSS y LPS, es que permiten conectarse mediante diferente tecnología de conexión (e.g., WIFI, ANT+, Bluetooth o Zigbee) a otros sensores como los monitores de frecuencia cardiaca, los dispositivos de medición de saturación de oxígeno o de electromiografía (Oliva-Lozano & Rago, 2020). Además, otra posibilidad de los EPTS es que se pueden realizar análisis en tiempo real, permitiendo así conocer objetivamente lo que está ocurriendo en el terreno de juego al instante (Oliva-Lozano et al., 2022). Con los EPTS también se pueden realizar análisis utilizando los datos brutos (en inglés, *Raw Data*) de los diferentes sensores. El dato bruto hace referencia al volumen de datos sin tratamiento y que provienen de los sensores que disponen los EPTS, permitiendo de este modo realizar el análisis que más se adecúa a las necesidades del usuario (Malone et al., 2017). Esta tecnología en algo habitual en los equipos profesionales de fútbol y de otros deportes. Con el objetivo de buscar una ventaja competitiva, los clubes están invirtiendo en medios tecnológicos como los EPTS para poder analizar objetivamente las demandas de los deportistas en competición y compararlas con las del entrenamiento y así diseñar tareas *ad hoc*, la relación carga-rendimiento, los comportamientos colectivos del propio

equipo y del rival en competición, el rendimiento de otros jugadores con el objetivo de ficharlos, el riesgo de lesiones y aspectos nutricionales (Ferraz et al., 2023; Torres-Ronda, Beanland, et al., 2022). Cabe indicar que los equipos profesionales de fútbol suelen tener instaladas en sus estadios sistemas basados en cámaras con sensor óptico. Existen varias herramientas de análisis de movimiento de vídeo desarrolladas por empresas que llegan a acuerdos con ligas de diferentes países para instalar las cámaras en los estadios y de esta manera, proporcionar a los equipos informes con parámetros físicos y decisionales tanto de jugadores como de equipos después de cada partido. Además de la tecnología mencionada hasta ahora, en el mercado hay diferentes compañías especializadas (e.g., *OPTA*®, *InStat*®, *WhyScout*®…) que proporcionan datos de eventos decisionales del partido y de la duración de los mismos. Esta fuente de datos suele estar disponible para los partidos oficiales de diferentes ligas del mundo. Cada conjunto de datos contiene información sobre acciones decisionales, una marca de tiempo, los jugadores, la posición y ubicación en el terreno de juego e información adicional (Pappalardo et al., 2019). El procedimiento de recopilación de datos de los eventos de partido lo realizan con una aplicación específica de la empresa varios expertos, normalmente analistas de juego. El etiquetado de los eventos lo suelen realizar habitualmente tres personas, una por cada equipo, y el tercero ejerce como supervisor de los resultados. Para la entrega de los datos en vivo, una cuarta persona se suele encargar de recopilar eventos complejos que necesitan etiquetado adicional y específico o revisiones rápidas (Pappalardo et al., 2019).

La validez, fiabilidad y precisión de los EPTS han sido estudiadas ampliamente (Bastida-Castillo et al., 2018 y 2019; Di Salvo et al., 2006; Linke et al., 2020; Rico-González, Los Arcos, Nakamura, Gantois, et al., 2020). Por una parte, la validez se refiere a si la herramienta que utilizamos mide lo que se pretende medir y, por otra, la fiabilidad se refiere a si la herramienta que utilizamos es reproducible, es decir, si en dos ocasiones distintas, pero en condiciones idénticas, se obtienen los mismos resultados (Hopkins, 2000). En la literatura científica, se pueden encontrar trabajos en el ámbito del fútbol sobre la validez y fiabilidad tanto de los GNSS y LPS (Bastida-Castillo et al., 2018 y 2019; Rico-González, Los Arcos, Nakamura, Gantois, et al., 2020) como de los sistemas basados en cámaras con sensor óptico (Di Salvo et al., 2006; Linke et al., 2020) para el dominio del análisis espacio-temporal, para el comportamiento colectivo y para el posicionamiento de los jugadores. Varios autores (Linke, Link, & Lames, 2018) señalaron tras comparar los GNSS, LPS y sistemas de seguimiento óptico con un sistema de referencia para

capturar los datos de posicionamiento espacial, que hay que tener mucha precaución a la hora de hacer comparaciones directas entre los diferentes EPTS, debido a que observaron las mayores diferencias en el posicionamiento espacial, en la velocidad instantánea y en la aceleración. Sin embargo, en el fútbol (profesional) suele ser habitual utilizar varios EPTS para monitorizar a los jugadores durante el entrenamiento y la competición a lo largo de la semana (Linke, Link, & Lames, 2018; Taberner et al., 2020). Hay jugadores que prefieren jugar los partidos sin el chaleco específico donde se coloca el dispositivo de los GNSS o LPS dentro de un bolsillo en posición vertical entre los omóplatos, o incluso hay clubs que prefieren que sus jugadores jueguen los partidos sin tener que ponérselo, lo que conlleva que en esos encuentros no se dispondrá de ese tipo de dato. No obstante, como ya se ha mencionado anteriormente, los estadios de los clubes de fútbol profesional disponen de la instalación de sistemas basados en cámaras con sensor óptico.

Otra situación que se puede dar en un partido de fútbol es que los jugadores estén siendo monitorizados por más de un EPTS y haya algún fallo de conexión en alguno de ellos, provocando una pérdida en los datos registrados. Por este motivo, comprender el acuerdo entre sistemas es muy importante. Existen diferentes estudios (Buchheit et al., 2014; Castellano et al., 2018; Pons et al., 2019; Taberner et al., 2020) que han estimado fórmulas para tener en cuenta las diferencias entre los sistemas y así poder mejorar la precisión de la intercambiabilidad de los datos obtenidos desde diferentes tecnologías.

Otra cuestión a tener en cuenta en los EPTS es la frecuencia de muestreo, es decir, la cantidad de datos registrados por segundo medidos en Hz. La mayoría de los GNSS normalmente funcionan a 10 Hz (10 datos por segundo), los LPS pueden oscilar entre 10 Hz y 50 Hz (de 10 datos a 50 por segundo), y los sistemas basados en cámaras con sensor óptico a 25 Hz (25 datos por segundo) (Robertson et al., 2023). Principalmente, el debate que surge acerca de la frecuencia de muestreo es que pocos datos por segundo podrían conducir a un análisis incompleto, o incluso erróneo, mientras que una cantidad excesiva de datos por segundo podría, inicialmente, influir en la calidad de la señal debido al ruido del sensor y, en segundo lugar, retrasar el análisis de los resultados (Malone et al., 2017; Rico-González, Los Arcos, Rojas-Valverde, et al., 2020). Por este último motivo, una mayor cantidad de datos por unidad de tiempo, que corresponde a una mayor frecuencia de muestreo, no implica necesariamente una mejor calidad de los datos (Rico-González, Los Arcos, Nakamura, Moura, et al., 2020). Algunas teorías sugieren que la frecuencia de muestreo debe ser al menos el doble de la frecuencia más alta dada por la propia señal, respetando así el

teorema de *Nyquist* (Winter, 2009), aunque su aplicación es complicada en el deporte, agravando la necesidad de buscar nuevas alternativas. Por lo tanto, la precisión de los EPTS depende más de algunas características que determinan la calidad de la señal, como el filtrado, la interpolación o el ruido de la señal, y no tanto de la frecuencia de muestreo (Bastida-Castillo et al., 2018).

Los árbitros de fútbol tienen la complicada tarea de emitir juicios en situaciones de juego que muchas veces involucran movimientos rápidos, una cantidad de jugadores y muchos otros factores con los que tienen que lidiar, aunque a menudo restringidos por una visibilidad limitada (Lex et al., 2015). Anteriormente, se han llevado a cabo diferentes estudios con el principal objetivo de examinar los factores que condicionan el trabajo del árbitro durante los partidos. Algunas de las limitaciones estudiadas incluyen: el efecto *flash-lag* (la dificultad de percibir la posición de un objeto cuando algo más está sucediendo al mismo tiempo) en el caso de errores cometidos en decisiones de fuera de juego (Helsen et al., 2006), ruido de los aficionados relacionado con decisiones favorables a los equipos locales (Nevill et al., 2002) o comentarios de los jugadores sobre juicios sobre la gravedad de una falta (Lex et al., 2015). Otros estudios sugieren que los árbitros añaden más tiempo extra en partidos igualados en los que el equipo local está detrás en el marcador y menos tiempo cuando está por delante (Garicano et al., 2005; Lago-Peñas & Gómez-López, 2016).

En la necesidad de tratar de ayudar el arbitraje, la tecnología EPTS, con el objetivo de facilitar el trabajo del equipo arbitral y reducir la probabilidad de error durante los partidos, en el año 2018 se introdujo en las Reglas de Juego el VAR (IFAB, 2018) para ayudar a evaluar las decisiones tomadas por el árbitro principal a través de imágenes de vídeo en tres situaciones: goles, penaltis e incidentes de tarjeta roja en los que existe confusión al identificar al jugador a amonestar. Una vez que el VAR ha comprobado la grabación del vídeo, se informa mediante auriculares al árbitro principal y es él quien toma la decisión final.

El uso del VAR en competiciones oficiales de fútbol profesional también ha sido objeto de estudio. Cabe mencionar que Spitz et al. (2021) recolectaron datos de 2.195 partidos de fútbol de 13 países distintos (Australia, Bélgica, China, República Checa, Inglaterra, Francia, Alemania, Italia, Países Bajos, Polonia, Portugal, Corea del Sur y Estados Unidos), donde el VAR realizó 9732 controles para detectar posibles incidentes que cambiaran el partido, con una duración media de un control de 22 s. Las comprobaciones dieron como resultado un total de 795 revisiones, con una duración media de 62,0 s para las revisiones en el campo (n=534) y 15,0 s para las revisiones

solo con VAR (n=261). Parece que las probabilidades predictivas de realizar la decisión correcta después de la intervención del VAR fueron significativamente mayores que la de la decisión inicial del árbitro, con una precisión que aumentó del 92,1% al 98,3%. Otro estudio previo sugiere que la implementación del VAR ha reducido el número de goles, faltas y tarjetas amarillas en la *Serie A* de Italia (Lago-Peñas et al., 2019). Este estudio también se encontró que el uso del VAR en la *Bundesliga* alemana resultó en una disminución en el número de fuera de juego y tarjetas amarillas, al tiempo que provocó un aumento en la prórroga agregada en la primera mitad y en el partido en su conjunto. Para ser exactos, los partidos de fútbol en los que se añadió más tiempo extra al final parecen provocar una mayor carga y limitar el rendimiento de la dimensión decisional en los siguientes partidos (Rampinini et al., 2009; Winder et al., 2018). La disminución del rendimiento físico de los futbolistas durante los partidos se ve sustancialmente potenciada por la presencia de prórrogas, en casos de empate al final de los 90 min reglamentarios en las competiciones eliminatorias (Lago-Peñas et al., 2015), y por un aumento en la duración del partido debido a un aumento en el número de interrupciones del juego a lo largo del juego (Linke, Link, Weber, et al., 2018). En este sentido, el número y duración de las paradas que se producen en un partido por pérdida de tiempo, atención a jugadores lesionados (en algunos casos por fatiga) o sustituciones, afecta tanto al tiempo efectivo de juego (TEJ) como al tiempo total de juego (TTJ). Por lo tanto, según las reglas, el tiempo dedicado a la sustitución de jugadores o el número de veces que los jugadores son atendidos en el campo conlleva una prolongación estipulada de la duración del partido (e.g., 30 s por cada sustitución).

Por todo lo comentado previamente, el tiempo real de juego es un aspecto muy a tener en cuenta, dado que proporciona información sobre el contexto que favorece una adecuada interpretación de las exigencias físicas de los jugadores en competición (Castellano et al., 2011) así como su comportamiento estratégico (Harper et al., 2014). Relativizar el rendimiento físico de los jugadores considerando la duración total del partido podría subestimar la respuesta condicional de los jugadores (Castellano et al., 2011; Wass et al., 2020).

2.1.2. Los datos en el fútbol profesional

El mundo del fútbol se ha convertido en una de las principales aplicaciones del *big data*, y su implementación abarcaría tres orientaciones en función del objetivo del análisis (Morgulev et al., 2018): 1) análisis para mejorar el rendimiento condicional y decisional tanto de los jugadores como

de los equipos de forma holística; 2) marketing (e.g., campañas de venta de entradas, identificación de posibles abonados, predicción de asistencia); y 3) ventas (e.g., evaluación de opciones de mercado).

En la línea del análisis de la actuación de jugadores y equipos, las nuevas tecnologías que se encuentran hoy en día en el mercado, junto con otros métodos o fuentes de información, permiten disponer una cantidad muy grande de datos, con gran celeridad y con una alta fidelidad y precisión. Esta era del dato ha traído consigo la oportunidad de explorar nuevas variables e IR y realizar nuevos análisis, facilitando respuestas y ayudando a formular nuevas preguntas de investigación. Con el reto de estudiar la incerteza del juego, se ha subrayado (Castellano, 2022) la oportunidad que brinda implementar los rasgos del dato (e.g., transformado, amplio, profundo, inmediato, completo e incrustado) que se dispone en la actualidad.

Para entender el concepto del dato transformado es importante conocer el funcionamiento de los EPTS. Estos sistemas registran básicamente el dato posicional de los jugadores e incluso del balón que, a través de las coordenadas geográficas (latitud, longitud y altitud en el caso de los GNSS) y coordenadas cartesianas (ejes X e Y en el caso de los LPS y sistemas basados en cámaras con sensor óptico), puede ser transformado en dato decisional en un tiempo (t), permitiendo calcular variables tácticas colectivas representadas en tres primitivas geométricas como el punto, la línea y el área (Rico-González et al, 2021; Rico-González, Pino-Ortega, Nakamura, Moura, et al., 2020a; Rico-González, Pino-Ortega, Nakamura, Moura, et al., 2020b). Por tanto, hoy día los comportamientos colectivos pueden medirse con precisión y de manera sostenible, además de poder conectarse con la dimensión condicional. Cabe destacar que el posicionamiento de un evento puede abordarse desde una mirada multinivel, donde una acción micro puede ser ubicada en una meso (e.g., grupo de jugadores) o en una macro (e.g., el equipo) de la interacción del juego (Castellano, 2022).

El dato amplio hace referencia, básicamente, al volumen de datos (Gandomi & Haider, 2015), aunque también se podrían incorporar en el concepto, el número de dimensiones y el espectro de variables con las que etiquetar las acciones. Debido a esa magnitud de los datos, los equipos de fútbol profesional disponen actualmente de registros del rendimiento de muchos jugadores, equipos, ligas y países, permitiendo además la incorporación de logaritmos, con intención explicativa, e incluso, predictiva, de variables que median y modelan el rendimiento (Castellano, 2022). Todo ello está suponiendo la creación de nuevas variables e IR y de nuevos análisis que

facilitarán la interpretación de la imprevisibilidad propia del fútbol en un partido de competición. Sin embargo, cabe destacar que cada partido tiene su propia particularidad. Las variables distintivas de cada partido, las llamadas variables contextuales y situacionales, permitirán mejorar la interpretación del rendimiento de los equipos. Las variables contextuales están relacionadas con los factores externos del juego (e.g., climatología, localización geográfica del partido, horario del partido, particularidades del campo donde se disputa el partido, público, presupuesto de los equipos, etc.). Las variables situacionales, por su parte, son aquellos factores de la lógica interna del juego. En este caso, se pueden diferenciar dos grupos: a) las referidas al *suprajuego* (Parlebas, 2001), como por ejemplo tipo de competición, categoría, periodo o parte del partido, ubicación del partido (casa o fuera), puntos conseguidos al final del partido, momento de la temporada del partido, ordenamiento de los enfrentamientos, formato de la competición, o criterios de clasificación de los equipos, etc.; y b) las internas (e.g., sustituciones, expulsiones, lesiones, resultado momentáneo del partido, actuación del rival, demarcaciones de los jugadores, sistemas de juego de los equipos, etc.).

El rasgo profundo del dato se vio claramente potenciado a mediados de la primera década del siglo XXI facilitado por la implementación de la micro-tecnología (e.g., acelerómetro, giroscopio y magnetómetro) en los dispositivos GNSS y LPS (Castellano, 2022). Gracias a ello, cada vez se sabe más acerca del patrón de movimiento de los jugadores, incluso existen propuestas que hacen posible detectar estados de forma y de fatiga de los futbolistas (Buchheit et al., 2018; Osgnach et al, 2010). Además, este tipo de dispositivos llevan conexión tipo ANT+ (tecnología de transmisión de datos inalámbrica a corta distancia y de bajo consumo energético) lo que les permite conectarse a otros sensores para registrar y sincronizar parámetros fisiológicos o de carga interna (e.g., frecuencia cardiaca, temperatura, activación muscular, etc.) con los habituales de carga externa (e.g., posiciones, distancias, velocidades, aceleraciones y movimientos inerciales). Gracias a este rasgo del dato, cada entrenamiento o partido se puede convertir en un día de test, ya que desde ellos se pueden hacer valoraciones sobre estados de forma y de fatiga de una manera no invasiva y en un contexto de validez ecológica (Castellano, 2022).

Se entiende que el dato es inmediato porque la velocidad a la que se generan los datos es enorme y a la prontitud a la que se deben analizar para poder actuar en consecuencia (Gandomi & Haider, 2015). Actualmente, la información que se obtiene desde los EPTS está disponible en tiempo real, tanto en el entrenamiento como en el partido. Es por ello que empieza a no ser

necesario esperar a que finalice la sesión para descargar los datos registrados, ya que el dato está accesible mientras transcurre la actividad (Castellano, 2022). Sin embargo, cabe resaltar que los sistemas tradicionales de gestión de datos a menudo no suelen ser capaces de manejar grandes cantidades de datos simultáneamente y al instante, y es aquí donde entran en juego las tecnologías que acompañan al *big data* (Gandomi & Haider, 2015).

Que el dato tenga el rasgo de completo se refiere a la disponibilidad que tienen los equipos de fútbol a día de hoy de tener información sin resquicios entre el proceso de entrenamiento y la competición. Es decir, que de manera multidimensional se dispone de un continuum de información de los jugadores y de los equipos tanto en sesiones de entrenamiento como de competición "con el mismo sistema de registro" (Castellano, 2022). Aunque se disponía de información de ambos, entrenamiento y competición, con sistemas de monitoreo diferentes, no fue hasta el año 2015 cuando la IFAB (2015) autorizó el uso de los EPTS también durante la competición, concretamente, a partir de la temporada 2015-16. El hecho de poder monitorizar a los jugadores con el mismo EPTS durante los siete días de la semana y a lo largo de la temporada, o de las temporadas, ha hecho emerger la implementación de análisis estadísticos de carácter longitudinal intensivo, facilitando conectar el proceso de entrenamiento y competición de manera bidireccional (Castellano, 2022). Por tanto, examinar si lo que se entrena optimiza el rendimiento de los jugadores y equipos en competición es ya una realidad, debido a que es posible saber qué se entrena y cómo se juega en competición de manera objetiva con el mismo sistema de registro.

Gracias a un buen entendimiento entre los sistemas de observación y de seguimiento, convertir el dato *eventing* (eventos decisionales observables) y el dato posicional (ubicación posicional de los jugadores y el balón) ha dado lugar al dato incrustado (Castellano, 2022). Las diferentes fuentes de datos se sincronizan con el objetivo de crear variables e IR complejos. Pero esto no está exento de dificultades, como, por ejemplo, la necesidad de limpiar, transformar y conectar datos recibidos de diferentes fuentes (Gandomi & Haider, 2015). Sin embargo, hay que tener en cuenta la veracidad de los datos, es decir, la falta de fiabilidad inherente de algunas fuentes de datos (Gandomi & Haider, 2015). Estos se pueden abordar utilizando herramientas y análisis desarrollados para la gestión y extracción de datos imprecisos e inciertos de las fuentes de datos que se utilizan. Finalmente, cabe destacar que la Inteligencia Artificial está ganando cada vez mayor relevancia, tratando de identificar de manera automática patrones, empleando para ello

algoritmos, en datos masivos con los que describir el juego e, incluso, predecirlo (Castellano, 2022).

Debido al incremento de fuentes de datos gracias al desarrollo tecnológico, especialmente de los EPTS, el análisis de datos ha empezado a tener cada vez más relevancia en las ciencias de la actividad física y del deporte (Goes et al., 2021; Rein & Memmert, 2016). El avance del análisis deportivo de datos, junto con el de su extensión al *big data*, ha permitido disponer de un nuevo enfoque para la comprensión del juego y para ofrecer información objetiva relevante que podría usarse en la prescripción del entrenamiento para, posteriormente, mejorar el rendimiento en situaciones de entrenamiento y competición, tanto de manera individual como colectiva (Goes et al., 2020; Rein & Memmert, 2016). El *big data*, por su parte, se expresa como la gran cantidad de información recopilada digitalmente y almacenada, resguardada, tratada y analizada, teniendo como objetivo interpretar y tomar decisiones para extraer información significativa (Rojas-Valverde, 2019).

2.2. Variables e indicadores de rendimiento (IR)

Con el objetivo de evaluar el rendimiento tanto de jugadores como de equipos en competición, el uso de variables que midan parámetros de diferentes dimensiones y a diferentes niveles es fundamental (Mackenzie & Cushion, 2013). A partir de la combinación de variables surgen los IR o, en inglés, los *key performance indicators* (KPI). Hoy día, la clave no es manejar muchas variables (habitualmente hay un exceso de información), sino aquellas métricas o IR que sean relevantes, debido a que son representativas del hacer de los jugadores y el equipo. Los IR sirven para atender diversas necesidades evaluativas en el proceso de entrenamiento y en la competición (Castellano & Casamichana, 2016a). Mediante el uso de IR es posible conocer lo realizado por los jugadores o por el equipo en una sesión de entrenamiento o en un partido, desde la carga externa e interna hasta el desarrollo del juego en el plano tanto condicional como decisional (Castellano & Casamichana, 2016a). Por lo tanto, la información obtenida de los IR permitirá tener una idea clara sobre los aspectos que describen la acción de los jugadores y/o del equipo en competición con los que poder orientar la prescripción del proceso de entrenamiento de manera más efectiva. Si bien los primeros IR fueron obtenidos a partir del método observacional, los denominados eventos decisionales (en inglés, *eventing*), que todavía están vigentes en la actualidad, cabe destacar que la incorporación de los diferentes EPTS han proporcionado no solo

multitud de variables en la dimensión condicional, sino que también proporcionan información en lo decisional. En los siguientes apartados explicaremos brevemente cada una de estas aportaciones.

2.2.1. IR de *eventing* en la dimensión decisional

Desde Reep & Benjamin (1968) hasta la actualidad (Castellano et al., 2024), la observación sigue ayudando a entrenadores, analistas e investigadores para 'destripar' el fútbol como deporte complejo que es. Con la observación sistemática es posible acercarse a describir las conductas desplegadas por jugadores y/o equipos durante la acción de juego. Aunque existen muchos ejemplos en el uso de este método, Castellano & Hernández-Mendo (2000) propusieron una mirada particular para observar la interacción de lo que acontece en un partido de fútbol, tomando como muestra la Copa Mundial de Fútbol Francia'98. Se toma este estudio como muestra porque los autores pudieron representar la acción recíproca entre equipos, es decir, la dinámica de los contextos de interacción en competición. Las variables e IR de este carácter pueden dividirse en dos grupos (Sarmento, Clemente, et al., 2018): las que incluyen los comportamientos técnico-tácticos (e.g., pases totales (PT), pases exitosos (PE), regates (REG), centros (CEN), tiros (TIR), tiros a portería, posesiones, etc.); y las que tienen que ver con el balón parado (e.g., goles (GOL), saques de esquina (COR), faltas (FAL), penaltis, fueras de juego, etc.).

El origen de este método se apoyó en aplicaciones diseñadas *ad hoc* (e.g., sistemas de categorías, formatos de campo o la combinación de ambos) con los que registrar el dato (Anguera & Hernández-Mendo, 2013). Este método implica sistematizar la codificación y registro de los datos, comprobando previamente a este proceso si es fiable (Anguera et al., 2000). Por lo tanto, el/la observador/a debe de estar familiarizado/a con la herramienta de codificación, siendo necesario establecer un protocolo de observación para conseguir una mayor fiabilidad inter y/o intra observador después de codificar un encuentro. Sin embargo, este método ha evolucionado tanto que, tal y como se ha mencionado en un apartado anterior, actualmente también existen empresas especializadas en el análisis del rendimiento deportivo que proporcionan datos a los equipos de fútbol (y de otros deportes) después de cada partido. Los datos que ofrecen estas empresas son el resultado de la codificación a partir de una herramienta de observación propia, como en el caso de *OPTA*® (e.g., 85 eventos o conductas y 350 calificadores, https://www.statsperform.com/opta/), registrando en torno a 3000 eventos por partido, en los que algunas veces incluyen información sobre la duración de dichos eventos.

2.2.2. IR de *tracking* en la dimensión condicional

En relación a la dimensión condicional, cabe indicar que los sistemas GNSS, LPS y seguimiento óptico desde el principio de sus orígenes proporcionan variables locomotoras como la distancia (e.g., distancia total recorrida (DT), distancia total recorrida en cada zona de velocidad absoluta y relativa, distancia total recorrida en frenada de alta intensidad, distancia total recorrida en alta demanda metabólica, etc.), el *sprint* (e.g., número de *sprints* por encima del umbral de velocidad absoluto y relativo de *sprint*, media de la duración de los *sprints* absolutos y relativos, velocidad máxima, velocidad media, etc.) y la aceleración (e.g., total de aceleraciones y desaceleraciones, aceleraciones y desaceleraciones por zonas absolutas y relativas, aceleración y desaceleración máxima, etc.), derivadas del desplazamiento espacial que realiza el deportista (Buchheit & Simpson, 2017). En el caso de los GNSS y LPS, también proporcionan variables de carga relacionadas con los patrones de movimiento del deportista (e.g., índice de carga, potencia metabólica, total de saltos, total de pasos, total de impactos horizontales, etc.), derivadas de los sensores inerciales (Buchheit & Simpson, 2017). Respecto a la dimensión fisiológica, los GNSS y LPS también pueden proporcionar variables e IR de carga interna (e.g., frecuencia cardiaca) gracias a que pueden recibir información desde otros sensores (e.g., bandas para registrar la frecuencia cardiaca) que deben llevar los jugadores (Molina-Carmona et al., 2018).

2.2.3. IR de *tracking* en el comportamiento colectivo

Un aspecto relevante de las tecnologías de seguimiento posicional, los EPTS, es que también puede obtenerse información en relación al comportamiento colectivo. Estas variables en realidad son la consecuencia de calcular y conectar el posicionamiento de los jugadores, sea mediante las coordenadas geográficas (latitud, longitud y altitud en el caso de los GNSS) o cartesianas (ejes X e Y, en el caso de los LPS o sistemas de seguimiento óptico).

Estas variables pueden ser agrupadas desde la perspectiva geométrica (Rico-González et al, 2021; Rico-González, Pino-Ortega, Nakamura, Moura, et al., 2020a; Rico-González, Pino-Ortega, Nakamura, Moura, et al., 2020b), dando lugar a: el punto (nodo), la línea (distancia) y el polígono (área). En primer lugar, el punto representa la posición promedio de un jugador, de varios jugadores o de todo el equipo, y es aquí donde surge la variable conocida como centro geométrico (también conocida como centroide) (Rico-González, Pino-Ortega, Nakamura, Moura, et al., 2020a). En segundo lugar, la distancia se refiere a la relación entre un punto y un oscilador o entre dos

osciladores, creando así variables como la amplitud (AMP), profundidad (PRO), altura (ALT), distancia entre el portero y el defensa más cercano de su equipo (PORDEF), diada o distancia entre líneas, entre otras (Rico-González, Pino-Ortega, Nakamura, Moura, et al., 2020b). En tercer y último lugar, el área representa el espacio ocupado por un grupo de jugadores (e.g., espacio de juego efectivo, área o superficie), el espacio explorado (e.g., la posición relativa del equipo) y el espacio dominante/influyente (e.g., la región a la que los jugadores pueden llegar antes que cualquier otro jugador, dependiendo de las regiones de Voronoi) del equipo o de varios jugadores (Rico-González et al., 2021). A partir de estas métricas, resulta posible conocer cómo se dan las relaciones interpersonales entre los jugadores que conforman el equipo y entre los jugadores de ambos equipos, siendo clave la ubicación del balón (Duarte et al., 2012).

2.2.4. La relación de los IR con el éxito

El fútbol al ser un deporte con una baja puntuación, a menudo el resultado final no es el reflejo del rendimiento de los equipos, por lo que utilizar IR al 'margen' del éxito, parece necesario (Lepschy et al., 2018). Se parte de la base, por tanto, que rendimiento y éxito no son lo mismo, aunque un mejor rendimiento aumenta las probabilidades de tener mayor éxito (Lago-Peñas, 2007), e, incluso, podría caber la posibilidad (sin explorar hasta el momento) que un primer éxito también podría influir en un posterior mejor rendimiento. En el fútbol, el azar o la casualidad también juega un papel en el resultado final de un partido. Errores arbitrales o errores graves de los jugadores individuales echan por tierra la interpretación analítica lógica del rendimiento del equipo.

Conocer los IR para saber cuáles son los que determinan el éxito es esencial (Lepschy et al., 2018). Para empezar, el éxito es relativo a las pretensiones o posibilidades de cada equipo, sin embargo, de manera estándar se utilizan diferentes maneras de identificar o etiquetar el éxito de los equipos en la competición. Las más habituales se refieren a los goles marcados (Tenga & Sigmundstad, 2011) o a los partidos ganados (Lago-Peñas et al., 2011), sin embargo, también se ha propuesto clasificar el éxito en función de las eliminatorias superadas (Clemente, 2012) y en función de todo lo acumulado al finalizar el campeonato, como por ejemplo, los puntos acumulados al final de temporada (Collet, 2013) o la clasificación final obtenida en liga (Lago-Peñas & Lago-Ballesteros, 2011). Todas ellas válidas, aunque no exentas de limitaciones.

Una de las principales limitaciones está relacionada con que, a veces, el resultado de un partido no ha sido reflejo del rendimiento de los equipos, ya comentado previamente. Otra limitación tiene que ver cuando se propone clasificar la calidad de los equipos en función de los puntos acumulados o la clasificación final obtenida, ya que quedan fuera de la consideración los diferentes momentos, mejores y peores, que un equipo haya podido tener a lo largo de la temporada. Un equipo, aunque haya quedado sexto y, por tanto, haya conseguido un puesto para competir la temporada siguiente en Europa, es posible que no en todas las jornadas de la temporada haya estado situado en ese grupo de candidatos a competir internacionalmente al siguiente año. En cualquier caso, conociendo estas limitaciones, hay que tomar algunas decisiones para etiquetar el éxito en competición.

Para identificar las dimensiones que conducen al éxito en el fútbol es necesario proponer IR que discriminen significativamente a ganadores y perdedores (Castellano et al., 2012). Algunos autores (Castellano, 2018; Vales-Vázquez et al., 2011) han descrito que la dimensión decisional (en un sentido más micro o individual) y el comportamiento colectivo tienen mayor relación con el éxito de los equipos que otras dimensiones, como por ejemplo la dimensión física, que es la más estudiada. En una revisión sistemática (Lepschy et al., 2018) donde se analizaron 76 variables e IR de 68 artículos relacionados con el análisis de la acción de juego del fútbol masculino adulto en diferentes tipos de competición (e.g., ligas domésticas, campeonatos internacionales o copas del mundo), se determinó que variables de la dimensión decisional como los tiros a portería o la posesión de balón y, sobre todo, la eficacia de estas conductas (ratio de goles entre tiros o ratio de pases exitosos vs. pases totales) tenían una alta correlación con los puntos obtenidos al final de la temporada o con un mayor nivel competitivo de los equipos, es decir, con el éxito. Sin embargo, en esta revisión no se incluyó ningún trabajo que incorporase variables de comportamiento colectivo.

A este respecto, Castellano (2018) encontró, tras analizar dos temporadas consecutivas (2013-14 y 2014-15) de *LaLiga*, que variables de comportamiento colectivo como PRO y ALT tuvieron una alta correlación con los puntos obtenidos por los equipos al final de la temporada, la variable AMP una moderada correlación, y la variable PORDEF una pequeña correlación. Además, este autor encontró que las variables GOL, TIR, PT, PE y COR también tuvieron una alta correlación con los puntos obtenidos por los equipos de *LaLiga* al final de la temporada, mientras que la variable FAL tuvo una moderada correlación. Cabe destacar que en este estudio la variable DT no se correlacionó con los puntos obtenidos por parte de los equipos de ninguna de las dos ligas

profesionales españolas. En un estudio más reciente (Brito-Souza et al., 2019), donde los autores trataron de identificar las estadísticas de partido que mejor explicaban el número de puntos obtenidos por los equipos de *LaLiga* al final del campeonato a lo largo de ocho temporadas (desde 2010-11 hasta 2017-18), se observó que las variables decisionales relacionadas con acciones ofensivas que más se asociaban con los puntos obtenidos eran los GOL, TIR, COR, precisión en el tiro, PT y PE. Respecto a las variables decisionales de carácter defensivo, los GOL recibidos fue la variable que presentó la correlación más alta con los puntos obtenidos, seguida de la efectividad de la defensa ante los TIR de los rivales y el número de recuperaciones.

Finalmente, cabe destacar que el estilo de juego parece tener una influencia significativa en las acciones de partido realizadas colectivamente por los equipos. En esta línea, Castellano & Pic (2019) analizaron los estilos de juego de los equipos de *LaLiga* durante una temporada y su relación con el resultado del partido, llegando a la conclusión de que la variable física DT no era representativa de ningún estilo de juego, por lo que este parámetro condicional parece no ser tan relevante en un deporte colectivo como el fútbol. Sin embargo, otras variables como la posesión del balón, PT, ALT o recuperaciones, entre otras, fueron representativas de diferentes estilos de juego de los equipos y, por tanto, claves para determinar su éxito en competición.

2.3. Variables contextuales y situacionales del fútbol

Las variables contextuales y situacionales son factores sobre los que se va teniendo evidencia de que influyen en el comportamiento de los jugadores en competición, donde los aspectos tácticos y estratégicos son clave en el enfrentamiento competitivo (Lago-Peñas et al., 2009). El resultado final de un partido de fútbol está impregnado por variables de diferente índole que se agruparán en contextuales o externas y situacionales o internas a la acción de juego. Estas variables o factores permitirán enmarcar mejor el rendimiento de jugadores o equipos a partir de variables o IR seleccionadas (Castellano, 2018). Tal y como se ha introducido brevemente en un apartado anterior, las variables contextuales son los factores externos del juego y las variables situacionales los factores en estrecha conexión con la lógica interna del juego. Las variables contextuales tienen que ver con la climatología, localización geográfica del partido (e.g., altitud), horario del partido, particularidades del campo donde se disputa el partido (siempre que respete la normativa), público, presupuesto de los equipos, etc. Las variables situacionales, en cambio, pueden dividirse en dos grupos: a) las referidas al *suprajuego* (Parlebas, 2001), que se ajustan a la normativa establecida

por la institución encargada de organizar la competición, donde se incluyen variables como el tipo de competición (formato liga, corta o larga, formato copa, corta o larga, y la combinación liga y copa), categoría, periodo o parte del partido, ubicación del partido (casa o fuera), puntos conseguidos al final del partido, momento de la temporada del partido, ordenamiento de los enfrentamientos, formato de la competición, o criterios de clasificación de los equipos, etc.; y b) las internas, que tienen que ver con las sustituciones, expulsiones, lesiones, resultado momentáneo del partido, actuación del rival, demarcaciones de los jugadores, sistemas de juego de los equipos, etc., que dependen básicamente de las decisiones que toman los protagonistas, jugadores y cuerpo técnico, durante el desarrollo del partido. Esta clasificación de variables contextuales y situacionales atiende a la necesidad de ordenar algunas fuentes de orden que tienen una relación bidireccional con la estrategia y táctica de los entrenadores y jugadores/equipos, respectivamente.

Algunas de las variables contextuales y situacionales que han sido estudiadas por investigadores con el fin de conocer cómo estas afectan en el rendimiento de los jugadores y equipos durante la competición en diferentes dimensiones son: ubicación del partido (Castellano et al., 2011; Fernandez-Navarro et al., 2018; Lago-Peñas & Lago-Ballesteros, 2011), nivel del rival (Aquino et al., 2017; Lago-Peñas, 2009; Taylor et al., 2008), resultado momentáneo del partido (Castellano & Blanco-Villaseñor, 2004; Gómez-Ruano et al., 2020; Moalla et al., 2018), resultado final del partido (Castellano, 2018; Collet, 2013; Lago-Peñas & Dellal, 2010), periodo del partido (Castellano et al., 2011, Harper et al., 2014; Rampinini et al., 2009), posiciones de juego (Bradley et al., 2009; Di Salvo et al., 2007; Mohr et al., 2003), categoría (Bradley et al., 2013; Castellano & Casamichana, 2015), momento de la temporada (Rampinini et al., 2007), clasificación (Bradley et al., 2016; Lago-Peñas et al., 2022; González-Rodenas et al., 2023), sustituciones (Bradley et al., 2014; Gómez-Ruano et al., 2016; Rey et al., 2015), sistemas de juego (Baptista et al., 2019; Bradley et al., 2011), climatología (Mohr et al., 2010; Nassis, 2013), localización geográfica (Gutiérrez, Casamichana, et al., 2018), horario del partido (Gutiérrez, Castellano, et al., 2018) y tamaño del campo (Gutiérrez, Castellano, et al., 2018), entre otras.

Cabe resaltar que en la presente tesis doctoral solamente se van a abordar dos variables situacionales, categoría y clasificación de los equipos, en un periodo de ocho temporadas consecutivas. La variable situacional categoría distingue el nivel de los equipos en las ligas de cada país. Unos investigadores ingleses (Bradley et al., 2013) compararon el rendimiento de la dimensión física y decisional de los jugadores de las tres primeras categorías del fútbol inglés.

Estos encontraron que los jugadores de la *Premier League*, es decir, de la máxima categoría del sistema de ligas de Inglaterra, cubrieron menor DT y de carrera a alta intensidad que los jugadores de la *Championship* (segunda división del sistema de ligas de Inglaterra) y de la *League 1* (tercera división del sistema de ligas de Inglaterra). Respecto al rendimiento de la dimensión decisional, los jugadores de la *Premier League* realizaron un mayor número de PT, PE, pases hacia adelante, balones recibidos y toques por posesión que los jugadores de las otras dos categorías. Bradley et al. (2013) también observaron que aquellos jugadores que pasaron de jugar de la *Premier League* a la *Championship* cubrieron de manera significativa más carreras de alta intensidad. Sin embargo, no observaron diferencias significativas en las carreras de alta intensidad cuando los jugadores ascendieron de categoría de la *Championship* a la *Premier League*.

Pons et al. (2021) analizaron y compararon la evolución del rendimiento de la dimensión física entre los equipos de *LaLiga* y de *LaLiga2* a lo largo de cuatro temporadas, concretamente desde 2015-16 hasta 2018-19. Estos autores observaron en las cuatro temporadas analizadas que los equipos de *LaLiga* mostraron valores superiores en variables como DT, distancia recorrida a alta intensidad y distancia recorrida a *sprint* que los equipos de *LaLiga2*. Castellano & Casamichana (2015), por su parte, analizaron y compararon el rendimiento de la dimensión condicional y decisional y el comportamiento colectivo de los equipos de *LaLiga* y *LaLiga2* durante una temporada. Para ello, dividieron los equipos de cada liga en dos grupos, los primeros 10 clasificados y los últimos 10. Estos autores observaron con relación al comportamiento colectivo que los equipos de *LaLiga*, en concreto los primeros 10, mostraron una mayor PRO que los equipos de *LaLiga2*. Cabe destacar que Castellano & Casamichana (2015) también encontraron que los últimos 10 equipos clasificados de *LaLiga* mostraron una menor ALT que los 10 primeros equipos clasificados de su misma liga y que los equipos de *LaLiga2*. En cuanto a la variable AMP, los últimos 10 clasificados de cada liga mostraron valores significativamente inferiores que los 10 primeros clasificados de cada liga. Estos investigadores también observaron que los equipos de *LaLiga* cubrieron una mayor DT que los equipos de *LaLiga2*, principalmente los primeros 10 clasificados. Además, encontraron que los equipos de *LaLiga*, concretamente los 10 primeros clasificados, mostraron valores superiores en variables decisionales como TIR, COR, PT y PE (medido en %) que los equipos de *LaLiga2*. Ferrandis et al. (2024) compararon el rendimiento de la dimensión condicional y decisional a lo largo de cinco temporadas de los jugadores que pasaron de jugar de *LaLiga2* a *LaLiga*. Estos observaron que el rendimiento físico de los jugadores fue

superior cuando jugaron en primera, mostrando valores más altos en DT y en la distancia recorrida a alta intensidad y un mayor número de acciones a alta intensidad, mientras que su rendimiento decisional fue superior cuando jugaron en segunda, mostrando más PT, pases cortos y largos, REG y TIR.

La variable situacional clasificación, por su parte, diferencia a los equipos según los puntos que estos hayan obtenido al final de la temporada. Con el objetivo de agrupar rendimientos en función del número de puntos acumulados, los equipos suelen ser divididos tomando como referencia la posición en la que estos hayan finalizado el campeonato liguero. González-Rodenas et al. (2023) han analizado recientemente el estilo de juego y el rendimiento decisional de los equipos de *LaLiga* desde la temporada 2008-09 hasta la 2020-21 teniendo en cuenta la clasificación final de liga cada temporada. Para ello, dividieron los equipos en cinco grupos: el campeón de liga, los equipos clasificados para jugar la Liga de Campeones (desde la posición 2 hasta la 4), los clasificados para la *Europa League* (las posiciones 5 y 6), los equipos clasificados en la mitad de la tabla (desde la posición 7 hasta la 17) y los equipos descendidos (desde la posición 18 hasta la 20). Respecto a las variables relacionadas con el estilo de juego, los autores españoles observaron que el campeón de liga solía iniciar las secuencias ofensivas de juego desde una posición más avanzada que el resto de los equipos, y, además, los equipos peor clasificados mostraron una reducción estadísticamente significativa y moderada de la posición donde se iniciaba la secuencia de juego. También observaron que la duración de las secuencias ofensivas y los pases por secuencia fue mayor en el campeón de liga y en los equipos clasificados para la Liga de Campeones en comparación con el resto. Sin embargo, la velocidad directa de progresión, es decir, la distancia en la que el balón se movió hacia la línea de gol del equipo contrario durante la secuencia fue mayor en los equipos peor clasificados. En cuanto a las variables decisionales, los autores observaron que hubo una pequeña reducción en el porcentaje de posesión del balón, precisión en los pases y pases en profundidad, así como una gran reducción en el número de CEN a medida que disminuyó la posición en la clasificación, siendo el campeón de liga el que mostró los valores más altos.

Como ya se ha mencionado anteriormente, Castellano & Casamichana (2015) analizaron y compararon el rendimiento tanto condicional como decisional y el comportamiento colectivo de los equipos de *LaLiga* y *LaLiga2* durante la temporada 2013-14, dividiendo los equipos de cada liga en dos grupos (primeros 10 y últimos 10 clasificados). En *LaLiga*, los primeros 10 equipos clasificados mostraron valores significativamente superiores que los de los últimos 10 clasificados

en la mayoría de las variables que analizaron, concretamente en las de comportamiento colectivo (PRO, ALT y AMP), en la condicional (DT) y respecto a las de rendimiento decisional, en TIR, PT y PE (medido en %). Por su parte, en *LaLiga2*, solamente se encontraron diferencias significativas en la variable AMP, siendo los valores de los primeros 10 clasificados superiores que los de los últimos 10. Finalmente, cabe resaltar que Bradley et al. (2016) y Lago-Peñas et al. (2022) analizaron la evolución del rendimiento condicional y decisional a lo largo de varias temporadas de la *Premier League* y *LaLiga*, respectivamente, considerando la clasificación final. No obstante, este asunto será abordado en el siguiente apartado.

2.4. Evolución de la acción de juego del fútbol

El fútbol, como cualquier otro deporte, es un sistema que cambia con el paso del tiempo (Torres-Ronda, Beanland, et al., 2022). Gracias a los diferentes sistemas de seguimiento electrónico del rendimiento (e.g., GNSS, LPS o sistemas basados en cámaras con sensor óptico), será posible utilizar datos de seguimiento continuo para actualizar la descripción objetiva de las demandas del juego del deporte en cuestión. Son varios los estudios que se han centrado en analizar el rendimiento físico en la competición desde una visión longitudinal (Allen et al., 2023; Barnes et al., 2014; Bradley et al., 2016; Bush et al., 2015; Lago-Peñas et al., 2022; Pons et al., 2021). En este sentido, estudios previos analizaron la evolución del rendimiento físico de los equipos de la *Premier League* inglesa a lo largo de siete temporadas (Barnes et al., 2014), la evolución del rendimiento físico de los futbolistas ingleses considerando su posición de juego (Bush et al., 2015) o la evolución del rendimiento físico de los equipos de la *Premier League* según la clasificación al final de la temporada (Bradley et al., 2016). Barnes et al. (2014) observaron que la DT por los equipos de la *Premier League* no había cambiado demasiado a lo largo de siete temporadas (desde 2006-2007 hasta 2012-2013), aumentando así el número de acciones y la distancia acumulada a alta intensidad, así como el número de acciones y la distancia acumulada a *sprint*. Por su parte, Bradley et al. (2016) encontraron que todos los equipos de la *Premier League* aumentaron la distancia recorrida a alta velocidad cuando no tenían la posesión de balón a lo largo de las siete temporadas. Además, parece que la distancia acumulada a alta intensidad y el número de acciones a alta intensidad y *sprint* aumentaron significativamente en todas las posiciones de juego en los equipos de la *Premier League* desde 2006-07 hasta 2012-2013 (Bush et al., 2015). Durante este periodo, Bradley et al. (2016) observaron que los equipos de la *Premier League* que terminaron

del quinto al octavo puesto al final de la temporada mostraron un ligero aumento en la distancia recorrida a alta intensidad cuando estaban en posesión del balón en comparación con otros equipos. Los equipos clasificados del quinto al octavo puesto también mostraron un aumento significativo en la distancia recorrida a *sprint* en comparación con otros equipos. Con el paso de los años, se han llevado a cabo nuevas propuestas sobre la evolución del rendimiento condicional en la *Premier League* inglesa. Una investigación publicada recientemente sobre las demandas de carrera de los jugadores de la máxima categoría del fútbol profesional inglés, en este caso desde 2014-15 hasta 2018-19, observó aumentos de una temporada a otra en variables como la DT, la carrera a alta velocidad y el *sprint*, pero estos incrementos no fueron consistentemente significativos (Allen et al., 2023). Sin embargo, estos cambios en las demandas de carrera a lo largo del tiempo pueden depender de la posición de juego (Bush et al., 2015). No se debe descartar que es posible que los resultados de este último estudio estén condicionados por la tecnología utilizada para evaluar el rendimiento de carrera. Allen et al. (2023) utilizaron el sistema de seguimiento óptico mediante cámaras *TRACAB*®, mientras que Barnes et al. (2014), Bush et al. (2015) y Bradley et al. (2016) utilizaron el mismo sistema, pero de la empresa *ProZone*®, habiendo diferencias significativas a favor de este último de 500 m en la DT y de 126 m en la distancia recorrida a *sprint* (Taberner et al., 2023). Respecto a *LaLiga* española, también se ha analizado la evolución del rendimiento condicional de los equipos a lo largo de ocho temporadas (desde 2012-13 hasta 2019-20), además de la evolución del rendimiento condicional de los jugadores teniendo en cuenta su posición de juego y la evolución del rendimiento condicional de los equipos considerando la clasificación final liguera (Lago-Peñas et al., 2022). Estos autores observaron una pequeña disminución en la DT por los equipos de *LaLiga* con un mayor número de esfuerzos a alta intensidad a medida que avanzaban las temporadas. También observaron un aumento en el número de acciones a alta intensidad para todas las posiciones de juego analizadas, además de observar una disminución en la DT y un aumento de la distancia recorrida a alta intensidad para casi todas las posiciones. Finalmente, encontraron que los equipos clasificados en la parte media-alta de la tabla (desde la posición 6 hasta la 10) y en la parte inferior de la tabla (desde la posición 16 hasta la 20) cubrieron una distancia mayor a alta intensidad. Al margen de posibles diferencias provocadas por cambios en las cámaras de seguimiento de vídeo (Linke et al., 2020), otro aspecto que podría haber condicionado estos resultados tiene que ver con la participación de diferentes equipos durante esas temporadas, como consecuencia de ascensos y descensos.

El rendimiento decisional también ha recibido una considerable atención en la literatura científica (Barnes et al., 2014; Barreira et al., 2015; Bradley et al., 2016; Bush et al., 2015; Errekagorri et al., 2022; González-Rodenas et al., 2023, 2024; Konefał et al., 2019; Lago-Peñas et al., 2022; Mićović et al., 2023; Wallace & Norton, 2014). En este sentido, Barreira et al. (2015) observaron y registraron 45 partidos y 6.791 ataques en las semifinales y finales del Campeonato de Europa de la UEFA y la Copa Mundial de la FIFA desde 1982 hasta 2010. Estos autores concluyeron que ataques similares liderados por equipos de fútbol de primer nivel se habían alejado de un comportamiento más individualizado, como REG y fintas en el centro del campo, hasta una actuación más grupal, como pases cortos y CEN. Wallace & Norton (2014) analizaron la evolución del juego en competiciones internacionales (Copas Mundiales de la FIFA) a lo largo de un período de 44 años. Estos investigadores indicaron que la velocidad del fútbol había aumentado debido a un aumento significativo en el número de PT en los últimos años. En cuanto a las ligas nacionales, Konefał et al. (2019) estudiaron la evolución del rendimiento decisional de los jugadores de fútbol en la *Bundesliga* alemana por posiciones de juego teniendo en cuenta el resultado final del partido durante tres temporadas consecutivas, concluyendo que la dimensión decisional había evolucionado en todas las posiciones. Esta investigación indica que la evolución de la dimensión decisional entre los jugadores de fútbol profesionales se está desarrollando en una dirección más precisa con una ausencia simultánea de cambios o incluso una disminución en la cantidad o los niveles de actividad. Otros investigadores (Barnes et al., 2014) observaron que en la *Premier League* inglesa se produjo un aumento en el número de PT y PE a lo largo de siete temporadas consecutivas (desde 2006-07 hasta 2012-13), con un aumento notable de los pases cortos y pases de media distancia. Durante este período de siete temporadas, los equipos clasificados en la parte alta de la tabla (desde la posición 1 hasta la 4) de la *Premier League* inglesa mostraron un mayor número de PT y PE que el resto de los equipos (Bradley et al., 2016). Sin embargo, los mayores aumentos en los parámetros decisionales de los pases realizados y recibidos los mostraron los equipos clasificados en la parte media-alta de la tabla (desde la posición 5 hasta la 8). En *LaLiga* española, por su parte, Lago-Peñas et al. (2022) también han analizado recientemente la evolución del rendimiento decisional de los equipos a lo largo de ocho temporadas consecutivas (desde 2012-13 hasta 2019-20), de los jugadores teniendo en cuenta su posición de juego y de los equipos teniendo en cuenta la clasificación final liguera. Estos autores observaron un pequeño aumento a lo largo del período de ocho temporadas en variables decisionales como

PT, pases largos, PE, duelos aéreos e intercepciones. Además, encontraron una ligera disminución durante este período en variables decisionales como TIR, entradas y despejes. Sin embargo, estos autores encontraron que la evolución del rendimiento decisional de los equipos de *LaLiga* a lo largo de las ocho temporadas depende del nivel de estos. Los equipos clasificados entre la primera y la decimoquinta posición presentaban menos TIR, entradas y despejes, y más pases cortos, pases largos y duelos aéreos a medida que avanzaban las temporadas. Finalmente, estos investigadores también investigaron la evolución de los parámetros decisionales considerando las posiciones de juego, y encontraron que los mediocentros extremos y delanteros disminuyeron significativamente los TIR en las últimas temporadas analizadas. González-Rodenas et al. (2024) también han analizado recientemente la evolución de la dimensión decisional con relación a las secuencias ofensivas colectivas en los equipos de *LaLiga* desde la temporada 2008-09 hasta la 2020-21, observando, por una parte, una pequeña tendencia ascendiente a lo largo de las temporadas en variables como el número de PT, los PE (medidos en porcentaje), los PT por secuencia y la duración promedio de las secuencias del equipo y, por otra, una pequeña tendencia descendente desde 2008-09 hasta 2020-21 en variables como la velocidad directa de progresión, los pases clave, pases en profundidad, y las secuencias que terminaron en el último tercio del campo de fútbol o en TIR. Según estos últimos resultados, parece que los equipos de *LaLiga* española han evolucionado ligeramente respecto a la dimensión decisional hacia un estilo de juego más asociativo que incluye secuencias de pases más largas. En los estudios relacionados con la evolución del rendimiento decisional, también se pueden encontrar trabajos realizados sobre la evolución de la formación de los equipos de fútbol. Un estudio reciente sobre la evolución de las formaciones de los equipos desde 2012-13 hasta 2020-21 en *LaLiga* (González-Rodenas et al., 2023) encontró que la estructura táctica más común utilizada por los equipos desde 2012-13 hasta 2016-17 fue el 1-4-2-3-1, mientras que el 1-4-4-2 fue la formación del equipo más frecuente desde la temporada 2017-18 hasta 2020-21. Además, formaciones de equipos como 1-4-3-3 y 1-4-5-1 mostraron una tendencia relativamente estable a medida que avanzaban las temporadas.

Por último, cabe destacar que cuando se llevan a cabo estudios longitudinales de competiciones ligueras, no se tiene en cuenta que el análisis incorpora las actuaciones de equipos que tienen una presencia "fugaz" en la liga. Fugaz porque llegan a la máxima competición una temporada y descienden la siguiente o, en el mejor de los casos, permanecen allí sólo unas pocas temporadas. Los equipos que se encuentran en la parte baja de las clasificaciones finales (e.g.,

desde la posición 11 hasta la 20) suelen tener rendimientos similares, normalmente alejados de los equipos ubicados en la parte alta del ranking (Bradley et al., 2016). Quizás, podría aportar información relevante analizar solamente aquellos equipos que han sido capaces de mantener la categoría durante varias temporadas, mostrando un rendimiento estable en la competición y en una determinada liga a lo largo de los años, que podrían servir como valores de referencia.

3. Objetivos e hipótesis

En esta sección se enumeran los objetivos generales y específicos, así como las hipótesis de la presente tesis doctoral, a partir de los cuales se enumeran los estudios que los han permitido desarrollar.

Este proyecto de investigación tiene como objetivo general describir la acción de juego de los equipos pertenecientes a las ligas profesionales españolas de fútbol masculino a partir de variables e IR, tomando como referencia un periodo de ocho temporadas consecutivas (desde 2011-12 hasta 2018-19). Se debe puntualizar que en la temporada 2018-19, la última analizada del periodo de ocho, la Liga Nacional de Fútbol Profesional implementó el uso del VAR durante los partidos oficiales. Para decidir la inclusión de esta temporada en la muestra, se realizó un estudio para evaluar si el VAR afectó en la dinámica del juego. Por este motivo, este estudio fue el primero que se realizó.

- **Objetivo específico 1:** Valorar si la intervención del VAR afectó al tiempo de juego, a la dimensión decisional y condicional, así como al comportamiento colectivo de los equipos de *LaLiga* española durante la competición.
    - **Hipótesis 1:** La hipótesis de partida fue que el tiempo de juego, la dimensión decisional y condicional, así como el comportamiento colectivo se verán afectados en los partidos en los que interviniera el VAR.
    - **Estudio 1:** "The effects of the Video Assistant Referee system (VAR) on the playing time, technical-tactical and physical performance in elite soccer".

- **Objetivo específico 2:** Describir la acción de juego de los equipos de *LaLiga* española a partir de variables e IR, tomando como referencia un periodo de ocho temporadas consecutivas. Para responder a este objetivo se consideraron, en primer lugar, a todos los equipos que cada año compitieron en *LaLiga*. En segundo lugar, solamente a aquellos equipos que fueron capaces de mantener la categoría durante el periodo de ocho temporadas. Finalmente, en tercer lugar, a todos los equipos que configuraron la liga cada temporada dividiéndolos por grupos en función de la clasificación final liguera.
    - **Hipótesis 2:** La hipótesis de partida será que los equipos de *LaLiga* mantendrán un rendimiento estable a lo largo de todo el periodo analizado.

- **Estudio 2:** "A longitudinal analysis of technical-tactical and physical performance of the teams in the Spanish *LaLiga* Santander: An eight-season study".
- **Estudio 3:** "Performance analysis of the teams that stayed up in the Spanish LaLiga during eight consecutive seasons".
- **Estudio 4:** "An eight-season analysis of the teams' performance in the Spanish LaLiga according to the final league ranking".

- **Objetivo específico 3:** Describir la acción de juego de los equipos de las dos ligas profesionales españolas, *LaLiga* y *LaLiga2,* a partir de variables e IR, tomando como referencia un periodo de ocho temporadas consecutivas.
  - **Hipótesis 3:** La hipótesis de partida será que los equipos de *LaLiga2* mantendrán un rendimiento estable a lo largo de todo el periodo analizado.
  - **Estudio 5**: "Performance Analysis of the Spanish Men's Top and Second Professional Football Division Teams during Eight Consecutive Seasons".

4. Methods

4.1. Sample

In order to carry out this project, the performances of the teams in the Spanish professional football leagues were analysed during a period of eight consecutive seasons (from 2011-12 to 2018-19). However, each study had its special features regarding the sample.

In study 1, out of a possible 380 matches played in the Spanish *LaLiga* during the 2018-19 season, there were a total of 375 matches analysed. Five matches were excluded due to technical issues. The Video Assistant Referee (VAR) intervened 121 times (once in 86 matches, twice in 13 matches and three times in three matches) in 102 matches (27% of the matches played). All the matches were divided into three groups according to the number of VAR interventions: none (VAR0, n=273), one (VAR1, n=86) and two or three (VAR2, n=16).

In study 2, all teams' performances in the Spanish Football First Division (*LaLiga*) were analysed throughout eight consecutive seasons (from 2011-12 to 2018-19). All matches where the information required was not available were excluded (e.g., technology technical errors), as well as matches where one or more players were sent off for a direct red card or double yellow card. As a result, out of a possible 6,080 performances, a total of 5,518 performances were analysed (20 teams, each playing 38 matches throughout the eight seasons), representing 90% of all the possible matches.

In study 3, only the performances of those teams that played in the Spanish *LaLiga* from 2011-12 to 2018-19 were analysed. Out of the 32 teams that participated in the Spanish men's top professional division during the seasons analysed, only eight of them (25% of the total) remained in *LaLiga* in that period. All matches where the information required was not available were excluded (e.g., technology technical errors), as well as matches where one or more players were sent off for a direct red card or double yellow card. As a result, out of a possible 2,432 performances (eight teams, each playing 38 matches throughout the eight seasons), a total of 2,212 performances were analysed.

In study 4, all teams' performances in the Spanish *LaLiga* across eight consecutive seasons (from 2011-12 to 2018-19) were analysed. All matches where the information required was not available were excluded (e.g., technology technical errors), as well as matches where one or more players were sent off for a direct red card or double yellow card. As a result, out of a possible 6,080 performances (20 teams, each playing 38 matches throughout the eight seasons), a total of 5,518 performances were analysed, representing 90% of all the possible matches. During the eight-

season period, 32 teams participated in the men's top professional football division from Spain. All the teams were divided into four groups according to the final league ranking each season: Europe (from 1st to 6th; n=1,642), Upper-Middle (from 7th to 11th; n=1,389), Lower-Middle (from 12th to 17th; n=1,656) and Relegation (from 18th to 20th; n=831).

Finally, in study 5, in addition to the performances of *LaLiga*, all teams' performances in the Spanish Football Second Division (*LaLiga2*) from 2011-12 to 2018-19 were analysed. All matches where the information required was not available were excluded (e.g., technology technical errors), as well as matches where one or more players were sent off for a direct red card or double yellow card. As a result, out of a possible 13,472 performances (6,080 in the Spanish *LaLiga*: 20 teams, each playing 38 matches throughout the eight seasons; and 7,392 in the Spanish *LaLiga2*: 22 teams, each playing 42 matches throughout the eight seasons), a total of 11,019 performances (5,518 in the Spanish *LaLiga* and 5,501 in the Spanish *LaLiga2*) were analysed, representing 82% of all the possible matches.

Data were obtained from the *Spanish Professional Football League*, which authorised the use of the variables included in this investigation. In accordance with its ethical guidelines, this investigation does not include information that identifies football players. Data were treated in accordance with the Declaration of Helsinki, having been approved by the Ethics Committee on Humans of the *University of the Basque Country* (UPV/EHU).

4.2. Variables

Considering previous studies (Castellano, 2018; Castellano et al., 2011; Castellano & Casamichana, 2015; Castellano & Casamichana, 2016b; Castellano & Echeazarra, 2019; Fradua et al., 2013; Harper et al., 2014), the variables used in this project were grouped into five dimensions: playing time (total playing time (TPT) and effective playing time (EPT)), technical-tactical (total passes, successful passes, dribbles, crosses and shots), set piece (goals, corners and fouls), collective behaviour (width, length, height and distance from the goalkeeper to his nearest defender (GKDEF)), and physical (total distance covered (TD) and total distance covered above 21 km/h (TD21)). Table 1 shows the definitions of all the variables used in the different studies. In the case of study 4, the number of points accumulated by the Spanish *LaLiga* teams was also calculated in each of the eight seasons.

Table 1. Definitions of the variables used in the different studies for each dimension.

Dimension	Variable	Definition	Study
Playing time	TPT	Total Playing Time is the duration of the match as a whole, including the amount of time in which the ball is out of play.	1
	EPT	Effective Playing Time is the duration of play after subtracting the amount of time in which the ball is out of play, due to actions such as stoppages, substitutions, goals and injuries, etc.	1
Technical-tactical	Total passes	An intentional played ball from one player to another with any part of the body that is allowed in the laws of the game. When calculating this variable, total number of successful and unsuccessful actions made by the team per match are considered.	1, 2, 3, 4, 5
	Successful passes	A successful pass is one that reaches its recipient. To calculate this variable, total number of successful exchanges of the ball between two players of the same team per match are considered.	3, 4, 5
	Dribbles	An attempt to beat an opponent by feinting to avoid letting the ball be taken from him. When calculating this variable, total number of successful and unsuccessful actions made by the team per match are considered.	1
	Crosses	Balls sent into the rival team's penalty box from a side area of the football pitch. When calculating this variable, total number of successful and unsuccessful actions made by the team per match are considered.	1, 2, 3, 4, 5
	Shots	An attempt to score a goal, made with any part of the body that is allowed in the laws of the game, either on or off the goal. When calculating this variable, total number of actions made by the team per match are considered.	1, 2, 3, 4, 5
Set piece	Goals	Total number of points scored by the team per match.	1, 3, 4, 5
	Corners	A kick that is performed on a set piece from the corner of the football pitch nearest to where the ball went out. When calculating this variable, total number of actions taken by the team per match are considered.	1, 2, 3, 4, 5
	Fouls	Any infringement that is penalised as foul play by the referee. When calculating this variable, total number of actions received by the team per match are considered.	1, 2, 3, 4, 5
Collective behaviour	Width	Mean team amplitude per match, considered as the distance (in m) between the two furthest-apart players of the same team along the amplitude of the pitch. To calculate this variable, the time in which the ball is out of play and the goalkeeper's activity is excluded.	1, 2, 3, 4, 5
	Length	Mean team depth per match, considered as the distance (in m) between the two furthest-apart players of the same team along the depth of the pitch. To calculate this variable, the time in which the ball is out of play and the goalkeeper's activity is excluded.	1, 2, 3, 4, 5
	Height	Mean team defence depth per match, considered as the distance (in m) between the furthest back player and the goal line he is defending. To calculate this variable, the time in which the ball is out of play and the goalkeeper's activity is excluded.	1, 2, 3, 4, 5
	GKDEF	Mean distance (in m) from the goalkeeper to the nearest defender of the same team per match. To calculate this variable, the time in which the ball is out of play is excluded.	1, 2, 3, 4, 5
Physical	TD	Total Distance covered (in m) by all the team's players that participated in the match, including the goalkeeper's activity.	1, 2, 3, 4, 5
	TD21	Total Distance covered (in m) above 21 km/h by all the team's players that participated in the match, including the goalkeeper's activity.	1

4.3. Procedure

Location and motion data were obtained by the computerised multi-camera tracking system *TRACAB*® (*ChyronHego*, New York, USA) and events were obtained by the data company *OPTA*® (*Opta Sports*, London, UK), both using the software *Mediacoach* (*LaLiga*, Madrid, Spain). The reports were generated using *Mediacoach*, for the predefined performance indicators. The reliability of the *OPTA*® system has been previously proved (Liu et al., 2013) and the reliability of the multi-camera tracking system *TRACAB*® has also been tested for positioning and physical performance of the players (Linke et al., 2020). The generated reports were exported into a *Microsoft Excel* spreadsheet (*Microsoft Corporation*, Washington, USA) to configure a matrix and later analyse it.

4.4. Statistical analysis

In study 1, descriptive statistics data from variables were presented using mean and standard deviation with 95% confidence intervals. The Levene test was used to assess equality of variances and the Kolmogorov Smirnov test to establish normality. One-way ANOVA analysis of variance for independent samples was used to test for differences in the variables between the three groups (VAR0, VAR1 and VAR2). Significant results were then analysed using post hoc Bonferroni's test, whereas Dunnett's T3 post hoc test was applied when the variances were not homogeneous. The level of significance was set at $p<0.05$. Effect size was also calculated to determine meaningful differences with magnitudes classified as (Batterham & Hopkins, 2006): trivial (<0.2), small (>0.2-0.6), moderate (>0.6-1.2), large (>1.2-2.0) and very large (>2.0-4.0). The statistical analysis was conducted using *Microsoft Office Excel* (*Microsoft Corporation*, Washington, USA) and *IBM SPSS v25.0* (*SPSS Inc.*, Illinois, USA) for *Windows*.

In study 2, descriptive statistics data from variables were presented using mean and standard deviation. The Levene test was used to assess equality of variances. One-way analysis of variance (ANOVA) for independent samples was used to test for differences in the variables between the eight seasons (from 2011-12 to 2018-19). Significant results were then analysed using the post hoc Bonferroni's test, whereas Dunnett's T3 post hoc test was applied when the variances were not homogeneous. The level of significance was set at $p<0.05$. Effect size was also calculated to determine meaningful differences with magnitudes classified as (Batterham & Hopkins, 2006): trivial (<0.2), small (>0.2-0.6), moderate (>0.6-1.2), large (>1.2-2.0) and very large (>2.0-4.0).

The statistical analysis was conducted using *Microsoft Office Excel* (*Microsoft Corporation*, Washington, USA) and *IBM SPSS v25.0* (*IBM Corp.*, Illinois, USA) for *Windows*.

In study 3, 4 and 5, the statistical analysis was conducted using the software *jamovi 2.4.8* (The jamovi project, 2023) for *Windows*. In the case of study 3, a linear mixed model was carried out for each dependent variable. Season was considered as fixed effect and team as random effect. With regard to study 4, a linear mixed model was carried out for each dependent variable in order to analyse the differences in teams' match performance according to the group and season. Group and season were considered as fixed effects and team as random effect. Regarding study 5, a linear mixed model was carried out for each dependent variable in order to analyse the differences in teams' match performance according to the league and season. League and season were considered as fixed effects and team as random effect. In the three studies, the Akaike information criterion (AIC) (Akaike, 1974) and a likelihood ratio test (Field, 2009) were used to select the model that best fitted each variable. The maximum likelihood (ML) estimation was used for model comparison and, for the final model of each variable, the best model again using restricted maximum likelihood (REML) estimation was refitted (Field, 2009). Marginal and conditional R^2 metrics (Nakagawa & Schielzeth, 2013) were provided for each linear mixed model as a measure of effect sizes. Marginal R^2 is concerned with the variance explained by fixed effects, and conditional R^2 is concerned with the variance explained by both fixed and random effects (Nakagawa & Schielzeth, 2013). The level of significance was set at $p<0.05$.

5. Resumen de resultados y discusión

5.1. Estudio 1: The effects of the Video Assistant Referee system (VAR) on the playing time, technical-tactical and physical performance in elite soccer

Errekagorri, I., Castellano, J., Echeazarra, I., & Lago-Peñas, C. (2020). The effects of the Video Assistant Referee system (VAR) on the playing time, technical-tactical and physical performance in elite soccer. *International Journal of Performance Analysis in Sport*, *20*(5), 808–817. https://doi.org/10.1080/24748668.2020.1788350

El objetivo de este estudio fue evaluar si la implementación del VAR afectaba al tiempo de juego, al rendimiento decisional y condicional, así como al comportamiento colectivo de los equipos de *LaLiga* española. Los principales resultados del estudio fueron que cuando intervino el VAR 1) hubo un ligero aumento del TTJ entre las tres situaciones (95,1 vs. 96,0 vs. 99,1 min, en VAR0, VAR1 y VAR2, respectivamente); 2) hubo una disminución significativa del TEJ entre VAR0 y VAR1 (52,5 vs. 51,5 min); 3) hubo un aumento en el número de GOL en los partidos (1,2 vs. 1,5 vs. 1,7, en VAR0, VAR1 y VAR2, respectivamente); y 4) hubo una ligera disminución en el DT entre las tres situaciones (108.916,2 vs. 107.916,2 vs. 106.977,0 m, en VAR0, VAR1 y VAR2, respectivamente).

Uno de los argumentos en contra del uso del VAR ha sido que el transcurso natural de un partido puede verse afectado negativamente por la tecnología de vídeo (Ryall, 2012; Svantesoon, 2014). Dado que un equipo de árbitros toma aproximadamente entre 200 y 250 decisiones de falta/no falta por partido (Helsen & Bultynck, 2004), el protocolo del VAR se limita a incidentes que cambian el partido. Este estudio demuestra que el VAR intervino muy pocas veces durante el campeonato, mediando solo en el 27% de los partidos. Esto implica, por tanto, que en más del 70% de todos los partidos, las comprobaciones de los incidentes de cambio de partido no dan lugar a una revisión. La mayoría de las comprobaciones del VAR se realizan en segundo plano, por lo que tienen un impacto mínimo en el transcurso del juego.

Los resultados de este estudio mostraron que hay un aumento significativo del TTJ en un partido y una disminución simultánea del TEJ. Estos hallazgos están en línea con los proporcionados por Lago-Peñas et al. (2019). Según estos autores, la duración media de la segunda parte y del partido completo en la *Serie A* italiana y en la *Bundesliga* alemana fue de 15 y 20 s

mayor, respectivamente, después de la implementación del VAR. En consecuencia, los hallazgos del presente trabajo sugieren que el sistema VAR no afecta drásticamente la duración del partido.

La intervención del VAR durante un partido apenas tuvo efecto en el juego del equipo ni a nivel decisional ni físico, ni tampoco en el comportamiento colectivo. El TTJ aumentó (VAR1 +1% y VAR2 +4%), mientras que el TEJ disminuyó (VAR1 y VAR2 disminuyeron un 1% respecto al VAR0) al igual que el DT (VAR0>VAR1=VAR2), y el número de GOL aumentó con relación al VAR0.

La intervención del VAR apenas modificó el rendimiento decisional y el comportamiento colectivo de los equipos. La única diferencia en este sentido es que en los partidos con algún tipo de intervención del VAR (VAR1 y VAR2) se marcaron más GOL. Este dato es difícil de interpretar, pero puede tener relación con las situaciones en las que el reglamento establece que debe intervenir el VAR. Suelen tener lugar normalmente cerca de la portería y surgen de acciones que podrían sugerir un penalti o un gol marcado desde una posición dudosa. En este sentido, es interesante destacar que en *LaLiga* los GOL de penalti aumentaron un 2% (del 9% al 11%) en la temporada 2017-18 (antes de la introducción del VAR) con respecto a la temporada 2018-19 (www.whoscored.com).

En cuanto a las variables físicas, en los partidos con intervención del VAR (VAR1 y VAR2), el DT descendió significativamente, aunque con un tamaño del efecto pequeño. Los resultados de esta investigación coinciden con los de un estudio previo (Lago-Peñas et al., 2015), en el que se observó una disminución del DT en partidos con mayor TTJ. Por otro lado, el VAR no pareció afectar en la variable DT por encima de 21 km/h, ya que los equipos acumularon la misma cantidad de distancia recorrida a esa velocidad. Sin embargo, si se considera que la mayor parte de la distancia acumulada en rangos de velocidad se produce cuando el balón está en juego (Castellano et al., 2011) y el TEJ fue menor en los partidos en los que intervino el VAR, se podría concluir que la intensidad y el ritmo de juego fue algo mayor en los partidos en los que intervino el VAR.

5.2. Estudio 2: A longitudinal analysis of technical-tactical and physical performance of the teams in the Spanish LaLiga Santander: An eight-season study

Errekagorri, I., Castellano, J., Echeazarra, I., López-Del Campo, R., & Resta, R. (2022). A longitudinal analysis of technical-tactical and physical performance of the teams in the Spanish LaLiga Santander: An eight-season study. *Biology of Sport*, *39*(2), 389–396. https://doi.org/10.5114/biolsport.2022.105331

El presente estudio tuvo como objetivo describir la acción de juego de todos los equipos que participaron en *LaLiga* española durante ocho temporadas consecutivas (desde 2011-12 hasta 2018-19). Este trabajo de investigación analizó la acción de juego de los equipos de *LaLiga* desde una perspectiva longitudinal amplia, considerando comportamientos técnicos, jugadas a balón parado, distancia total recorrida y uso colectivo del espacio en el terreno de juego. La información proporcionada por este estudio, especialmente por la inclusión de 5.518 rendimientos y por el hecho de que se analizaron todos los equipos a lo largo de ocho temporadas consecutivas, sugiere que estos resultados son útiles para conocer la evolución de los rendimientos de los equipos. La principal conclusión fue que, a lo largo de las temporadas estudiadas, los equipos españoles de *LaLiga* mostraron un estilo de juego indirecto que se mantuvo a lo largo de los años, con un ligero cambio en la manera de jugar en las últimas temporadas hacia un juego menos profundo y con menos llegadas al área del equipo rival. Considerando la limitación que supone intentar describir algo tan complejo como el estilo de juego a partir de determinadas variables, los resultados del estudio mostraron que el estilo de juego de los equipos españoles de *LaLiga* ha ido cambiando con el paso de las temporadas. Cabe señalar que, dentro del estilo de juego indirecto que caracteriza a *LaLiga*, la defensa parece prevalecer sobre el ataque.

En las cuatro primeras temporadas (desde 2011-12 hasta 2014-15), los equipos de *LaLiga* se caracterizaron por tener mayores valores en TIR, COR y CEN, por correr mayor DT y jugar con mayor PRO y PORDEF. Estos resultados podrían interpretarse como que los equipos mostraron un mayor grado de juego ofensivo, ya que pudieron jugar más profundos y llegar con mayor frecuencia al área rival. Sin embargo, con el paso de las temporadas, los valores de estas variables

que caracterizaban a los equipos con un estilo de juego más directo y profundo (Castellano & Pic, 2019), disminuyeron.

En este sentido, cabe destacar que los equipos españoles de *LaLiga* se caracterizaron por un estilo de juego indirecto que se mantuvo a lo largo de los años, representado por un número similar de PT y un uso colectivo del espacio similar en cuanto a la AMP. Sin embargo, a partir de la temporada 2015-16 estas variables mostraron un pequeño incremento. Parece que a partir de esa temporada los equipos reforzaron los aspectos defensivos de tal manera que, si bien los equipos aumentaron ligeramente el número de PT y la AMP en el juego, provocó una menor eficiencia en el juego (e.g., menos intentos de gol). Es ampliamente conocido que el estilo de juego de *LaLiga* se caracteriza por un fútbol de posesión con un alto índice de PT (Dellal et al., 2011). Además, varios autores observaron en *LaLiga* altas correlaciones entre el número de TIR (y en general, su precisión), el número de COR y el número de PT (y su eficiencia) con el número de puntos obtenidos al final del campeonato liguero (Brito-Souza et al., 2019; Castellano, 2018). Estudios previos (Barnes et al., 2014; Barreira et al., 2014, 2015; Wallace & Norton, 2014) han señalado la existencia de un aumento en el número de PT en las últimas temporadas analizadas, lo que demuestra que el fútbol puede estar evolucionando hacia un estilo de juego más directo. En este sentido, parece que cuantos más PT se realizan, mayores son las posibilidades de conseguir una victoria (Castellano et al., 2012; Konefał et al., 2019). Al igual que en otras ligas, como por ejemplo en la *Premier League* inglesa (Jones et al., 2004) o en la *Bundesliga* alemana (Kempe et al., 2014), en *LaLiga* española (Lago-Peñas et al., 2010) existe una correlación directa entre la posesión del balón y el éxito.

Los valores de las variables PRO y PORDEF disminuyeron a medida que pasaron las temporadas, mientras que la ALT se mantuvo estable. Sin embargo, comparando los valores de esta última variable entre las primeras temporadas estudiadas (desde 2011-12 hasta 2014-15) y las últimas (desde 2015-16 hasta 2018-19), se observó un ligero descenso en las últimas temporadas. Esto significa que las posiciones de los jugadores retrocedieron. No obstante, cabe destacar que el presente estudio no investigó la variabilidad del posicionamiento de la defensa dependiendo de la posición del balón en el campo, o de qué equipo tenía la posesión del balón (Castellano et al., 2013). Esto coincidió con una disminución en los TIR, CEN y COR, probablemente debido a la mayor eficacia defensiva de los equipos. En una revisión sistemática donde estudió acerca de las variables que conducen al éxito en el fútbol (Lepschy et al., 2018), se encontró que las variables

más influyentes eran aquellas relacionadas con la eficiencia (tiros a portería, posesión del balón y precisión del pase), apoyando la idea de que en el fútbol moderno la calidad es más importante que la cantidad a la hora de evaluar la acción de juego de un equipo (Konefał et al., 2019). Este resultado es consistente con el hecho de que la media de GOL por partido no cambió demasiado desde la temporada 2011-12 hasta la 2018-19, con una media de 2,8 (±0,1) GOL por partido (rango entre 2,6 y 2,9). Excepcionalmente, la última temporada de este estudio (2018-19) obtuvo el valor más bajo de GOL por partido (2,6), 983 en un total de 380 partidos (https://www.worldfootball.net/stats/esp-primera-división1/). Quizás, modificaciones sustanciales en el juego (e.g., la incorporación del árbitro asistente de vídeo) podrían justificar un enfoque diferente de los equipos en competición y, como consecuencia, una disminución en el número de GOL por partido (Lago-Peñas et al., 2019). Algo similar ocurrió con las FAL, ya que el efecto de una mayor profesionalización del cuerpo arbitral e incluso la implantación del árbitro asistente de vídeo probablemente podrían haber influido en su tendencia a la baja.

En cuanto a la DT, los resultados mostraron una disminución a lo largo de las temporadas, coincidiendo con los resultados obtenidos por parte de un estudio sobre la evolución del rendimiento físico y decisional de la *Premier League* inglesa (Barnes et al., 2014) y de otro sobre la evolución del rendimiento físico de *LaLiga* española (Pons et al., 2021). La disminución en el número de llegadas al área rival o de TIR podría explicarse por una organización defensiva más eficiente de los equipos. Esta falta de llegadas a la zona provocó un menor desplazamiento de los equipos *box to box*, lo que explica que la DT haya ido disminuyendo con el paso de los años. Por su parte, varios autores (Vales-Vázquez et al., 2011) observaron que los índices de rendimiento decisional tienen una mayor influencia que los de carácter condicional a la hora de determinar la diferencia entre los equipos más exitosos de un campeonato. Esto está en línea con los resultados presentados por Castellano (2018), quien encontró que la DT no se relacionó con el éxito alcanzado por los equipos al final del campeonato.

5.3. Estudio 3: Performance analysis of the teams that remained in the top-tier division of the Spanish LaLiga during eight consecutive seasons

Errekagorri, I., López-Del Campo, R., Resta, R., & Castellano, J. (2024). Performance analysis of the teams that remained in the top-tier division of the Spanish LaLiga during eight consecutive seasons. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 1-10. https://doi.org/10.1177/17543371241232034

El objetivo de este estudio fue analizar la acción de juego de los mismos ocho equipos que se mantuvieron en *LaLiga* española a lo largo de ocho temporadas consecutivas (desde 2011-12 hasta 2018-19). Los principales resultados del estudio fueron que: 1) los ocho equipos, a pesar de la variabilidad mostrada en los partidos, mantuvieron un rendimiento estable a lo largo de las ocho temporadas analizadas; 2) los valores de PRO disminuyeron significativamente a partir de la temporada 2015-16; 3) los valores de PORDEF disminuyeron significativamente a partir de la temporada 2014-15; y 4) los valores de DT disminuyeron significativamente a partir de la temporada 2013-14.

Respecto a las variables técnico-tácticas, la temporada no tuvo un efecto significativo en PT, PE y TIR. La distribución tanto de los PT como de los PE realizados por los equipos que se mantuvieron en la máxima categoría del fútbol español supone una estabilidad en el rendimiento a lo largo del periodo analizado, coincidiendo con los resultados de estudios previamente publicados sobre *LaLiga* española y *Premier League* inglesa. Lago-Peñas et al. (2022) analizaron la evolución de parámetros físicos y decisionales en *LaLiga* entre 2012-13 y 2019-20, encontrando más PT y PE (denominados como precisión de pase y medidos en porcentaje) en las últimas cuatro temporadas en comparación con la primera temporada. Sin embargo, la tendencia de estas variables a lo largo de los años no estaba clara, porque el tamaño del efecto de las diferencias entre temporadas fue pequeño. Por tanto, el estudio realizado por Lago-Peñas et al. (2022) también mostró estabilidad en los PT y PE realizados durante las temporadas analizadas. No obstante, cuando estos autores analizaron el rendimiento decisional de *LaLiga* a lo largo de las temporadas considerando la posición de juego, observaron que los defensas centrales aumentaron significativamente el número de PT y PE, mientras que los delanteros disminuyeron

significativamente el número de PT. Barnes et al. (2014) encontraron un aumento significativo en los PT y PE (medidos en porcentaje) en la *Premier League* en las dos últimas temporadas analizadas (2011-12 y 2012-13) respecto a la primera temporada (2006-07), pero con un tamaño del efecto moderado. Por tanto, cabe mencionar que los resultados del estudio de Barnes et al. (2014) indican una tendencia estable de estas dos variables a lo largo de las temporadas estudiadas en la *Premier League*, coincidiendo de esta manera con los resultados del presente trabajo. Bush et al. (2015), por su parte, analizaron la evolución de los parámetros del rendimiento físico y decisional en la *Premier League* inglesa entre 2006-07 y 2012-13, observando aumentos de magnitud moderada-grande en el número de PT realizados y aumentos moderados en el número de PE de los defensores centrales y mediocentros defensivos. En cuanto a los TIR, que es un indicador de rendimiento que puede determinar el éxito de un equipo (Brito-Souza et al., 2019), los resultados del presente estudio son similares a los de Lago-Peñas et al. (2022) sobre *LaLiga* española y a los de Barnes et al. (2014) sobre la *Premier League* inglesa. En *LaLiga* se encontraron menos TIR desde 2014-15 hasta 2019-20 respecto a la primera temporada analizada (2012-13), pero con un pequeño tamaño del efecto de las diferencias entre temporadas. En la *Premier League*, por su parte, no se encontraron diferencias significativas en el número de TIR entre las temporadas analizadas (desde 2006-07 hasta 2012-13). Por tanto, la tendencia de los TIR realizados en estos dos estudios también se mantuvo bastante estable a lo largo de los periodos estudiados. Sin embargo, Lago-Peñas et al. (2022) también investigaron la evolución del rendimiento decisional en *LaLiga* considerando las posiciones de juego, y encontraron que los mediocentros extremos y delanteros disminuyeron significativamente los TIR realizados en las últimas temporadas respecto a la primera temporada analizada. Finalmente, cabe mencionar que en el presente trabajo la temporada tuvo un efecto importante en la variable CEN. Aunque los equipos que permanecieron en *LaLiga* durante las ocho temporadas analizadas mostraron bastante estabilidad en este indicador de rendimiento relacionado con las acciones de ataque de los equipos que pueden determinar el éxito de un equipo (Brito-Souza et al., 2019), parece que en las dos últimas temporadas (2017-18 y 2018-19) estos equipos realizaron significativamente menos CEN.

En cuanto a las variables relacionadas con el balón parado, la temporada solo tuvo un efecto significativo en los COR. En las temporadas 2016-17 y 2018-19 los equipos realizaron menos COR respecto a la primera temporada analizada (2011-12). Sin embargo, la tendencia de esta variable a lo largo de los ocho años es bastante estable. Cabe mencionar que los COR también

pueden determinar el éxito de un equipo, ya que este tipo de acciones ocurren cerca de la portería rival (Brito-Souza et al., 2019). Por el contrario, no hubo diferencias significativas entre temporadas en GOL y FAL. Por tanto, los equipos que se mantuvieron en la máxima categoría del fútbol español también mostraron una estabilidad en el rendimiento en estas variables a lo largo del periodo estudiado.

En el caso de las variables de comportamiento colectivo, la temporada tuvo un efecto significativo en la PRO y PORDEF. A partir de la quinta temporada (desde 2015-16 hasta 2018-19) se encontraron valores inferiores de la variable PRO. Los ocho equipos que se mantuvieron en *LaLiga* española entre 2011-12 y 2018-19 mostraron los mismos valores de AMP, pero menos PRO, aumentando la densidad del espacio efectivo de juego (mismos jugadores en menos espacio). A partir de la cuarta temporada (desde 2014-15 hasta 2018-19) se encontraron valores inferiores de PORDEF. Este hallazgo podría explicarse por el hecho de que se exige a los porteros un mayor protagonismo en la fase ofensiva del juego, iniciando o continuando el ataque con los jugadores más cercanos a su propia portería, como los defensas centrales (Bush et al., 2015), o que los equipos han podido adoptar un estilo de juego más defensivo debido a una menor posesión del balón durante los partidos.

En cuanto a la variable física, la temporada tuvo un efecto significativo en la DT. Los valores de esta variable disminuyeron significativamente a partir de la tercera temporada (desde 2013-14 hasta 2018-19). Esto podría explicarse por el cambio en la forma de jugar de los equipos de esta liga a lo largo de los años, dando menos prioridad a la DT. Vales-Vázquez et al. (2011) señalaron que los índices de rendimiento decisional tienen una mayor influencia que los de carácter condicional a la hora de determinar la diferencia entre los equipos más exitosos del campeonato. En esta línea, Castellano (2018) constató que la DT no tiene relación con el éxito alcanzado por los equipos de la Primera y Segunda División Española de Fútbol Profesional Masculino al finalizar la liga. Coincidiendo con los resultados del presente estudio, Lago-Peñas et al. (2022) observaron una disminución en la DT a medida que pasaban las temporadas en *LaLiga* española. Pons et al. (2021) también encontraron en *LaLiga* un descenso en la DT en la temporada 2018-19 respecto a las tres anteriores. Sin embargo, estos últimos autores analizaron sólo cuatro temporadas consecutivas, por lo que las conclusiones no son tan claras. Barnes et al. (2014), en cambio, observaron una estabilidad en la DT por parte de los equipos de la *Premier League* a lo largo de siete temporadas (desde 2006-07 hasta 2012-13). Allen et al. (2023) encontraron pequeños

incrementos en la última temporada analizada (2018-19) respecto a la primera (2014-15), y de temporada en temporada (i.e., 2016-17>2015-16=2017-18>2016-17). Sin embargo, estos hallazgos no fueron consistentemente significativos, por lo que se puede concluir que la DT por los jugadores de la *Premier League* inglesa se mantuvo estable durante cinco temporadas (desde 2014-15 hasta 2018-19).

5.4. Estudio 4: An eight-season analysis of the teams' performance in the Spanish LaLiga according to the final league ranking

Errekagorri, I., Fernandez-Navarro, J., López-Del Campo, R., Resta, R., & Castellano, J. (2024). An eight-season analysis of the teams' performance in the Spanish LaLiga according to the final league ranking. *PLOS ONE*, *19*(2), e0299242. https://doi.org/10.1371/journal.pone.0299242

El objetivo de este estudio fue analizar la acción de juego de los equipos de *LaLiga* española a lo largo de un periodo continuo de ocho temporadas (desde 2011-12 hasta 2018-19), considerando la clasificación final liguera. Los principales resultados del estudio fueron que: 1) el grupo Europa mostró valores significativamente más altos en comparación con los otros grupos en la mayoría de las variables durante las ocho temporadas; 2) los equipos del grupo Europa mostraron valores más bajos de PRO a partir de la quinta temporada (desde 2015-16 hasta 2018-19), y valores más bajos de PORDEF a partir de la cuarta temporada (desde 2014-15 hasta 2018-19); 3) los equipos del grupo Medio-Alto mostraron valores más bajos de PRO a partir de la quinta temporada (desde 2015-16 hasta 2018-19); 4) los equipos del grupo Medio-Bajo mostraron menos TIR a partir de la tercera temporada (desde 2013-14 hasta 2018-19), y valores más bajos de PRO, PORDEF y DT a partir de la cuarta temporada (desde 2014-15 hasta 2018-19); y, 5) el grupo Descenso apenas mostró diferencias significativas entre temporadas en ninguna variable.

En relación con las variables técnico-tácticas, el factor temporada tuvo un efecto significativo en la variable CEN para los grupos Europa, Medio-Alto, Medio-Bajo y Descenso, y un efecto significativo en los TIR para el grupo Medio-Bajo. El factor grupo también tuvo un efecto significativo en las variables PT, PE y TIR. La distribución en estas variables realizada por los equipos de los cuatro grupos implicó en gran medida una estabilidad en el rendimiento a lo largo del periodo analizado. Con relación a los PT y PE, los resultados de este trabajo son similares a los de un estudio publicado recientemente sobre la evolución de parámetros físicos y decisionales en *LaLiga* española entre las temporadas 2012-13 y 2019-20 (Lago-Peñas et al., 2022). Estos investigadores no encontraron una tendencia clara en los PT a medida que avanzaban las temporadas para ninguno de los cuatro grupos analizados, pero sí encontraron una tendencia ascendente en la precisión de los PT para los equipos de la parte alta de la tabla (desde la posición

1 hasta la 5) y de la parte medio-baja (desde la posición 11 hasta la 15). Sin embargo, el tamaño del efecto de las diferencias entre temporadas fue pequeño. Por ello, cabe mencionar que el estudio de Lago-Peñas et al. (2022) también mostró estabilidad en los PT durante las temporadas estudiadas. Bradley et al. (2016), por su parte, observaron un aumento de PT y PE realizados por los equipos de la *Premier League* inglesa a lo largo de siete temporadas (desde 2006-07 hasta 2012-13). Los equipos de la parte alta de la tabla (desde la posición 1 hasta la 4) y de la parte media-baja (desde la posición 9 hasta la 14) aumentaron significativamente los PT y PE con un tamaño del efecto pequeño, los equipos de la parte baja de la tabla (desde la posición 15 hasta la 20) con un tamaño del efecto moderado y equipos de la parte medio-alta de la tabla (desde la posición 5 hasta la 8) con un tamaño del efecto grande. Una posible explicación de esto podría ser que los equipos ubicados en lo más alto de la clasificación han podido mantener un rendimiento alto y estable a lo largo de los años, lejos del rendimiento más inestable del resto de equipos ubicados en lo más bajo de la clasificación, cuyo objetivo principal suele ser el de mantener la categoría temporada tras temporada. Otra posible explicación podría ser que la dimensión decisional prevaleciera sobre la condicional a lo largo de las temporadas en la *Premier League* inglesa. Sin embargo, los resultados del presente trabajo difieren de los obtenidos por Bradley et al. (2016).

Respecto a los CEN, cabe destacar que los equipos de Europa mostraron menos acciones de esta variable en las temporadas 2017-18 y 2018-19 respecto a la temporada 2011-12. Sin embargo, al igual que en los otros tres grupos, la tendencia de los CEN a lo largo de las ocho temporadas fue bastante estable para el grupo Europa. En el caso de los TIR, solo se encontraron diferencias significativas entre temporadas para el grupo Medio-Bajo. Los equipos de este grupo mostraron menos TIR desde la temporada 2013-14. Lago-Peñas et al. (2022), por su parte, observaron un descenso significativo en la temporada 2019-20 respecto a la 2012-13 para los equipos de la parte alta de la tabla (desde la posición 1 hasta la 5) y de la parte medio-alta (desde la posición 6 hasta la 10) de *LaLiga* española. Sin embargo, el tamaño del efecto de estas diferencias fue pequeño y no se observó ninguna tendencia para ningún grupo a medida que pasaban los años. Por tanto, la tendencia de los TIR en el trabajo de Lago-Peñas et al. (2022) se mantuvo bastante estable durante todo el período estudiado. Al comparar las variables técnico-tácticas entre grupos a lo largo del periodo estudiado (las ocho temporadas juntas), el grupo Europa obtuvo valores significativamente superiores a los otros tres grupos en las variables PT, PE y TIR. Parece que la frecuencia y eficacia

de los TIR y PT son algunos de los indicadores de rendimiento que diferencian a los equipos más exitosos del resto (Lago-Peñas et al., 2011). Según diferentes trabajos (Castellano et al., 2012, Collet, 2013), una elevada posesión de balón y, por tanto, un elevado número de pases acumulados parecen ser de gran importancia en la victoria de los equipos de fútbol. Además, un estudio que tuvo como objetivo identificar las estadísticas de los partidos que mejor explican el éxito del fútbol en *LaLiga* española utilizando como muestra ocho temporadas (desde 2010-11 hasta 2017-18), concluyó que las dos variables que mejor determinan el éxito de un equipo son la efectividad de los tiros y el número total de tiros realizados (Brito-Souza et al., 2019). Por tanto, el grupo de Europa destacó por mostrar valores elevados en las variables de la dimensión técnico-táctica más relacionadas con el éxito.

Con respecto a las variables relacionadas con el balón parado, el factor temporada tuvo un efecto significativo en los COR y FALT para los grupos Europa y Descenso, un efecto significativo en los GOL para el grupo Medio-Alto y un efecto significativo en los GOL, COR y FAL para el grupo Medio-Bajo. El factor grupo también tuvo un efecto significativo en GOL, COR y FAL. La distribución en estas variables realizada por los equipos de los cuatro grupos también representa una estabilidad en el rendimiento a lo largo del periodo analizado. Cabe señalar que los equipos del grupo Medio-Bajo mostraron menos GOL en las temporadas 2013-14 y 2014-15 en comparación con la 2011-12. En estas dos temporadas los equipos de este grupo, además de mostrar menos TIR, mostraron menor efectividad ante la portería rival. Sin embargo, la tendencia de los GOL a lo largo de las ocho temporadas fue bastante estable para el grupo Medio-Bajo. Al comparar las variables de balón parado entre grupos a lo largo del periodo estudiado, el grupo Europa mostró valores significativamente superiores al resto en las variables GOL y COR. El factor clave que puede determinar el resultado de un partido de fútbol, y por tanto el éxito de un equipo, es el gol. Castellano (2018) observó que los goles marcados tenían una relación muy alta con la consecución de un mayor número de puntos al final de la competición liguera en *LaLiga* española en las temporadas 2013-14 y 2014-15. También cabe señalar que el córner es un indicador de rendimiento relacionado con las acciones de ataque que, tras la efectividad de los tiros y el número total de tiros realizados, puede determinar mejor el éxito de un equipo, ya que la acción se produce cerca de la portería rival (Brito-Souza et al., 2019). Una característica de los equipos mejor clasificados de una liga es que a menudo tienden a conseguir más jugadas a balón parado, como los COR, después de mantener una posesión alta del balón (Castellano 2018), especialmente

cuando la posesión se produce en el último tercio del campo, cerca de la portería contraria (Göral, 2015). En consecuencia, el éxito de los equipos del grupo Europa podría deberse a que también se destacaron por mostrar valores altos en variables que mejor explican el éxito de un equipo como el gol y el córner.

En cuanto al comportamiento colectivo, el factor temporada tuvo un efecto significativo en la PRO y PORDEF para Europa, un efecto significativo en la PRO para el grupo Medio-Alto y un efecto significativo en la PRO, ALT y PORDEF para el grupo Medio-Bajo y Descenso. El factor grupo también tuvo un efecto significativo en las variables AMP, PRO, ALT y PORDEF. Se encontró una disminución significativa en los valores de PRO a partir de la temporada 2015-16 para los grupos Europa y Medio-Alto, y a partir de la temporada 2014-15 para el grupo Medio-Bajo. Parece que los equipos de estos grupos aumentaron la densidad del espacio de juego efectivo (mismos jugadores en menos espacio) a medida que avanzaban las temporadas. Además, se encontró una disminución significativa en los valores de PORDEF desde la temporada 2014-15 para los grupos Europa y Medio-Bajo. Esto podría explicarse por el hecho de que a los porteros de los equipos de estos grupos se les exige un mayor papel en la fase ofensiva del juego, requiriendo su participación para iniciar o continuar un ataque con los jugadores más cercanos a él, como por ejemplo con sus centrales (Bush et al., 2015). También podría ser que estos equipos hayan podido adoptar un estilo de juego más defensivo debido a una menor posesión del balón durante los partidos. Por su parte, el grupo Descenso mostró una tendencia estable en esta dimensión a lo largo de las ocho temporadas. Probablemente valores bajos en las variables de comportamiento colectivo, representadas en este grupo con bajo rendimiento (Castellano, 2018), pueden ser una de las razones que justifiquen la estabilidad en el comportamiento colectivo descrito. Al comparar las variables de comportamiento colectivo entre grupos a lo largo del periodo estudiado, el grupo Europa mostró valores significativamente más altos que los otros grupos en AMP, PRO, ALT y PORDEF. Según un estudio previo (Castellano, 2018), una mayor amplitud, profundidad y altura de la defensa se asoció con los equipos que acumularon mayor número de puntos al final de la temporada en *LaLiga* española (en las temporadas 2013-14 y 2014-15). Parece, por tanto, que el estilo de juego de los equipos más exitosos (e.g., posiciones más altas en la clasificación final) tiene valores más altos en las variables que representan el uso colectivo del espacio como rasgo.

En relación con la variable física, el factor temporada tuvo un efecto significativo en la DT para los grupos Europa, Medio-Bajo y Descenso. El factor grupo también tuvo un efecto

significativo sobre la variable DT. La media baja mostró valores más bajos de DT desde la temporada 2014-15. Los equipos de este grupo probablemente cambiaron su forma de jugar a lo largo de las temporadas, desplegando una distancia total recorrida menor. Sin embargo, los equipos de los otros tres grupos mostraron una estabilidad en la distancia total recorrida a lo largo de las ocho temporadas. Lago-Peñas et al. (2022) encontraron una disminución significativa en la distancia total recorrida para los diferentes grupos analizados de *LaLiga* española a lo largo de ocho temporadas (desde 2012-13 hasta 2019-20). Al comparar la variable física entre grupos a lo largo del periodo estudiado, el grupo Medio-Alto fue el que obtuvo mayores valores en la DT, pero solo mostró valores significativamente superiores que grupo Europa. Cabe mencionar que algunos autores (Vales-Vázquez, 2011) indican que los indicadores de rendimiento decisional tienen mayor influencia que los de carácter condicional a la hora de determinar la diferencia entre los equipos más exitosos del campeonato. Esto está en línea con los resultados presentados por Castellano (2018), quien encontró que la distancia total recorrida no está relacionada con el éxito alcanzado por los equipos (en este caso de la Primera y Segunda División Española de Fútbol Masculino) al final del campeonato.

La tendencia en el número de puntos acumulados por los equipos de los distintos grupos de *LaLiga* española desde la temporada 2011-12 hasta la 2018-19 se mantuvo estable. Algunos autores ingleses (Bradley et al., 2016) aseguraron que los equipos de la parte alta de la tabla (desde la posición 1 hasta la 4) y de la parte media-baja (desde la posición 9 hasta la 14) de la *Premier League* acumularon, de media, 0,43 y 0,31 puntos menos temporada tras temporada (desde 2006-07 hasta 2012-13), respectivamente, y por su parte, los equipos de la parte media-alta de la tabla (desde la posición 5 hasta la 8) y de la parte baja (desde la posición 15 hasta la 20) agrupan 0,32 y 0,20 puntos más, respectivamente. Parece que, a lo largo de las siete temporadas analizadas por estos investigadores, los equipos ingleses de la parte media-alta de la tabla (desde la posición 5 hasta la 8) fueron acortando la diferencia de puntos con los que se clasificaban para competiciones europeas. Sin embargo, esta diferencia de puntos entre los equipos ingleses temporada tras temporada fue mínima, por lo que cabe mencionar que la tendencia en el número de puntos acumulados en la *Premier League* inglesa también se mantuvo estable.

5.5. Estudio 5: Performance Analysis of the Spanish Men's Top and Second Professional Football Division Teams during Eight Consecutive Seasons

Errekagorri, I., López-Del Campo, R., Resta, R., & Castellano, J. (2023). Performance Analysis of the Spanish Men's Top and Second Professional Football Division Teams during Eight Consecutive Seasons. *Sensors*, *23*(22), 9115. https://doi.org/10.3390/s23229115

El objetivo de este estudio fue analizar la acción de juego de los equipos profesionales del fútbol español (*LaLiga* y *LaLiga2*) durante un período continuo de ocho temporadas (desde 2011-12 hasta 2018-19). Los principales resultados del este estudio fueron que: 1) los equipos de *LaLiga* mostraron valores más bajos de PRO a partir de la tercera temporada (desde 2013-14 hasta 2018-19), y valores más bajos de PORDEF y DT a partir de la cuarta temporada (desde 2014-15 hasta 2018-19); 2) los equipos de *LaLiga2* mostraron menos PT y valores más bajos de PORDEF y DT a partir de la cuarta temporada (desde 2014-15 hasta 2018-19), y menos GOL y valores más bajos de PRO a partir de la quinta temporada (desde 2015-16 hasta 2018-19); y 3) los equipos de *LaLiga* mostraron más PT, PE, TIR, GOL y valores más altos de DT en comparación con los equipos de *LaLiga2* durante el período de ocho temporadas.

En relación con las variables técnico-tácticas, la distribución de las variables PT y PE realizados por los equipos de *LaLiga* española supone una estabilidad del rendimiento a lo largo del periodo analizado, coincidiendo con un estudio previo (Lago-Peñas et al., 2022) realizado recientemente también en *LaLiga*. Barnes et al. (2014), por su parte, encontraron en la *Premier League* inglesa un aumento significativo en los PT y PE en las dos últimas temporadas que analizaron (2011-12 y 2012-13) en comparación con la primera (2006-07), con un tamaño del efecto moderado. Estas diferencias descritas entre la liga inglesa y la española pueden deberse a que los periodos fueron consecutivos, por lo que es probable que esta progresión se haya frenado en los últimos 15 años. Por el contrario, los resultados del presente estudio mostraron que los equipos españoles de *LaLiga2* disminuyeron significativamente el número de PT desde la temporada 2014-15. Estos resultados coinciden con el mayor protagonismo de la fase defensiva del juego en segunda división (Castellano & Casamichana, 2015), lo que podría estar relacionado con un mejor rendimiento en competición.

En el caso de los CEN, cabe mencionar que los equipos de *LaLiga* realizaron menos acciones de esta variable a partir de la temporada 2016-17. En cuanto a los TIR, ambas ligas mostraron una tendencia estable a lo largo de las ocho temporadas. Estos resultados también son similares a los de Lago-Peñas et al. (2022) y Barnes et al. (2014). Por tanto, cabe señalar que la tendencia de los TIR en estos dos trabajos también se mantuvo bastante estable a lo largo del periodo estudiado. Teniendo en cuenta la dificultad de describir la manera de jugar de los equipos en competición a partir de ciertas variables (Fernandez-Navarro et al., 2016), parece que a medida que transcurrieron las temporadas, los equipos españoles de *LaLiga* mostraron un menor grado de juego ofensivo efectivo, representado por un número similar de PT y menos CEN. Sin embargo, parece que los equipos españoles de *LaLiga2* se caracterizaron por un estilo de juego directo con el paso de las temporadas, representado por un menor número de PT y un número similar de CEN y TIR. Además, aunque los equipos de *LaLiga2* redujeron el número de PT, mostraron una precisión similar a lo largo de las ocho temporadas (es decir, un número similar de PE).

Al comparar las variables técnico-tácticas entre ligas durante el periodo estudiado, *LaLiga* obtuvo valores significativamente superiores a los de *LaLiga2* en PT, PE y TIR. Estos resultados son similares a los de Castellano & Casamichana (2015). Sin embargo, cabe señalar que estos autores matizan que en realidad fueron los 10 equipos mejor clasificados de la Primera División de España los que mostraron valores significativamente superiores en PT, PE (medidos en porcentaje) y TIR que los otros tres grupos. En el fútbol inglés, algunos investigadores (Bradley et al., 2013) encontraron que los jugadores de la *Premier League* realizaron más PT y PE que los jugadores de la *Championship* (la Segunda División del sistema de ligas de Inglaterra) y la *League One* (la Tercera División del sistema de ligas de Inglaterra). Según diferentes estudios publicados anteriormente (Lago-Peñas et al., 2010 y 2011; Moura et al., 2014), parece que los PT, PE o TIR, entre otras variables, están directamente relacionados con el éxito o un mayor nivel competitivo de los equipos. Además, Castellano (2018) encontró que variables como PT, PE o TIR tenían una fuerte relación con la clasificación final en *LaLiga*, mientras que no encontró la misma relación en *LaLiga2*. Sin embargo, este estudio sólo analizó dos temporadas, por lo que no permitió establecer ninguna tendencia. Por ello, cabe mencionar que en el presente trabajo los equipos españoles de *LaLiga* destacaron por mostrar valores altos en las variables de la dimensión técnico-táctica más relacionadas con el éxito.

En cuanto a las variables de balón parado, los equipos de *LaLiga* mostraron menos COR en las últimas tres temporadas analizadas (desde 2016-17 hasta 2018-19). Ya se ha mencionado anteriormente que hay que tener cautela al describir la manera en que los equipos juegan en competición considerando ciertas variables, pero esto podría ser otro indicador de que los equipos de *LaLiga* mostraron un menor grado de juego ofensivo efectivo a medida que transcurrían las temporadas. También se encontraron menos FAL en *LaLiga* española en las temporadas 2015-16, 2017-18 y 2018-19 en comparación con la temporada 2011-12. Parece que los equipos de *LaLiga* mostraron estrategias defensivas más cautelosas y conservadoras a medida que pasaban las temporadas (Li et al., 2023). Sin embargo, los equipos de *LaLiga2* mostraron menos GOL desde la temporada 2015-16. Si bien los equipos de esta liga mostraron un número similar de TIR a lo largo de las temporadas, su eficacia disminuyó con el tiempo. Este resultado, unido a la reducción del número de PT por partido, podría interpretarse como una reducción en la calidad de los equipos de esta categoría. Al comparar las variables de balón parado entre ligas durante el periodo de ocho temporadas, por un lado, *LaLiga* mostró valores significativamente más altos en GOL. Esto parece respaldar la idea sugerida por Castellano (2018) cuando encontró que los GOL marcados tenían una relación muy fuerte con la consecución de un mayor número de puntos al final de la competición liguera en *LaLiga*, en el sentido de que marcar GOL acerca a los equipos al éxito. Por otro lado, *LaLiga2* mostró valores de FAL significativamente más altos. Sumado al menor número de GOL por partido, esto podría indicar que el aspecto defensivo tiende a ser más relevante en esta liga, en el sentido de que no encajar GOL acerca a los equipos al éxito (Castellano, 2018).

Respecto a las variables de comportamiento colectivo, se encontraron valores similares de AMP, pero menores de PRO a partir de la temporada 2013-14 para los equipos de *LaLiga* española. Parece que los equipos aumentaron la densidad del espacio de juego efectivo (el mismo número de jugadores en menos área) a medida que avanzaban las temporadas. En *LaLiga2* esto fue más notable, reduciéndose tanto la AMP como la PRO a medida que avanzaban las temporadas. En cuanto a la variable ALT, los equipos de *LaLiga2* mostraron valores inferiores en las temporadas 2014-15, 2016-17 y 2017-18 respecto a la temporada 2011-12. Por ello, cabe mencionar que estos equipos jugaron más cerca de su propia línea de gol durante algunas temporadas. También se encontró una disminución significativa en los valores de PORDEF a partir de la temporada 2014-15 para ambas ligas. Esto podría explicarse por el hecho de que los porteros de los equipos del fútbol profesional español han ido adquiriendo un mayor protagonismo en la fase ofensiva del

juego, exigiendo su participación para iniciar o continuar un ataque con los jugadores más cercanos a él, como por ejemplo con sus defensas centrales (Bush et al., 2015), o que los equipos han podido adoptar un estilo de juego más defensivo al tener una menor posesión de balón durante los partidos. Cabe señalar que no se encontraron diferencias significativas entre las ligas en las ocho temporadas analizadas. Contrariamente a estos resultados, Castellano & Casamichana (2015) observaron valores más altos en la variable AMP para los equipos mejor clasificados en comparación con los equipos peor clasificados tanto para *LaLiga* como para *LaLiga2*.

Por último, con relación a la variable física, los equipos de ambas ligas mostraron valores inferiores de DT desde la temporada 2014-15. Esto podría deberse por la reducción del tiempo efectivo de juego de los partidos, que se sabe que tiene un efecto destacado en el rendimiento físico acumulado de los jugadores (Castellano et al., 2022). Lago-Peñas et al. (2022) también observaron una pequeña disminución en la DT entre 2014-15 y 2019-20 en comparación con la temporada 2012-13. Otro estudio (Pons et al., 2021) también encontró una disminución en la DT por los equipos de *LaLiga* en la temporada 2018-19 en comparación con las tres anteriores. De todos modos, estos autores analizaron sólo cuatro temporadas consecutivas, por lo que las conclusiones no son muy claras. Por el contrario, Barnes et al. (2014) observaron que la DT por los equipos de la *Premier League* inglesa se mantuvo estable durante siete temporadas (desde 2006-07 hasta 2012-13). Allen et al. (2023), por su parte, observaron pequeños aumentos en la *Premier League* inglesa en la última temporada analizada (2018-19) en comparación con la primera (2014-15), y de una temporada a otra (es decir, 2016-17>2015-16=2017-18>2016-17). Sin embargo, estos hallazgos no fueron consistentemente significativos, por lo que se puede concluir que la DT por los jugadores de la *Premier League* también se mantuvo estable durante las cinco temporadas analizadas (desde 2014-15 hasta 2018-19). En cuanto a las diferencias entre ligas, *LaLiga* mostró valores significativamente superiores a *LaLiga2* durante el periodo de ocho temporadas, similar a lo descrito por Pons et al. (2021). Un mayor número de jugadas a balón parado (e.g., FAL) en *LaLiga2*, con una mayor importancia de la fase defensiva, podría limitar el tiempo disponible para jugar (e.g., menor tiempo efectivo de juego) y, en consecuencia, reducir la distancia acumulada (Castellano et al., 2022). Bradley et al. (2013) encontraron que los equipos de la *Championship* y de la *League One* cubrieron una DT mayor que los equipos de la *Premier League*. A este respecto, cabe destacar que cada liga doméstica o país se caracteriza por tener una exigencia particular del juego (Dellal et al., 2011).

6. Consideraciones finales

6.1. Limitaciones

La información aportada en este proyecto de investigación, especialmente por la inclusión de un gran volumen de rendimientos de los equipos de las ligas profesionales del fútbol español a lo largo de ocho temporadas en el caso de los últimos tres estudios, permite disponer de valores de referencia que han caracterizado el rendimiento de los equipos en las dimensiones y variables analizadas. Sin embargo, la presente tesis doctoral no está exenta de limitaciones. En primer lugar, hay que considerar posibles diferencias relacionadas con los cambios que se han ido realizando en el sistema basado en cámaras con sensor óptico *TRACAB*® a lo largo de los años (Linke et al., 2020). En segundo lugar, los rendimientos de los equipos se calcularon utilizando los promedios de las variables predefinidas por la aplicación *Mediacoach*, sin tener la opción de obtener diferentes variables calculándolas por sí mismas accediendo a los datos brutos, por lo que hay que tener cautela a la hora de interpretar el rendimiento estable general mostrado por parte de los equipos a lo largo de los años, ya que las necesidades específicas de cada partido podrían diferir de su rendimiento estándar. En tercer lugar, en los estudios que componen este proyecto de investigación no se consideraron los momentos con o sin balón, es decir, la fase de ataque y defensa de los equipos. Se sabe que las respuestas físicas (Castellano et al., 2022) y tácticas (Castellano & Echeazarra, 2019; Castellano & Pic, 2019) de los equipos difieren cuando el equipo tiene o no la posesión del balón. En cuarto lugar, la inclusión de otras variables decisionales y condicionales (e.g., recuperaciones, duelos, tipos de pases, distancia acumulada en carreras de alta velocidad y *sprints*, número de carreras de alta velocidad y *sprints* acumulados, etc.) y de variables contextuales y/o situacionales como el cambio de entrenador, el período de la temporada, la ubicación del partido o el nivel del rival (Gómez-Ruano et al., 2021; O'Donoghue; 2009; Sarmento, Figueiredo, et al., 2018), entre otras, podrían ayudar a mejorar posibles inferencias sobre el rendimiento de los equipos y explicar mejor su variabilidad/estabilidad a lo largo de las temporadas e incluso conocer con mayor exactitud si la intervención del VAR afecta a la dinámica del juego de los equipos. En quinto y último lugar, no se diferenciaron las distintas intervenciones del VAR en relación con el tipo de acción que la requiere, lo que podría permitir valorar la influencia particular de cada uno de ellos en el desarrollo del juego. Cabe señalar que, aunque en este proyecto se utilizó una muestra de ocho temporadas, hay que tener cautela a la hora de extrapolar estos resultados ligueros a otros países o competiciones, ya que representan las características específicas del fútbol masculino profesional de España. Por tanto, proponer este

tipo de estudios en otras ligas o países podría ayudar a comprender mejor la evolución del juego a un nivel más global.

6.2. Conclusions

- The teams for both Spanish *LaLiga* and *LaLiga2* presented some changes in different dimensions throughout the eight seasons analysed. It should be noted that *LaLiga* teams showed fewer final offensive actions such as crosses and corners throughout the years, while *LaLiga2* teams showed fewer total passes and goals. It seems that *LaLiga* teams were characterised by an indirect style of play with a lower degree of effective offensive play, while those in *LaLiga2* were characterised by a more direct style of play with a lower degree of efficacy of shots. Nevertheless, the teams of both leagues displayed their collective behaviour in a space with greater density, playing with the goalkeepers closer and closer to their defensive line and deploying less TD as the seasons passed. Additionally, the Spanish *LaLiga* stood out for obtaining higher values than *LaLiga2* in variables associated with success, such as total passes, successful passes, shots and goals during the whole period studied.
- The eight teams that remained in the Spanish *LaLiga* have shown stable performance over the eight seasons analysed. This allows to have reference values of the variables studied, having had a stable positive result over time (i.e., stayed up at the highest tier). Within the framework of this performance stability, it should be noted that the teams deployed their behaviour in a space with greater density (same width, but less length), playing with the goalkeeper closer to the nearest defender of his team and covering less TD by all the team's players as the seasons passed.
- The teams of the Europe, Upper-Middle and Relegation groups showed a quite stable performance, while the teams of the Lower-Middle group presented some changes in different dimensions throughout the eight seasons analysed. It could be said that the Spanish football is in a plateau period in the performance of the best teams, which showed the ability to play in spaces with high player density as the seasons passed. Furthermore, they showed higher values in variables associated with success such as passes, success passes, shots and corners, and in variables representative of the collective use of space (width, length, height and GKDEF) during the whole period studied. However, this does

not detract from the fact that the teams that qualify in the less good half try to propose strategies that allow them in some cases to stay in the category, playing with the goalkeepers closer and closer to their defensive line.

6.3. Futuras líneas de investigación

A raíz de los estudios realizados, han surgido nuevas preguntas de investigación relacionadas con la evolución de la acción de juego, donde además de considerarse otros aspectos de la dimensión decisional y física, estudiadas en la presente tesis doctoral, podrían incorporarse otras dimensiones como la emocional. Asimismo, podría ser interesante abarcar más categorías además de las ligas profesionales españolas de fútbol, es decir, *LaLiga* y *LaLiga2*. A continuación, se detallan algunas de las propuestas:

- Es necesario avanzar en la descripción de la acción de juego de los equipos de *LaLiga* y *LaLiga2* durante un periodo largo de tiempo considerando nuevas variables contextuales y/o situacionales no abordadas en la presente tesis doctoral, como el nivel del equipo rival, el nivel del propio equipo, la ubicación del partido, el resultado final del partido y el periodo de competición, entre otras.
- La dimensión condicional ha sido abordada de manera residual, prácticamente utilizando un único indicador global de la carrera acumulada por los equipos, por lo que abordar un análisis tomando como unidad al jugador, diferenciando las posiciones de juego, los momentos con y sin balón, así como un amplio abanico de variables de contexto y de situación conectándolas con la dimensión decisional permitirá afinar en la comprensión de la evolución de la acción de juego.
- Conocedores de que los cambios normativos tienen incidencia en la manera en que jugadores y equipos despliegan su comportamiento, profundizar en las novedades implementadas anualmente por los organismos responsables de marcar las directrices del juego, es un reto necesario. En este trabajo se ha analizado cómo afectó la implementación del VAR en la acción de juego de los equipos de *LaLiga* española en una única temporada (2018-19). Nuevos estudios donde se aborde un mayor número de temporadas o de casuísticas del VAR con relación a las variables contextuales y situacionales, permitirán una mejor comprensión de la acción de juego del fútbol.

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8. Anexos

8.1. Anexo 1: Estudio 1

Errekagorri, I., Castellano, J., Echeazarra, I., & Lago-Peñas, C. (2020). The effects of the Video Assistant Referee system (VAR) on the playing time, technical-tactical and physical performance in elite soccer. *International Journal of Performance Analysis in Sport*, *20*(5), 808–817. https://doi.org/10.1080/24748668.2020.1788350

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The effects of the Video Assistant Referee system (VAR) on the playing time, technical-tactical and physical performance in elite soccer

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ABSTRACT

The main purpose of the present study was to assess if the intervention of the Video Assistant Referee (VAR) had effects in the playing time and in the technical-tactical and physical performances of the teams in the Spanish LaLiga during 2018-19 season. A total of 375 matches were grouped according the number of VAR interventions: none (VAR0), one (VAR1) and two or three (VAR2). The variables recorded were: total (TPT) and effective (EPT) playing time, passes, dribbles, crosses, shots, goals, corners, fouls, width, length, height, distance from the goalkeeper to their defence, and total (TD) and above 21 km/h distance covered. The results were: I) there was a slight increase in the TPT in VAR2 compared to VAR1 and VAR0 (99.1 vs. 96.0 vs. 95.1, respectively); II) there was a decrease in the EPT between VAR0 and VAR1 (52.5 vs. 51.5); III) there was an increase in the number of goals (1.2 vs. 1.5 vs. 1.7, in VAR0, VAR1 and VAR2); and, IV) there was a slight decrease in the TD (108,916 vs. 107,916 vs. 106,977, in VAR0, VAR1 and VAR2). In conclusion, the findings of the study suggest that the VAR hardly changes the game in elite soccer.

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1. Introduction

Football referees have the arduous task of making judgements in game situations many times involving rapid movement, a number of players and many other factors which they have to deal with although often restricted by limited visibility (Lex et al., 2015). This has given rise to a deepening interest in examining the factors that condition the referee's job during matches. Some of the constraints studied include: the *flash-lag effect* (the difficulty of perceiving the position of an object when something else is happening at the same time) in the case of mistakes made in offside decisions (Helsen et al., 2006), *supporter noise* relating to favourable decisions for local teams (Nevill et al., 2002) or *player comments* on judgements about the seriousness of a foul (Lex et al., 2015). Other studies

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suggest that referees add more extra time in close games when the home teams are behind and less time when they are ahead (Garicano et al., 2005; Lago-Peñas & Gómez-López, 2016).

With the aim of making the referee team's job easier and reducing the probability of error during matches, the Video Assistant Referee (VAR) was introduced into the Laws of the Game in 2018 (Fédération Internationale de Football Association, 2019) to help assess decisions taken by the main referee via video images in three situations: (I) goals, (II) penalties, and (III) red card incidents in which there is confusion identifying the player to be booked. Once the VAR has checked the video recording, the main referee is informed via earphones and he is the one who takes the final decision.

A previous study suggests that the implementation of the VAR has reduced the number of goals, fouls and yellow cards in Italy's *Serie A* (Lago-Peñas et al., 2019). This study also found that the use of the VAR in Germany's *Bundesliga* resulted in a fall in the number of off-sides and yellow cards, whilst provoking a rise in extra time added in the first half and to the match as a whole. To be exact, football matches which had more extra time added at the end appear to provoke a higher conditioning load and limit technical performance in the following matches (Rampinini et al., 2009; Winder et al., 2018). The decrease in footballers' physical performance during matches is substantially enhanced by the presence of extra time, in cases of a draw at the end of the regulatory 90 min in knock out competitions (Lago-Peñas et al., 2015), and by an increase in the length of the match due to a rise in the number of play interruptions throughout the game (Linke et al., 2018). In this sense, the number and duration of stoppages produced in a match due to time wasting, attention to injured players (in some cases due to fatigue) or substitutions, affects both playing time and total time. Therefore, according to the rules, the time spent on player substitution or the number of times players are treated on the pitch carry a stipulated prolongation of match length (e.g., 30 s for each substitution). Therefore, actual playing time is an aspect to take into account, given that it provides more precise information about the interpretation of the physical demands (Castellano et al., 2011) and of the strategic behaviour of the players (Harper et al., 2014). Only taking into account the total duration of the match when quantifying match demands could underestimate the physical performance of the players (Castellano et al., 2011; Wass et al., 2020).

Consequently, it would be interesting to know whether the implementation of the VAR influences game dynamics of teams in the Spanish *LaLiga*. Therefore, the aim of this study was to assess whether the VAR's intervention affects playing time and team performance, both technical-tactical and physical, during the match. The working hypothesis was that playing time and both performances would be affected in matches in which the VAR intervened.

2. Methods

2.1. Participants

For the elaboration of this study, out of a possible 380 matches played in the Spanish *LaLiga* during 2018–19 season, there were a total of 375 matches analysed. Five matches were excluded due to technical issues. The Video Assistant Referee (VAR) intervened 121

times (once in 86 matches, twice in 13 matches and three times in 3 matches) in 102 matches (27% of the matches played). All the matches were divided into three groups according to the number of VAR interventions: none (VAR0, n = 273), one (VAR1, n = 86) and two or three (VAR2, n = 16).

2.2. Variables

Taking into account previous studies (Castellano et al., 2011; Castellano & Casamichana, 2015; Castellano & Echeazarra, 2019; Harper et al., 2014; Lago-Peñas et al., 2019; Rampinini et al., 2009), the following variables were recorded for each match: 1) playing time variables [total playing time (TPT) and effective playing time (EPT)]; 2) technical-tactical performance variables [passes (PASS), dribbles (DRIBBLE), crosses (CROSS), shots (SHOT), goals (GOAL), corners (CORNER), fouls (FOUL), width (WIDTH), length (LENGTH), defence depth (HEIGHT) and distance from the goalkeeper to their defence (GKDEF)]; and, 3) physical performance variables [total distance covered (TD) and total distance covered above 21 km/h (TD21)]. The technical-tactical performance variables were grouped into three dimensions: individual performance, set piece and collective performance. Table 1 shows the dimensions, codes and definitions of these variables. Regarding the physical performance variables, they were evaluated based on the total distance covered by all the players in the team that participated in the match. Goalkeeper activity was also included.

2.3. Procedure

Location and motion data were obtained by the computerised multi-camera tracking system *TRACAB*® (*ChyronHego*, New York, USA) and events were obtained by *OPTA*® Sportsdata company (*Opta Sports*, London, UK), both using *Mediacoach*® software (*Mediapro*®, Barcelona, Spain). The reports were generated using *Mediacoach*®, for the predefined performance indicators. To ensure the reliability of the data collecting

Table 1. Codes and definitions of the technical-tactical performance variables for each dimension.

Dimensions	Codes	Definitions
Individual performance	PASS	Total number of passes completed by the team per match.
	DRIBBLE	Total number of attempts to beat an opponent by the team per match.
	CROSS	Total number of crosses made into the penalty box by the team per match.
	SHOT	Total number of shots made by the team per match.
Set piece	GOAL	Total number of goals scored by the team per match.
	CORNER	Total number of corners taken by the team per match.
	FOUL	Total number of fouls received by the team per match.
Collective performance	WIDTH	Mean team width per match, understood as the distance between the two furthest-apart players across the width of the pitch. To calculate this variable, the time in which the ball is out of play is excluded.
	LENGTH	Mean team length per match, understood as the distance between the two furthest-apart players along the length of the pitch. To calculate this variable, the time in which the ball is out of play is excluded.
	HEIGHT	Mean team defence depth per match, understood as the distance between the furthest back defender and the goal he is defending. To calculate this variable, the time in which the ball is out of play is excluded.
	GKDEF	Mean distance from the goalkeeper to their defence per match. To calculate this variable, the time in which the ball is out of play is excluded.

and codification processes of the *OPTA*® Sportsdata company a reliability test was conducted by two experienced analysts, using the Cohen's Kappa test. First, to assess the inter-observer reliability they carried out the codification of a randomly selected match of Spanish *LaLiga* showing a very good data quality (k = 0.89), and then four matches were randomly selected, observed and compared with the *OPTA*® reports showing a good data quality (k = 0.80) (Altman, 1991). The reliability of the *TRACAB*® video-tracking system has also been recently tested for positioning of the players (Linke et al., 2020) and physical performance (Pons et al., 2019), showing in both dimensions a good quality of the data. The generated reports were exported into *Microsoft Office Excel* (*Microsoft Corporation*, Washington, USA), a matrix was made and later analysed.

2.4. Statistical analysis

Descriptive statistics data from variables were presented using mean and standard deviation (±sd) with 95% confidence intervals (95% CI). The Levene test was used to assess equality of variances and the Kolmogorov Smirnov test to establish normality. One-way ANOVA analysis of variance for independent samples was used to test for differences in the variables between the three groups (VAR0, VAR1 and VAR2). Significant results were then analysed using post hoc Bonferroni's test, whereas Dunnett's T3 post hoc test was applied when the variances were not homogeneous. The level of significance was set at $p < 0.05$. Cohen's d effect size (ES) was also calculated (Cohen, 1988) to determine meaningful differences with magnitudes classified as (Batterham & Hopkins, 2006): trivial (<0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0) and very large (>2.0–4.0). The statistical analysis was conducted using *Microsoft Office Excel* (*Microsoft Corporation*, Washington, USA) and *IBM SPSS v25.0* (*SPSS Inc*., Illinois, USA) for *Windows*.

3. Results

Figure 1 shows the VAR's influence on playing time variables. As can be seen, there was a slight increase ($p < 0.05$) in the TPT between VAR0< VAR1< VAR2 (95.1 vs. 96.0 vs. 99.1 min; ES = 0.5 for VAR0< VAR1, ES = 1.8 for VAR0< VAR2 and ES = 1.3 for VAR1< VAR2) and a significant decrease ($p < 0.05$) in the EPT between VAR0> VAR1 (52.5 vs. 51.5 min; ES = 0.2 for VAR0> VAR1).

Tables 2 and 3 show the VAR's influence on individual technical-tactical performance and set piece, and collective technical-tactical performance variables, respectively. As can be seen in Table 2, there was a significant ($p < 0.05$) in the number of goals between the three situations (VAR0< VAR1 = VAR2), however the differences' magnitude was small (ES = 0.2 for VAR0< VAR1 and ES = 0.5 for VAR0< VAR2). No differences were found for the other technical-tactical variables.

Figure 2 shows the VAR's influence on physical performance variables. As can be seen, there was a slight decrease ($p < 0.05$) in the TD between VAR0> VAR1 = VAR2 (108,916.2 vs. 107,916.2 vs. 106,977.0 m, respectively; ES = 0.2 for VAR0> VAR1 and ES = 0.4 for VAR0> VAR2). Nevertheless, no differences were found for TD21.

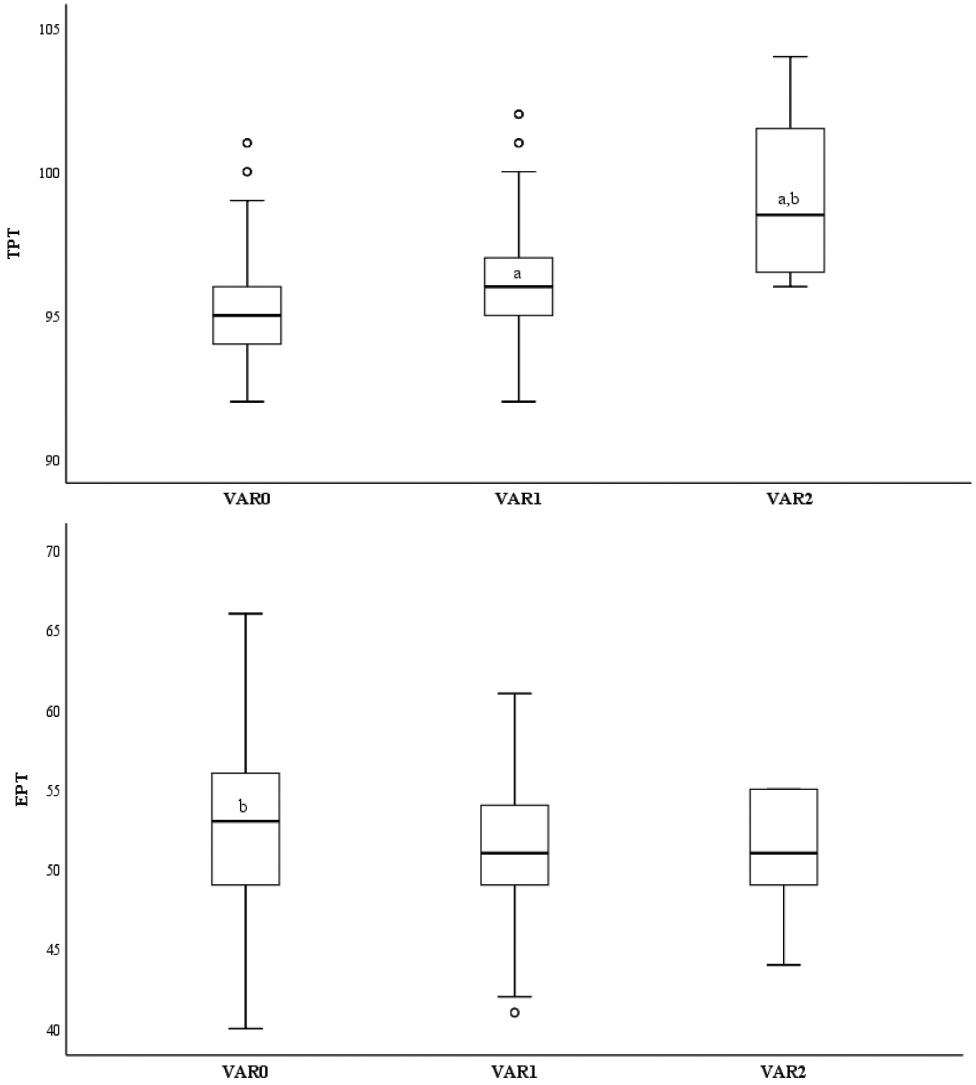

Figure 1. Means, standard deviations (±sd) and 95% confidence intervals (95% CI) of the TPT and EPT for each VAR group. Note: TPT is total playing time, EPT is effective playing time, VAR0 is matched without VAR intervention, VAR1 is matches with one VAR intervention, and VAR2 is matched with two or three VAR interventions. a> VAR0 and b> VAR1 for a significance level of $p < 0.05$.

4. Discussion

The aim of this research was to assess whether the VAR's intervention affected playing time and both technical-tactical and physical performance of teams in the Spanish *LaLiga*. The main findings of the study are as follows: I) the VAR intervenes only a few times during a match, with a revision of game action being necessary in scarcely 27% of matches; II) implementation of the VAR has a slight influence on match length and on the technical-tactical and physical team performance.

Table 2. Means, standard deviations (±sd) and 95% confidence intervals (95% CI) for each individual technical-tactical performance and set-piece variables according to the VAR group.

	VAR0		VAR1		VAR2	
Variables	Mean (±sd)	95% CI	Mean (±sd)	95% CI	Mean (±sd)	95% CI
PASS	474.4 (±126.2)	463.8–485.0	467.9 (±113.2)	450.8–484.9	439.3 (±112.8)	398.7–480.0
DRIBBLE	17.7 (±6.4)	17.2–18.3	18.4 (±6.2)	17.5–19.3	18.1 (±7.2)	15.5–20.7
CROSS	18.2 (±8.5)	17.5–19.0	18.8 (±9.0)	17.5–20.2	18.4 (±10.1)	14.7–22-0
SHOT	12.0 (±4.7)	11.6–12.4	12.5 (±4.9)	11.8–13.2	12.9 (±6.5)	10.6–15.2
GOAL	1.2 (±1.1)	1.1–1.3	1.5 (±1.3)[a]	1.3–1.7	1.7 (±1.1)[a]	1.3–2.1
CORNER	4.7 (±2.6)	4.5–5.0	5.0 (±2.9)	4.6–5.5	5.0 (±3.7)	3.6–6.3
FOUL	13.5 (±4.0)	13.2–13.9	13.7 (±4.1)	13.0–14.3	13.3 (±3.8)	11.9–14.6

Note: PASS is total number of passes completed, DRIBBLE is total number of attempts to beat an opponent, CROSS is total number of crosses made into the penalty box, SHOT is total number of shots made, GOAL is total number of goals scored, CORNER is total number of corners taken, FOUL is total number of fouls received, VAR0 is matches without VAR intervention, VAR1 is matches with one VAR intervention, and VAR2 is matches with two or three VAR interventions. a> VAR0 for a significance level of $p < 0.05$.

One of the arguments against the use of the VAR is that the natural flow of a game may be negatively affected by video-technology (Ryall, 2012; Svantesson, 2014). Since a referee team makes approximately 200–250 foul/no foul decisions per game (Helsen & Bultynck, 2004), the VAR protocol is restricted to match-changing incidents. This study shows that the VAR intervened very few times during the championship, only mediating in 27% of matches. This implies, therefore, that in more than 70% of all matches, checks of match-changing incidents do not lead to a revision. Most VAR checks occur in the background, thus having a minimal impact on the course of the game.

The current results showed that there is a significant increase in the TPT in the full game and a simultaneous decrease in the EPT. These findings are in line with those provided by Lago-Peñas et al. (2019). According to this study, the average duration of the second half and the full game in the Italian *Serie A* and the German *Bundesliga* was 15 and 20 s higher, respectively, after the implementation of the VAR. Consequently our findings suggest that the VAR system does not dramatically affect the duration of the match.

The VAR's intervention during a match had hardly any effect on team play both on a technical-tactical and physical level. TPT increased (VAR1 + 1% and VAR2 + 4%), while EPT decreased (VAR1 and VAR2 decreased by 1% with respect to VAR0) as did the TD (VAR0> VAR1 = VAR2), and the number of goals increased in relation to VAR0.

Table 3. Means, standard deviations (±sd) and 95% confidence intervals (95% CI) for each collective technical-tactical performance variables according to the VAR group.

	VAR0		VAR1		VAR2	
Variables	Mean (±sd)	95% CI	Mean (±sd)	95% CI	Mean (±sd)	95% CI
WIDTH	43.4 (±2.8)	43.1–43.6	43.4 (±2.6)	43.0–43.7	44.1 (±2.4)	43.2–44.9
LENGTH	35.9 (±1.8)	35.8–36.1	35.9 (±1.5)	35.7–36.2	36.3 (±1.6)	35.7–36.8
HEIGHT	37.4 (±3.2)	37.1–37.6	37.2 (±3.2)	36.7–37-6	37.2 (±3.7)	35.8–38.5
GKDEF	24.4 (±1.9)	24.3–24.6	24.6 (±2.0)	24.3–24.9	24.3 (±2.0)	23.6–25.0

Note: WIDTH is mean team width, LENGTH is mean team length, HEIGHT is mean team defence depth, GKDEF is mean distance from the goalkeeper to their defence, VAR0 is matches without VAR intervention, VAR1 is matches with one VAR intervention, and VAR2 is matches with two or three VAR interventions.

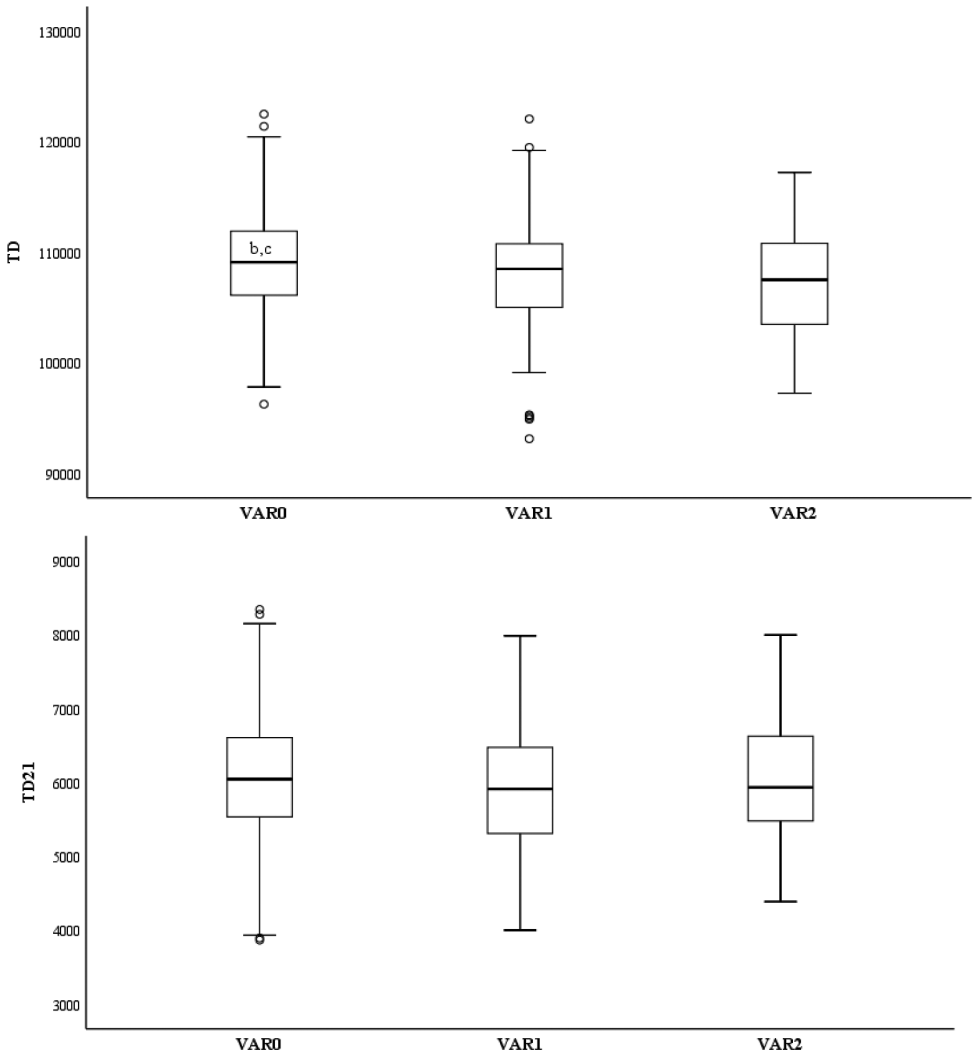

Figure 2. Means, standard deviations (±sd) and 95% confidence intervals (95% CI) of the TD and TD21 for each VAR group. Note: TD is total distance covered by all the players in the team, TD21 is total distance covered above 21 km/h by all the players in the team, VAR0 is matched without VAR intervention, VAR1 is matched with one VAR intervention, and VAR2 is matched with two or three VAR interventions. b> VAR1 and c> VAR2 for a significance level of $p < 0.05$.

The VAR's intervention hardly altered the teams' technical-tactical performance. The only difference in this sense is that in matches with some kind of VAR intervention (VAR1 and VAR2) more goals were scored. This data is difficult to interpret, but it may be related to the situations in which the rules state that the VAR should intervene. These tend to take place usually near to the goal, arising from actions which could suggest a penalty or a goal scored from a dubious position. In this sense, it is interesting to note that goals scored from a penalty increased 2% (from 9% to 11%) in the 2017–2018 season

(before the introduction of the VAR) in relation to the 2018–2019 season of this study (www.whoscored.com).

In terms of conditional variables, in matches with VAR intervention (VAR1 and VAR2), the TD dropped significantly albeit with a small magnitude. The results of this research coincide with those of a previous study (Lago-Peñas et al., 2015), in which a drop in TD was observed in matches with a higher TPT. On the other hand, the VAR did not appear to affect the TD21 variable, as the teams accumulated the same quantity of distance covered at that speed. However, if we consider that the greatest part of accumulated distance in speed ranges takes place when the ball is in play (Castellano et al., 2011) and the EPT was lower in matches where the VAR intervened, it could be concluded that the intensity and rhythm of play were somewhat higher in matches where the VAR intervened.

In terms of limitations, it would have been interesting to have considered contextual variables (Castellano et al., 2011), such as season phase (beginning, middle or end), the place where the match takes place (home or away), the momentary result or the quality of the opponent, to know whether VAR intervention affects teams' game dynamics in terms of these variables. Another limitation of this research was to not differentiate between the different types of VAR intervention in relation to the kind of action requiring it, something which could allow an assessment of the particular influence of each type on game development.

Overall, the findings of the present study showed that when the VAR system intervened: I) there was a slight increase in the TPT between the three situations (95.1 vs. 96.0 vs. 99.1 min, in VAR0, VAR1 and VAR2, respectively); II) there was a significant decrease in the EPT between VAR0 and VAR1 (52.5 vs. 51.5 min); III) there was an increase in the number of goals scored in the matches (1.2 vs. 1.5 vs. 1.7, in VAR0, VAR1 and VAR2, respectively); and IV) there was a slight decrease in the TD between the three situations (108,916.2 vs. 107,916.2 vs. 106,977.0 m, in VAR0, VAR1 and VAR2, respectively). These findings suggest that the VAR system hardly affects the game in elite football. However, it would appear necessary to continue studying the effects on the game in other variables, with the implementation of innovations for aiding conventional refereeing, in order to know with greater exactitude the type and degree of repercussion and assess its applicability.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Ethical approval

The data have been treated in accordance with the Declaration of Helsinki, being granted the clubs' consent to access the data and having received permission from the Ethics Committee on Humans (CEISH) of the University of the Basque Country (UPV/EHU).

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8.2. Anexo 2: Estudio 2

Errekagorri, I., Castellano, J., Echeazarra, I., López-Del Campo, R., & Resta, R. (2022). A longitudinal analysis of technical-tactical and physical performance of the teams in the Spanish LaLiga Santander: An eight-season study. *Biology of Sport*, *39*(2), 389–396. https://doi.org/10.5114/biolsport.2022.105331

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A longitudinal analysis of technical-tactical and physical performance of the teams in the Spanish LaLiga Santander: An eight-season study

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ABSTRACT: The aim of this study was to describe in the way teams played for the last eight seasons (from 2011–12 to 2018–19) in the Spanish Football First Division (Spanish LaLiga Santander), taking into account team match performances (n = 5,518). Ten technical-tactical and physical variables grouped into five dimensions were used: final behaviour (shots and crosses), set piece (corners and fouls), match volume (passes), physical performance (total distance covered) and collective use of the space (team width, team length, team defence height and distance from the goalkeeper to their defence). The main results were that the number of passes and team width showed a stable trend as the seasons passed. Nevertheless, the number of shots, crosses and corners, total distance covered, team length and distance from the goalkeeper to their defence showed a descending trend. The main conclusion was that over the seasons studied, the Spanish LaLiga Santander teams were characterized by an indirect style of play that, being the usual in this league, presented some evolution. The trend in the evolution of the game is that defence is put before attack. The findings of the study may be of interest to professional football staff to know more about the particular way teams play in competition, as well as its evolution, so as to focus on the training process according to the trend that is taking place in the game.

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Evolution

INTRODUCTION

Performance analysis of professional football teams represents a key aspect in achieving success in sport [1]. In order to do so, the use of performance indicators is essential [2], especially the selection and combination of Performance Key Elements, because they can positively impact the achievement of the best performances [3]. Generally, notational analysis has been used to objectively describe and explain football players' and teams' behaviour during a match, providing invaluable information to improve future performances [4]. The variables used to describe group behaviour are already included in the modelling of procedures proposed by football teams. Therefore, it is essential to describe the strategy performance so as to provide essential and useful information for training sessions and sport education [5]. In this sense, technological development as well as introduction of big data in top-level football teams has provided new opportunities to carefully study, even longitudinally, football players' strategy performance as well as teams' behaviour in competition [6].

Several studies have been carried out with the aim of describing the development of the game throughout history [7, 8, 9, 10]. Lago-Peñas [11] stated that the advantage of assessing performance longitudinally is that it allows one to distinguish possible match frameworks, determining the influence that several contextual or random variables may affect specific performance on a given day or during a short period of time. This kind of longitudinal studies have been generally conducted using notational analysis [7]. Nevertheless, the different cooperative variables that could be obtained through technological improvements offer information about players' and teams' technical-tactical and physical performance during matches [12].

Considering this longitudinal viewpoint, the physical dimension has received close attention [13, 14, 15]. In this line, several authors have studied the evolution of English teams playing in the Premier League throughout seven seasons [13], regarding the specific position of the players[15], or taking into account how they ended up at the end of the season [14]. Barnes et al. [13] reported that the distance covered by teams in the English Premier League had not changed much throughout the seven years, this way increasing the distance covered and high intensity actions, as well as the number

and sprint distance. Furthermore, high intensity distance and the number of high intensity runs and sprints increased significantly in all player positions in English Premier League teams [15]. Bradley et al. [14] showed that throughout the seven seasons, all the English Premier League teams increased the high intensity distance covered when they were not in possession of the ball. However, teams that finished fifth to eighth by the end of the season showed a slight increase in the short distance covered in high intensity compared to other teams when in possession of the ball. The teams ranked fifth to eighth also showed a significant increase in the distance covered while sprinting, in comparison to other teams. These results may be related to an additional motivation caused by competing for European berths. Regarding the Spanish Football First Division (Spanish LaLiga Santander), a recent study throughout four seasons [16] showed a decrease in the total distance covered and an increase in the high-intensity distances and number of sprints performed by the teams. Anyway, the conclusions of this study are not clear due to the number of seasons being just four consecutive seasons.

After describing the football players' technical activity evolution of the German Bundesliga by specific positions during three consecutive seasons, Konefał et al. [17] concluded that technical activity had developed in all players' positions. This research indicates that the technical activity evolution among professional footballers is developing in a more precise direction with a simultaneous absence of change or even a decrease in quantity or activity levels. In other leagues, as in the English Premier League, an evolution in teams' technical activity throughout the seven seasons has also been found [13, 15]. Specifically, there has been an increase in the number of passes and their effectiveness; probably the ones that have increased notably are short and medium-distance passes. Similarly, it has also been revealed that the technical requirement of those players who play in the centre of the pitch (centre-backs and central midfielders) has increased. After some time, similar attacks made by top-tier football teams had moved away from a more individualized behaviour, such as dribbling and feints in the centre of the pitch, to a more group-based performance, such as short passes and crosses into the box [7, 8]. As a result of a significant boost in the number of passes in the past years, the speed in football has also increased [10].

To sum up, it seems that football has changed in the last decades and especially in recent seasons, so it is of great interest to find

TABLE 1. Codes and definitions of the variables for each dimension analysed.

Dimensions	Codes and definitions
Final behaviour	SHOT: an attempt to score a goal, made with any part of the body that is allowed in the laws of the game, either on or off the goal. To calculate this variable, total number of shots made by the team per match are taken into account. CROSS: any ball sent into the rival team's penalty box from a wide position. To calculate this variable, total number of successful and unsuccessful crosses made by the team per match are taken into account.
Set piece	CORNER: a kick that is performed on a set piece from the corner of the field of play nearest to where the ball went out. To calculate this variable, total number of corners taken by the team per match are taken into account. FOUL: any infringement that is penalised as foul play by the referee. To calculate this variable, total number of fouls received by the team per match are taken into account.
Match volume	PASS: an intentional played ball from one player to another with any part of the body that is allowed in the laws of the game. To calculate this variable, total number of successful and unsuccessful passes made by the team per match are taken into account.
Physical performance	KM: total distance covered and accumulated by all the players in the team that participated in the match. Goalkeeper activity was also included.
Collective use of the space	WIDTH: mean team width per match, understood as the distance between the two furthest-apart players across the width of the pitch. To calculate this variable, the time in which the ball is out of play is excluded. LENGTH: mean team length per match, understood as the distance between the two furthest-apart players along the length of the pitch. To calculate this variable, the time in which the ball is out of play is excluded. HEIGHT: mean team defence depth per match, understood as the distance between the furthest back defender and the goal he is defending. To calculate this variable, the time in which the ball is out of play is excluded. GKDEF: mean distance from the goalkeeper to their defence per match. To calculate this variable, the time in which the ball is out of play is excluded.

out whether the teams' performances in their league have caused modifications in the dynamics of the game over the years. Taking this into consideration, the aim of this study was to describe the game play during eight consecutive seasons (from 2011–12 to 2018–19) in the Spanish LaLiga Santander bearing in mind the analysis of all team performances. The findings of this study may be of interest to professional football staff to have a clear idea of the aspects that describe performance in the Spanish LaLiga Santander, as well as its evolution, and on which to focus the training process. For the clubs, it would allow them to know the profile of players, who could better adjust to the present and future demands of the competition.

MATERIALS AND METHODS

Sample

For the purposes of this study, all teams' performances in the Spanish LaLiga Santander were analysed for the past eight seasons (from 2011–12 to 2018–19). All matches where the information required was not available were excluded, as well as matches where one or more players were sent off. As a result, out of a possible 6,080 performances, a total of 5,518 performances were analysed (20 teams, each playing 38 matches throughout the eight seasons), representing 90% of all the possible matches. Data were obtained from the Spanish Professional Football League, which authorised the use of the variables included in this investigation. In accordance with its ethical guidelines, this investigation does not include information that identifies football players. Data were treated in accordance with the Declaration of Helsinki, having been approved by the Ethics Committee on Humans (CEISH) of the University of the Basque Country (UPV/EHU).

Variables

Similar to other studies [18, 19], the variables were grouped into five dimensions (Table 1). In the first dimension, also known as final behaviour [13, 15] the number of shots at goal (SHOT) and the number of crosses into the penalty box (CROSS) were included. In the second dimension, set piece [20] included the number of corners taken (CORNER) and fouls (FOUL). The third dimension or the so-called match volume [14, 17] was represented by the total number of passes (PASS). The fourth dimension gave information about the physical performance of the teams [21] and was evaluated based on the total distance covered by all the players in the team (KM). The fifth and last dimension showed the collective pitch use of the teams [22, 23] grouped with the mean team width (WIDTH), mean team length (LENGTH), mean team defence depth (HEIGHT), and mean distance from the goalkeeper to their defence (GKDEF).

Procedure

Location and motion data were obtained by the computerized multi-camera tracking system *TRACAB* (ChyronHego, New York, USA) and events were obtained by the data company OPTA Sports (Opta Sports, London, UK), both using Mediacoach software. The reports were generated using Mediacoach, for the predefined performance indicators. The reliability of the OPTA system has been previously proved [24] and the reliability of the TRACAB video-tracking system has also been recently tested for positioning of the players [25] and physical performance [26], showing in both dimensions good quality of the data. The generated reports were exported into Microsoft Office Excel (Microsoft Corporation, Washington, USA), and a matrix was configured and later analysed.

Statistical analysis

Descriptive statistics data from variables were presented using mean and standard deviation. The Levene test was used to assess equality of variances. One-way analysis of variance (ANOVA) for independent samples was used to test for differences in the variables between the eight seasons (from 2011–12 to 2018–19). Significant results were then analysed using the post hoc Bonferroni's test, whereas Dunnett's T3 post hoc test was applied when the variances were not homogeneous. The level of significance was set at $p < 0.05$. Effect size (ES) was also calculated to determine meaningful differences with magnitudes classified as [27]: trivial (< 0.2), small (> 0.2–0.6), moderate (> 0.6–1.2), large (> 1.2–2.0) and very large (> 2.0–4.0). The statistical analysis was conducted using Microsoft Office Excel (Microsoft Corporation, Washington, USA) and IBM SPSS v25.0 (IBM Corp.) for Windows.

RESULTS

Final behaviour

As shown in Table 2, the SHOT values were higher ($p < 0.05$) in the first two seasons analysed (2011–12 and 2012–13) compared to the last five (from 2014–15 to 2018–19), the magnitude of these differences being small (ES = 0.2–0.3). In CROSS, the values were higher ($p < 0.05$) in the first four seasons (from 2011–12 to 2014–15) with respect to the last four (from 2015–16 to 2018–19), the magnitude of the differences being small (ES = 0.2–0.4).

Set piece

Regarding this dimension (Table 2), the first two seasons analysed (2011–12 and 2012–13) showed higher values ($p < 0.05$) compared to the last three (2016–17, 2017–18 and 2018–19) in CORNER. However, the 2013–14 season showed higher values ($p < 0.05$) compared to the last five studied (from 2014–15 to 2018–19). The 2014–15 season showed higher values ($p < 0.05$) only with respect to 2016–17. The magnitude of the differences between all these seasons was small (ES = 0.2–0.4). The FOUL variable showed the lowest values in the 2013–14, 2015–16, 2017–18 and 2018–19 seasons in relation to the 2011–12 season ($p < 0.05$) with a small magnitude (ES = 0.2–0.3).

Match volume

In relation to this dimension (Table 2), the PASS values of the 2011–12 season were higher ($p < 0.05$) than those of the 2014–15

season, with a small magnitude (ES = 0.2). However, the values of the 2016–17 and 2017–18 seasons were higher ($p < 0.05$) than those of the 2013–14 and 2014–15 seasons. The magnitude of the differences between these seasons was trivial-small (ES = 0.1–0.2).

Physical performance

The values of the KM variable (Table 2) were higher ($p < 0.05$) in the first three seasons (2011–12, 2012–13 and 2013–14) compared to the rest of the seasons analysed (from 2014–15 to 2018–19). On the one hand, the 2011–12 season showed higher values in relation to the last six seasons (from 2013–14 to 2018–19). On the other hand, the values of the 2012–13 and 2013–14 seasons were higher compared to the last five (from 2014–14 to 2018–19). The magnitude of the differences between these seasons ranged from small to moderate (ES = 0.2–0.7). It should also be noted that between the 2015–16 and 2017–18 seasons the values were higher in relation to the 2014–15 and 2018–19 seasons. The magnitude of the differences between these seasons was small (ES = 0.2–0.3).

Collective use of the space

As shown in Figure 1, the seasons 2011–12 (mean and standard deviation, 43.6 ± 2.6 m), 2013–14 (43.7 ± 2.5 m), 2015–16 (43.4 ± 2.5 m) and 2017 -18 (43.7 ± 2.7 m) showed higher values ($p < 0.05$) than those of 2014–15 (43.0 ± 2.6 m) of small magnitudes (ES = 0.2–0.3) in the WIDTH variable. Likewise, the values of the 2016–17 season (43.9 ± 2.7 m) were higher ($p < 0.05$) compared to those of 2012–13 (43.4 ± 2.7 m), 2014–15, 2015–16 and 2018–19 (43.4 ± 2.7 m) with small magnitudes (ES = 0.2–0.3). The LENGTH values for the 2011–12 season (38.2 ± 1.8 m) were higher ($p < 0.05$) than those of the other seasons studied, with a magnitude of the differences between them that ranged from small to large (ES = 0.2–1.2). With this, the 2012–13 season (37.7 ± 1.8 m) showed higher values ($p < 0.05$) compared to the 2014–15 seasons (37.2 ± 2.4 m), 2015–16 (36.6 ± 1.8 m), 2016–17 (36.2 ± 1.9 m), 2017–18 (36.1 ± 1.9 m) and 2018–19 (36.0 ± 1.7 m), with a magnitude that ranged from small to moderate (ES = 0.2–1.0). Likewise, the 2013–14 (37.5 ± 1.9 m) and 2014–15 seasons showed higher values ($p < 0.05$) in relation to those of the last four seasons analysed (from 2015–16 to 2018–19) with a magnitude that ranged from small to moderate (ES = 0.3–0.9). Finally, the values of the 2015–16 season were higher ($p < 0.05$) than those of the last three (2016–17, 2017–18 and 2018–19), the magnitude of the differences being small (ES = 0.2–0.3). In the case of HEIGHT, the values of the 2014–15 season (36.5 ± 3.2 m) were lower ($p < 0.05$) with respect to those of the other seasons analysed (2011–12 [37.8 ± 3.8 m], 2012–13 [37.9 ± 3.5 m],

TABLE 2. Means and standard deviations (sd) of the variables of the final behaviour, set piece, match volume and physical performance dimensions for each season.

	Final behaviour		Set piece		Match volume	Physical performance
Seasons	**SHOT**	**CROSS**	**CORNER**	**FOUL**	**PASS**	**KM**
2011–12	13.2[c,d,e,f,g] (5.4)	20.8[d,e,f,g] (8.7)	5.5[e,f,g] (3.0)	14.7[b,d,f,g] (4.7)	480.0[c] (121.2)	111665.8[b,c,d,e,f,g] (4683.4)
2012–13	13.2[c,d,e,f,g] (5.2)	21.1[d,e,f,g] (8.9)	5.5[e,f,g] (2.9)	14.2 (4.4)	472.4 (127.6)	111088.2[c,d,e,f,g] (4382.7)
2013–14	12.6 (5.1)	21.4[d,e,f,g] (8.8)	5.7[c,d,e,f,g] (2.9)	13.9 (4.1)	463.3 (117.0)	110508.6[c,d,e,f,g] (4464.2)
2014–15	11.9 (4.9)	21.5[d,e,f,g] (9.2)	5.1[e] (2.8)	14.2 (4.2)	459.9 (115.4)	108520.8 (4244.9)
2015–16	11.9 (4.8)	19.1 (8.9)	5.1 (2.8)	13.7 (4.3)	474.7 (110.7)	109609.3[c,g] (4207.8)
2016–17	12.1 (4.8)	18.0 (9.0)	4.6 (2.9)	14.1 (4.1)	483.6[b,c] (113.3)	109445.1[c,g] (4211.4)
2017–18	12.1 (4.7)	18.0 (8.5)	5.0 (2.7)	13.8 (4.4)	480.7[c] (116.9)	109492.4[c,g] (4060.0)
2018–19	12.2 (4.8)	18.4 (8.7)	4.8 (2.7)	13.5 (4.0)	471.6 (122.8)	108622.5 (4969.7)

SHOT is the number of shots at goal, CROSS is the number of crosses into the penalty box, CORNER is the number of corners taken, FOUL is the number of fouls received, PASS is the total number of passes, and KM is the total distance covered by all the players in the team. b > 2013–14, c > 2014–15, d > 2015–16, e > 2016–17, f > 2017–18 and g > 2018–19 for a significance level of $p < 0.05$.

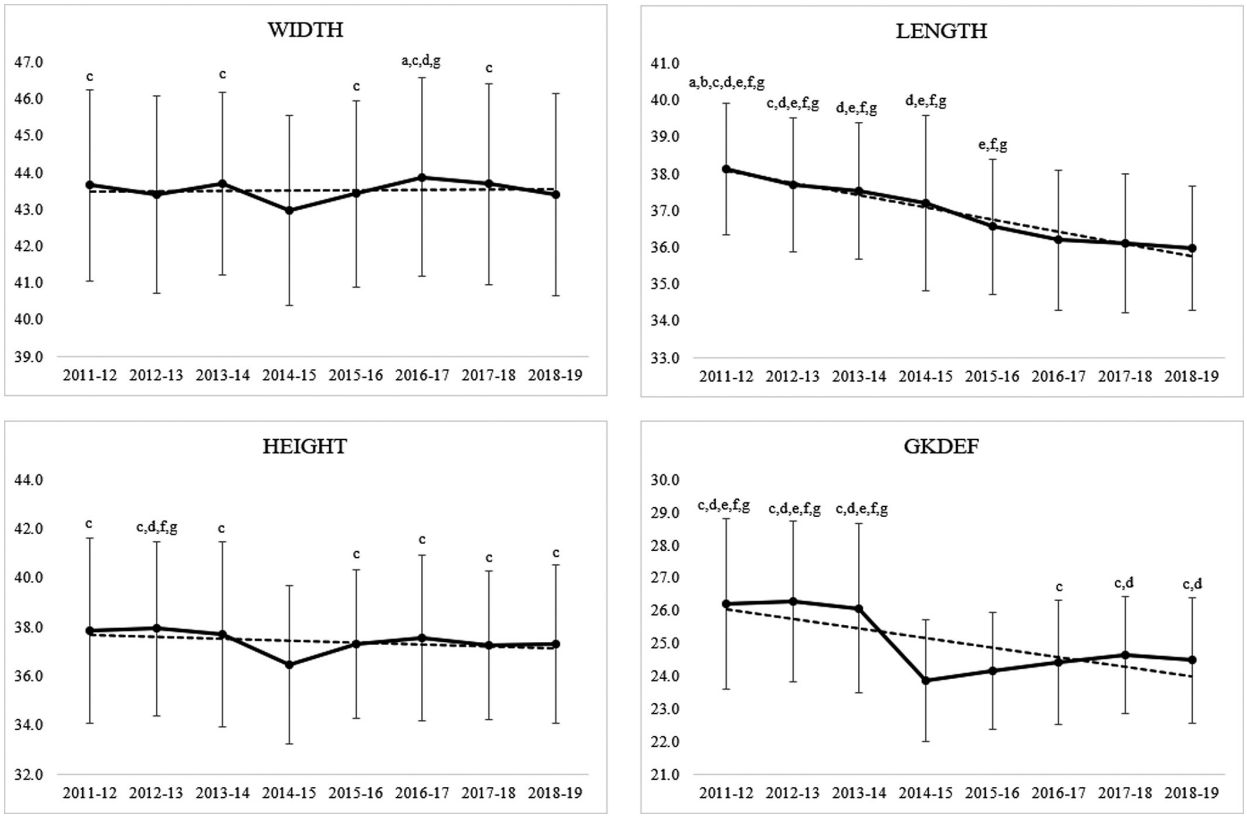

FIG. 1. Means and standard deviations (sd) of the variables of the collective use of the space dimension for each season. Dotted lines represent the trend line. WIDTH is the mean team width, LENGTH is the mean team length, HEIGHT is the mean team defence depth, and GKDEF is the mean distance from the goalkeeper to their defence. a > 2012–13, b > 2013–14, c > 2014–15, d > 2015–16, e > 2016–17, f > 2017–18 and g > 2018–19 for a significance level of $p < 0.05$.

2013–14 [37.7 ± 3.8 m], 2015–16 [37.3 ± 3.0 m], 2016–17 [37.6 ± 3.4 m], 2017–18 [37.3 ± 3.0 m] and 2018–19 [37.3 ± 3.2 m]). In this sense, the 2012–13 season also showed higher values ($p < 0.05$) than those of the 2015–16, 2017–18 and 2018–19. The magnitudes of the differences between the seasons were small (ES = 0.2–0.4). Finally, GKDEF showed higher values ($p < 0.05$) in the first three seasons (2011–12 [26.2 ± 2.6 m], 2012–13 [26.3 ± 2.5 m] and 2013–14 [26.1 ± 2.6 m]) compared to the last five (2014–15 [23.9 ± 1.8 m], 2015–16 [24.2 ± 1.8 m], 2016–17 [24.4 ± 1.9 m], 2017–18 [24.6 ± 1.8 m] and 2018–19 [24.5 ± 1.9 m), the magnitudes of the differences being moderate (ES = 0.7–1.1). In this regard, the magnitude was small (ES = 0.2–0.4). The values of the last three seasons (2016–17, 2017–18 and 2018–19) were also higher ($p < 0.05$) than those of 2014–15 and 2015–16.

DISCUSSION

The present study aimed to describe the game play during eight consecutive seasons (from 2011–12 to 2018–19) in the Spanish LaLiga Santander considering the average performance analysis of the teams during each season. This is the first research paper that analyses teams' performances in the Spanish LaLiga Santander from a large longitudinal perspective, taking into account technical behaviours, set pieces, total displacement and collective use of pitch space. The information provided by this study, especially due to the inclusion of the 5,518 performances and the fact that all of the teams in the eight championships were analysed, suggests that these outcomes are useful for learning about the evolution of the teams' performances. The main conclusion was that over the seasons studied, the Spanish LaLiga Santander teams showed an indirect playing style that remained throughout the years, changing the style somewhat in recent seasons towards a less deep game with fewer arrivals in the rival team's area. Considering the limitation of trying to describe

something as complex as style of play from certain variables, the results of the study showed that the Spanish LaLiga Santander teams' style of play has changed somewhat as the seasons have passed. It should be noted that within the indirect style of play that characterizes the Spanish LaLiga Santander, the defence seems to prevail over the attack.

In the first four seasons (from 2011–12 to 2014–15), Spanish LaLiga Santander teams were characterized by having higher values in SHOT, CORNER, and CROSS, running greater distance (KM), and playing with greater LENGTH and a greater distance from the goalkeeper to the defensive line (GKDEF). These results could be interpreted as teams showing a higher degree of offensive play, as they were able to play higher up and reach the rival's area more often. However, as the seasons passed, the values of these variables that characterized teams with a more direct and deep playing style [28] decreased.

In this sense, it should be noted that the Spanish LaLiga Santander teams were characterized with an indirect style of play that remained throughout the years, represented by a similar number of PASS and WIDTH. Nevertheless, as of the 2015–16 season, these variables showed a small increase. It seems that from that season on, the teams strengthened the defensive aspects in such a way that, although the teams increased somewhat the number of passes and the amplitude in the game, it caused lower efficiency in the game (e.g., fewer attempts on goals). It is widely known [29] that the game style of the Spanish LaLiga Santander is characterized by a possession style football with a high pass rate. Furthermore, in a recent Spanish LaLiga Santander study [18, 30], the number of shots (and overall, their accuracy), the number of corners, and the number of passes (and their efficiency) demonstrated high correlations with the number of points at the end of the seasons. Previous studies [7, 8, 10, 13] have pointed to the existence of an increase in the number of passes in the last few seasons, from 2011–12 onwards, which has not shown evolution to an indirect game style. It seems that the more passes there were, the greater were the chances of victory [17, 20]. As in other leagues, such as the English Premier League [31] or the German Bundesliga [32], in the Spanish LaLiga Santander [33] there is a direct correlation between ball possession and success.

Team LENGTH and GKDEF have decreased as the seasons have passed, while HEIGHT has kept stable. Comparing the first seasons studied (from 2011–12 to 2014–15) to the last ones (from 2015–16 to 2018–19) a regression in the last seasons can be observed. This means that player positions have moved back. It is an average value due to the fact that the present study has not investigated the variability of defence positioning depending on where the ball is on the pitch, or having possession of the ball or not [22]. This correlates with a decrease in SHOT, CROSS and CORNER, probably due to the greater defensive efficacy of the teams. A systematic recent review of the variables that lead to success in football [34] found that the most influential variables are efficiency (shots on goal, ball possession and pass accuracy), supporting the idea that in modern football, quality is more important than quantity in the assessment of a team's performance [17]. This result is consistent with the fact that the average number of goals per game has not changed much from seasons 2011–12 to 2018–19, with an average of 2.8 (± 0.1) goals per match (range between 2.6 to 2.9). Exceptionally, the last season in this study (2018–19) obtained the lowest value of goals per game (2.6), 983 goals in a total of 380 matches (https://www.worldfootball.net/stats/esp-primera-division/1/). Perhaps, substantial modifications to the game (e.g., incorporation of the Video Assistant Referee) might justify a different approach of the teams, and as a consequence, a decrease in the number of goals per match [35]. Something similar occurs with FOUL, as the effect of greater professionalisation in the refereeing establishment and even the implementation of the Video Assistant Referee probably could have influenced its downward trend.

Regarding the KM variable, the results showed a decrease throughout all the seasons, similar to the results of a previous study on the English Premier League [13] and of a recent study of match running performance in the Spanish LaLiga Santander [16]. The decrease in the number of arrivals in the rival team's area or shots could be explained by more efficient defensive organization of the teams. This lack of arrivals in the area caused less displacement of the box-to-box teams, which explains why the total distance covered has been decreasing over the years. Several authors [21] realized that the performance rates of a technical-tactical nature have a greater influence than those of a conditional nature when it comes to determining the difference between the most successful teams in the championship. This is in line with the results presented by Castellano [18], who found that the total distance covered is not related to the success achieved by the teams at the end of the championship.

Despite the fact that the present paper studied eight seasons in a domestic league (Spanish LaLiga Santander), care must be taken when extrapolating these league results to other countries or competitions with different characteristics [29]. A principal limitation of the study was that the mean rate of performance of all the teams in each season had to be taken into consideration, whereas performance variability, such as looking for the equalizer, could not be considered [36, 37]. It is widely known that team performance will vary during the same season, due to, in most cases, strategic coaching decisions [38, 39] and the contextual variables [40, 41]. Additionally, the choice of other variables (e.g., high intensity physical activity, the type of pass or cross, defensive variables, the efficacy of the variables) could have provided relevant information and another possible interpretation of this study's results. Future research should, therefore, take into account more contextual variables such as the result (e.g., won, drawn or lost), final ranking (e.g., points accumulated), or period in the season (e.g., whether teams are playing at the beginning, middle or end of the season) among others. Additional information regarding individual teams (not used in this methodology) would thus generate the right kind of information when planning training sessions and strategies for upcoming matches.

CONCLUSIONS

The analysis of the eight seasons (from 2011–12 to 2018–19) has revealed that throughout the years Spanish LaLiga Santander teams' style of play has changed somewhat. The main conclusion was that the Spanish LaLiga Santander teams displayed a style of play based on possession that remained throughout the years, represented by a similar number of PASS and WIDTH. However, some changes were found in recent seasons: some variables such as SHOT, CORNER, CROSS, KM, LENGTH and GKDEF decreased as the seasons passed, suggesting that the defence game prevails over the attack game. Furthermore, quality prevails over quantity because teams have fewer final behaviours and set pieces (SHOT, CROSS and CORNER) but continue scoring a similar number of goals per match (2.8). The present study provides ideas to establish a method to describe how Spanish LaLiga Santander football teams' performances have been changing in the last years. The results of this study may help football professionals to decide where to focus the process of scouting or training, considering the evolution of players' and teams' performances in the next years. They would allow the coaching staff to have a clear idea about the aspects that describe performance in the Spanish LaLiga Santander and on which aspects to focus the training process. For the clubs, it would mean the possibility of knowing the profile of players who could better adjust to the present and future demands of the competition.

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Conflict of interest declaration

No potential conflict of interest was reported by the authors.

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8.3. Anexo 3: Estudio 3

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Performance analysis of the teams that remained in the top-tier division of the Spanish *LaLiga* during eight consecutive seasons

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Abstract

The present study aimed to analyse the performance of 2212 collective observations of the eight teams that remained in the Spanish men's top professional football division (Spanish *LaLiga*) for eight consecutive seasons (from 2011–2012 to 2018–2019), intending to understand the reference values of these teams. The variables recorded were passes, successful passes, crosses, shots, goals, corners, fouls, width, length, height, distance from the goalkeeper to the nearest defender (GkDef) and total distance covered (TD). A linear mixed model was performed for each dependent variable ($p < 0.05$). The main results were: (1) the eight teams, to a large extent, maintained a stable performance throughout the eight seasons analysed; (2) the length values decreased significantly from the fifth season (from 2015–2016 to 2018–2019); (3) the GkDef values decreased significantly from the fourth season (from 2014–2015 to 2018–2019); and 4) the TD values decreased significantly from the third season (from 2013–2014 to 2018–2019). The study concludes that within the framework of a performance stability, the teams over the seasons increased the density of players (e.g. less effective playing space), playing with the goalkeeper closer to the nearest defender of his team and covering less total distance.

Keywords

Team sport, football, soccer, match analysis, time-motion analysis, collective behaviour, evolution, domestic competition, electronic performance and tracking systems, mixed model

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Introduction

The game of football is characterised as dynamic interactions of technical, tactical and physical actions and movements from all competing players during a match.[1,2] The use of variables measuring physical and technical-tactical aspects and covering individual player and teams' units is essential to evaluate the performance of players and teams in competition.[3] To this end, the observational methodology has been fundamental to objectively describe and explain the behaviour of football players and teams during a match, mainly through the frequency of game events, providing very valuable information to improve future performances.[4,5] However, technological development as well as the introduction of sports analytics in top-level teams have over time provided new opportunities to carefully study and to carry out longitudinal monitoring of football players' strategy performances as well as teams' behaviour in competition.[6]

Previous studies explored the development of the game of football throughout the years, both in domestic competitions[7–13] and in international competitions.[14,15] Considering this longitudinal viewpoint, the physical performance has received close attention.[7–10,12,13] In this line, several authors have studied the evolution of English teams playing in *Premier League* throughout seven seasons,[8] bearing in mind the specific

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positions of players,[10] or taking into account the teams' final ranking.[9] Barnes et al.[8] reported that the distance covered by the teams in the English *Premier League* had not changed much throughout seven years (from 2006–2007 to 2012–2013), nevertheless they increased the number of high-intensity and sprint actions and accumulated distance. Research published recently on the running load demands of football players in the English *Premier League* from 2014–2015 to 2018–2019, observed increases from season to season in variables such as total distance covered, high-speed running and sprint, but these increments were not consistently significant.[7] These changes in running load over time may be dependent on playing position.[10] In addition, it is possible that these results might be conditioned by the technology used for assessing the running performance. Allen et al.[7] used the *TRACAB*® optical sensor camera-based system, while Barnes et al.,[8] Bush et al.[10] and Bradley et al.[9] used *ProZone*®, with significant differences in favour of the latter of 500 m in the total distance covered and 126 m in the sprint distance.[16] With respect to the Spanish *LaLiga*, a recent work over eight seasons showed a small decrease in the total distance covered.[12] However, the authors of this study found that in the Spanish *LaLiga* a greater distance was covered at high-intensity and a higher number of high-intensity efforts were performed as the seasons progressed, specifically from 2012–2013 to 2019–2020. Apart from possible differences motivated by changes in video-tracking cameras,[17] another aspect that could have conditioned these results relied upon different teams participating during those seasons, as a consequence of promotions and relegations.

Nevertheless, the technical-tactical performance has also received quite a lot of attention.[8–12,14,15] Konefał et al.[11] concluded that the technical-activity evolution among professional football players is developing in a more precise direction with a simultaneous absence of change or even a decrease in quantity or activity levels. In other domestic leagues, such as the English *Premier League*, an evolution in teams' technical activity throughout the seven seasons (from 2006–2007 to 2012–2013) has also been found.[8–10] Specifically, there has been an increase in the number of passes and their effectiveness, probably the ones that have notably increased are short and medium-distance passes.[8] A study published recently about the game evolution during eight consecutive seasons (from 2012–2013 to 2019–2020) of the teams in the Spanish *LaLiga* observed a small increase throughout this period in technical variables such as passes, long passes, passing accuracy, aerial duels and interceptions.[12] Furthermore, the researchers of the study found a slight decrease during this period in technical variables such as shots, tackles and clearances. Another recent study about the evolution of team formations from 2012–2013 to 2020–2021 in the Spanish *LaLiga*[18] found that the most common tactical structure used by the teams from 2012–2013 to 2016–2017 was the 1-4-2-3-1, while the 1-4-4-2 was the most frequent team formation from 2017–2018 to 2020–2021. Additionally, team formations such as 1-4-3-3 and 1-4-5-1 showed a relatively stable trend as the seasons progressed. It should be noted that each domestic league or country is characterised by having own unique style of playing football.[19]

When longitudinal studies of entire leagues are carried out, however, they do not take into account that the analysis incorporates the performances of teams that have a fleeting presence in the league. A team may reach the top competition one season and relegation the next or at best remain for only a few seasons. The teams in the lower part of the ranking (from position 11th to 20th) tend to have similar performances, usually much lower than the teams located in the upper part of the ranking.[9] Therefore, analysis of those teams that have been able to maintain a stable performance in competition and in a certain league over the years could provide relevant information which could serve as reference values.

No research has analysed the evolution of any domestic league considering only the teams that remained in the top-tier division over the years. Therefore, the present study aimed to analyse the performance of the teams that remained in the Spanish *LaLiga* over a continuous period of eight seasons considering some key competitive performance variables.

Methods

Sample

For the objective of this study, only the performances of those teams that played in the Spanish *LaLiga* (the men's top professional football division) during eight consecutive seasons (from 2011–2012 to 2018–2019) were analysed. Out of the 32 teams that participated during the seasons analysed, only eight of them (25% of the total) remained in the Spanish *LaLiga* during the full eight season period. All matches where the information required was not available were excluded (e.g. technology technical errors), as well as matches where one or more players were sent off for a direct red card or double yellow card. As a result, out of a possible 2432 performances (eight teams, each playing 38 matches throughout the eight seasons), a total of 2212 performances were analysed.

Data were obtained from the Spanish *Professional Football League*, which authorised the use of the variables included in this investigation. In accordance with its ethical guidelines, this investigation does not include information that identifies football players. Data were treated in accordance with the Declaration of Helsinki, having been approved by the Ethics Committee on Humans of the *University of the Basque Country* [M10_2019_099 - 11/04/2019].

Table 1. Definitions of the variables for each dimension.

Dimensions	Variables	Definitions
Technical-tactical	Passes	An intentional played ball from one player to another with any part of the body that is allowed in the rules of the game. When calculating this variable, the total number of successful and unsuccessful actions made by the team per match are considered.
	Successful passes	A successful pass is one that reaches its recipient. To calculate this variable, the total number of successful exchanges of the ball between two players of the same team per match are considered.
	Crosses	Balls sent into the rival team's penalty box from a side area of the football pitch. When calculating this variable, the total number of successful and unsuccessful actions made by the team per match are considered.
	Shots	Attempt to score a goal, made with any part of the body that is allowed in the rules of the game. When calculating this variable, the total number of actions made by the team per match are considered.
Set piece	Goals	Total number of points scored by each team per match.
	Corners	A kick that is performed on a set piece from the corner of the football pitch nearest to where the ball went out of the playing area. When calculating this variable, the total number of actions taken by the team per match are considered.
	Fouls	Any infringement that is penalised as foul play by the referee. When calculating this variable, the total number of actions received by the team per match are considered.
Collective tactical behaviour	Width	Mean team amplitude per match, considered as the distance (in m) between the two furthest-apart players of the same team along the amplitude of the pitch. To calculate this variable, the times in which the ball is out of play and the goalkeeper's activity are excluded.
	Length	Mean team depth per match, considered as the distance (in m) between the two furthest-apart players of the same team along the depth of the pitch. To calculate this variable, the times in which the ball is out of play and the goalkeeper's activity are excluded.
	Height	Mean team defence depth per match, considered as the distance (in m) between the furthest back player and the goal line he is defending. To calculate this variable, the times in which the ball is out of play and the goalkeeper's activity are excluded.
	GkDef	Mean distance (in m) from the goalkeeper to the nearest defender of the same team per match. To calculate this variable, the times in which the ball is out of play is excluded.
Physical	TD	Total distance covered (in m) by all the team's players that participated in the match, including the goalkeeper's activity.

Variables

Considering previous studies,[20,21] the variables used in this study were grouped into four dimensions: technical-tactical (passes, successful passes, crosses and shots), set piece (goals, corners and fouls), collective tactical behaviour (width, length, height and distance from the goalkeeper to the nearest defender (GkDef)) and physical (total distance covered (TD)). Table 1 shows the definitions of all variables.

Procedures

Location and motion data were obtained by the computerised multi-camera tracking system *TRACAB*® (*ChyronHego*, New York, NY, USA) and events were obtained by the data company *OPTA*® (*Opta Sports*, London, UK), both using *Mediacoach* software (*LaLiga*, Madrid, Spain). The reports were generated using *Mediacoach*, for the predefined performance indicators. The reliability of the *OPTA*® system has been proved previously[22] and the reliability of the multi-camera tracking system *TRACAB*® has also been tested for accurate positioning and physical performance of the players.[17] The generated reports were exported into a *Microsoft Excel* spreadsheet (*Microsoft Corporation*, Redmond, WA, USA) to configure a matrix.

Statistical Analysis

The statistical analysis was conducted using the software *jamovi 2.4.8*[23] for *Windows*. A linear mixed model was carried out for each dependent variable. Season was considered as fixed effect and team as random effect. The Akaike information criterion (AIC)[24] and a likelihood ratio test[25] were used to select the model that best fitted each variable. The maximum likelihood (ML) estimation was used for model comparison and for the final model of each variable the best model again using restricted maximum likelihood (REML) estimation was refitted.[25] Marginal and conditional R^2 metrics[26] were provided for each linear mixed model as a measure of effect sizes. Marginal R^2 is concerned with the variance explained by fixed effects, and conditional R^2 is concerned with the variance explained by both fixed and random effects.[26] The level of significance was set at $p < 0.05$.

Results

The distribution of the ranking of the teams that remained in the Spanish *LaLiga* between 2011–2012 and 2018–2019 seasons (eight teams × eight possible places = 64) were: 1st, $n = 8$; 2nd, $n = 8$; 3rd, $n = 8$; 4th, $n = 6$; 5th, $n = 5$; 6th, $n = 2$; 7th, $n = 6$; 8th, $n = 2$; 9th, $n = 4$; 10th, $n = 2$; 11th, $n = 1$; 12th, $n = 5$; 13th, $n = 4$; 14th, $n = 2$; and 16th, $n = 1$. Therefore, the eight teams that remained in the Spanish *LaLiga* ranked in the upper-middle of the classification 80% of the time during the eight seasons analysed.

Table 2 shows the effects of seasons on the technical-tactical variables. Teams showed fewer crosses in the 2017–2018 (−4.577; $p = 0.013$) and 2018–2019 (−5.186; $p = 0.005$) seasons compared to the 2011–2012 season. The marginal and conditional R^2 values for crosses were 0.050 and 0.168, respectively. No significant differences were found between seasons in passes, successful passes and shots.

Table 3 shows the effects of seasons on the set piece variables. Teams showed fewer corners in the 2016–2017 (−1.240; $p = 0.005$) and 2018–2019 (−1.033; $p = 0.017$) seasons compared to the 2011–2012 season. The marginal and conditional R^2 values for corners were 0.020 and 0.070, respectively. No significant differences were found between seasons regarding goals and fouls.

Table 4 shows the effects of seasons on the collective tactical behaviour variables. Teams showed lower values of length in the 2015–2016 (−1.838; $p < 0.001$), 2016–2017 (−1.975; $p < 0.001$), 2017–2018 (−1.800; $p < 0.001$) and 2018–2019 (−2.161; $p < 0.001$) seasons compared to the 2011–2012 season. The marginal and conditional R^2 values for length were 0.176 and 0.399, respectively. Likewise, teams showed lower values of GkDef in the 2014–2015 (−2.576; $p < 0.001$), 2015–2016 (−2.384; $p = 0.002$), 2016–2017 (−2.185; $p = 0.004$), 2017–2018 (−2.293; $p = 0.003$) and 2018–2019 (−2.377; $p = 0.002$) seasons compared to the 2011–2012 season. The marginal and conditional R^2 values for GkDef were 0.197 and 0.510, respectively. No significant differences were found between seasons regarding width and height.

Table 5 shows the effects of seasons on the physical variable. Teams showed lower values of TD in the 2013–2014 (−2988.182; $p = 0.042$), 2014–2015 (−4649.150; $p = 0.002$), 2015–2016 (−3341.710; $p = 0.023$), 2016–2017 (−2812.710; $p = 0.054$) and 2018–2019 (−4254.413; $p = 0.004$) seasons compared to the 2011–2012 season. The marginal and conditional R^2 values for TD were 0.085 and 0.444, respectively.

Discussion

The objective of this study was to analyse the performance of the same eight teams that remained in the Spanish *LaLiga* during eight consecutive seasons (from 2011–2012 to 2018–2019). The main results of the study were that (1) the eight teams, in spite of the variability shown in the matches, maintained a stable performance throughout the eight seasons analysed; (2) the length values decreased significantly from 2015–2016 to 2018–2019; (3) the GkDef values decreased significantly from 2014–2015 to 2018–2019; and (4) the TD values decreased significantly from 2013–2014 to 2018–2019.

Regarding the technical-tactical variables, seasons had no significant effect on passes, successful passes and shots. In relation to passes and successful passes, the distribution in the passes made by the teams that remained in *LaLiga* represent a performance stability throughout the period analysed, coinciding with the results of previously published studies about the Spanish *LaLiga* and English *Premier League*. Lago-Peñas et al.[12] analysed the evolution of physical and technical parameters in the Spanish *LaLiga* between 2012–2013 and 2019–2020, finding more total passes and successful passes (denominated as passing accuracy and measured in percentage) in the last four seasons compared to the first season. However, the trend of these variables throughout the years was not clear, because the effect size of the differences between seasons was small. Therefore, the study carried out by Lago-Peñas et al.[12] also showed stability in the passes made during the analysed seasons. Nevertheless, when these authors analysed the technical performance of the Spanish *LaLiga* throughout the seasons considering the playing positions, they observed that central defenders significantly increased the number of total passes and passing accuracy, while the forwards significantly decreased the number of total passes. Barnes et al.[8] found a significant increase in the total passes and successful passes (measured in percentage) in the English *Premier League* in the last two seasons analysed (2011–2012 and 2012–2013) compared to the first season (2006–2007), but with a moderate effect size. Therefore, it is worth mentioning that the results of the Barnes et al.[8] study also indicated a stable trend of these two variables throughout the seasons studied in the English *Premier League*, coinciding in this way with the results of the present work. Bush et al.,[10] for their part, analysed the evolution of physical and technical performance parameters in the English *Premier League* between 2006–2007 and 2012–2013 and observed moderate-large magnitude increases in the total number of passes performed and moderate increases in the pass success rate for central defenders and central midfielders. As for shots, which are a performance indicator that can determine the success of a team,[27] the results of the present study are similar to those of Lago-Peñas et al.[12] regarding the Spanish *LaLiga* and of Barnes et al.[8] about the English *Premier League*. In the Spanish *LaLiga* fewer shots were found from 2014–2015 to 2019–2020 compared to the first season analysed (2012–2013), but with a small effect size of the differences between seasons. In the English *Premier League*, for its part, no significant differences were found in the total number of shots between the seasons

Table 2. Effects of seasons on each of the technical-tactical variables.

Fixed effects	Passes					Successful passes				
	Estimate	SE	95% CI		*P*	Estimate	SE	95% CI		*p*
Intercept	522.401	11.861	499.153	545.648	< 0.001	412.516	12.895	387.241	437.790	< 0.001
2012–2013 to 2011–2012	−24.380	47.411	−117.304	68.544	0.609	−21.084	51.549	−122.119	79.950	0.684
2013–2014 to 2011–2012	−42.030	47.550	−135.226	51.166	0.380	−36.512	51.678	−137.799	64.775	0.483
2014–2015 to 2011–2012	−46.304	47.413	−139.231	46.624	0.333	−44.408	51.551	−145.445	56.630	0.393
2015–2016 to 2011–2012	−36.061	47.404	−128.971	56.850	0.450	−30.770	51.543	−131.792	70.252	0.553
2016–2017 to 2011–2012	−18.469	47.403	−111.378	74.439	0.698	−9.030	51.542	−110.051	91.990	0.862
2017–2018 to 2011–2012	−12.600	47.439	−105.579	80.380	0.792	2.560	51.575	−98.525	103.646	0.961
2018–2019 to 2011–2012	−20.558	47.413	−113.458	72.369	0.666	−5.472	51.551	−106.510	95.565	0.916
Random effects	SD	Variance	95% CI		ICC	SD	Variance	95% CI		ICC
Team	93.547	8751.109	5429.036	11,125.917	0.510	101.928	10,389.381	6461.626	13,196.539	0.553
Residual	91.721	8412.777	7929.024	8936.554		91.674	8404.134	7920.890	8927.396	
Marginal R^2	0.012					0.014				
Conditional R^2	0.516					0.559				
	Crosses					Shots				
Fixed effects	Estimate	SE	95% CI		*P*	Estimate	SE	95% CI		*p*
Intercept	20.599	0.448	19.722	21.476	< 0.001	13.624	0.330	12.978	14.270	< 0.001
2012–2013 to 2011–2012	−0.094	1.784	−3.591	3.402	0.958	−0.511	1.316	−3.090	2.068	0.699
2013–14 to 2011–2012	0.126	1.809	−3.419	3.671	0.945	−0.853	1.327	−3.455	1.748	0.523
2014–15 to 2011–2012	0.451	1.785	−3.047	3.949	0.801	−2.061	1.316	−4.640	0.518	0.123
2015–2016 to 2011–2012	−1.680	1.782	−5.174	1.813	0.350	−1.807	1.315	−4.384	0.771	0.175
2016–2017 to 2011–2012	−3.202	1.782	−6.695	0.291	0.078	−1.463	1.315	−4.040	1.115	0.271
2017–2018 to 2011–2012	−4.577	1.791	−8.087	−1.067	0.013	−1.326	1.318	−3.910	1.258	0.319
2018–2019 to 2011–2012	−5.186	1.785	−8.683	−1.688	0.005	−1.910	1.316	−4.489	0.669	0.152
Random effects	SD	Variance	95% CI		ICC	SD	Variance	95% CI		ICC
Team	3.257	10.608	5.886	13.983	0.125	2.505	6.276	3.691	8.114	0.217
Residual	8.629	74.456	70.174	79.091		4.763	22.690	21.387	24.105	
Marginal R^2	0.050					0.016				
Conditional R^2	0.168					0.229				

SE: standard error; 95% CI: 95% confidence intervals; SD: standard deviation; ICC: intraclass correlation coefficient.
Statistical significance is set at $p < 0.05$.

Table 3. Effects of seasons on each of the set piece variables.

Fixed effects	Goals					Corners					Fouls				
	Estimate	SE	95% CI		p	Estimate	SE	95% CI		p	Estimate	SE	95% CI		p
Intercept	1.787	0.087	1.616	1.958	< 0.001	5.639	0.106	5.432	5.846	< 0.001	14.553	0.128	14.302	14.804	< 0.001
2012–2013 to 2011–2012	0.075	0.348	−0.607	0.757	0.831	−0.285	0.421	−1.110	0.539	0.501	−0.137	0.509	−1.135	0.861	0.789
2013–2014 to 2011–2012	0.091	0.352	−0.598	0.780	0.796	0.030	0.430	−0.813	0.873	0.945	−0.680	0.523	−1.706	0.345	0.198
2014–2015 to 2011–2012	0.051	0.348	−0.631	0.733	0.884	−0.803	0.421	−1.628	0.022	0.062	0.040	0.510	−0.959	1.039	0.938
2015–2016 to 2011–2012	−0.066	0.348	−0.747	0.616	0.851	−0.585	0.420	−1.408	0.238	0.169	−0.785	0.508	−1.781	0.210	0.128
2016–2017 to 2011–2012	0.120	0.348	−0.561	0.802	0.731	−1.240	0.420	−2.064	−0.418	0.005	−0.333	0.508	−1.329	0.662	0.514
2017–2018 to 2011–2012	−0.052	0.349	−0.736	0.632	0.882	−0.705	0.424	−1.536	0.126	0.102	−0.898	0.515	−1.907	0.111	0.086
2018–2019 to 2011–2012	−0.273	0.348	−0.955	0.409	0.435	−1.033	0.421	−1.859	−0.208	0.017	−0.913	0.510	−1.912	0.086	0.079
Random effects	SD	Variance	95% CI		ICC	SD	Variance	95% CI		ICC	SD	Variance	95% CI		ICC
Team	0.655	0.429	0.250	0.557	0.182	0.681	0.463	0.198	0.652	0.051	0.734	0.538	0.154	0.814	0.030
Residual	1.390	1.931	1.820	2.051		2.931	8.592	8.098	9.127		4.185	17.511	16.503	18.600	
Marginal R^2	0.006					0.020					0.008				
Conditional R^2	0.187					0.070					0.037				

SE: standard error; 95% CI: 95% confidence intervals; SD: standard deviation; ICC: intraclass correlation coefficient.
Statistical significance is set at $p < 0.05$.

Table 4. Effects of seasons on each of the collective tactical behaviour variables.

Fixed effects	Width					Length				
	Estimate	SE	95% CI		*P*	Estimate	SE	95% CI		*p*
Intercept	44.148	0.238	43.682	44.614	< 0.001	37.403	0.123	37.163	37.644	< 0.001
2012–2013 to 2011–2012	−0.302	0.950	−2.165	1.560	0.752	−0.085	0.490	−1.045	0.876	0.863
2013–2014 to 2011–2012	−0.622	0.954	−2.491	1.247	0.517	−0.433	0.494	−1.401	0.534	0.384
2014–2015 to 2011–2012	−1.359	0.950	−3.222	0.503	0.158	−0.925	0.490	−1.886	0.036	0.064
2015–2016 to 2011–2012	−1.021	0.950	−2.883	0.841	0.287	−1.838	0.490	−2.798	−0.877	< 0.001
2016–2017 to 2011–2012	−0.283	0.950	−2.145	1.579	0.767	−1.975	0.490	−2.935	−1.015	< 0.001
2017–2018 to 2011–2012	−0.509	0.951	−2.373	1.355	0.595	−1.800	0.491	−2.762	−0.838	< 0.001
2018–2019 to 2011–2012	−0.894	0.950	−2.756	0.969	0.351	−2.161	0.490	−3.122	−1.201	< 0.001
Random effects	SD	Variance	95% CI		ICC	SD	Variance	95% CI		ICC
Team	1.868	3.491	2.155	4.445	0.451	0.944	0.892	0.532	1.147	0.270
Residual	2.060	4.244	4.000	4.509		1.553	2.412	2.273	2.562	
Marginal R^2	0.022					0.176				
Conditional R^2	0.464					0.399				
Fixed effects	Height					GkDef				
	Estimate	SE	95% CI		*P*	Estimate	SE	95% CI		*p*
Intercept	38.302	0.242	37.828	38.776	< 0.001	25.375	0.181	25.020	25.730	< 0.001
2012–2013 to 2011–2012	−0.365	0.966	−2.259	1.529	0.707	0.062	0.724	−1.358	1.481	0.933
2013–2014 to 2011–2012	−0.421	0.973	−2.329	1.486	0.667	−0.216	0.727	−1.642	1.210	0.767
2014–2015 to 2011–2012	−1.708	0.966	−3.602	0.186	0.083	−2.576	0.724	−3.996	−1.157	< 0.001
2015–2016 to 2011–2012	−1.026	0.966	−2.919	0.867	0.293	−2.384	0.724	−3.803	−0.965	0.002
2016–2017 to 2011–2012	−0.780	0.966	−2.673	1.113	0.423	−2.185	0.724	−3.604	−0.766	0.004
2017–2018 to 2011–2012	−1.533	0.968	−3.430	0.364	0.119	−2.293	0.725	−3.714	−0.872	0.003
2018–2019 to 2011–2012	−1.580	0.966	−3.474	0.314	0.108	−2.377	0.724	−3.796	−0.958	0.002
Random effects	SD	Variance	95% CI		ICC	SD	Variance	95% CI		ICC
Team	1.860	3.460	2.080	4.448	0.264	1.417	2.008	1.232	2.562	0.390
Residual	3.103	9.630	9.076	10.229		1.773	3.145	2.964	3.341	
Marginal R^2	0.027					0.197				
Conditional R^2	0.284					0.510				

SE: standard error; 95% CI: 95% confidence intervals; SD: standard deviation; ICC: intraclass correlation coefficient.
Statistical significance is set at $p < 0.05$.

Table 5. Effects of seasons on the physical variable.

Fixed effects	TD				
	Estimate	SE	95% CI		*p*
Intercept	110,293.494	358.342	109,591.157	110,995.830	< 0.001
2012–2013 to 2011–2012	−1846.818	1431.784	−4653.063	959.428	0.202
2013–2014 to 2011–2012	−2988.182	1438.179	−5806.961	−169.403	0.042
2014–2015 to 2011–2012	−4649.150	1431.869	−7455.560	−1842.739	0.002
2015–2016 to 2011–2012	−3341.710	1431.453	−6147.306	−536.114	0.023
2016–2017 to 2011–2012	−2812.710	1431.411	−5618.223	−7.196	0.054
2017–2018 to 2011–2012	−2765.959	1433.140	−5574.861	42.944	0.059
2018–2019 to 2011–2012	−4254.413	1431.924	−7060.932	−1447.893	0.004
Random effects	SD	Variance	95% CI		ICC
Team	2802.411	7,853,507.267	4,813,837.401	10,022,481.963	0.393
Residual	3484.468	12,141,515.847	11,443,348.386	12,897,905.548	
Marginal R^2	0.085				
Conditional R^2	0.444				

SE: standard error; 95% CI: 95% confidence intervals; SD: standard deviation; ICC: intraclass correlation coefficient.
Statistical significance is set at $p < 0.05$.

analysed (from 2006–2007 to 2012–2013). Therefore, the trend of shots performed in these two works was also quite stable throughout the period studied. However, Lago-Peñas et al.[12] also investigated the evolution of technical performance in the Spanish *LaLiga* considering playing positions, and they found that external midfielders and forwards significantly decreased the shots performed in the last seasons regarding the first season analysed. Finally, it is worth mentioning that season had a significant effect on crosses. Although the teams that remained in the Spanish *LaLiga* during the eight seasons analysed showed stability in the performance indicator related to teams' attack actions that can determine the success of a team,[27] in the last two seasons analysed (2017–2018 and 2018–2019) these teams performed significantly fewer crosses.

Regarding the set piece variables, seasons only had a significant effect on corners. In the 2016–2017 and 2018–2019 seasons the teams performed fewer corners compared to the first season analysed (2011–2012). Nevertheless, the trend of this variable over the eight years is quite stable. It is worth mentioning that corners are also a performance indicator that can determine the success of a team, as the action happens close to the rival's goal.[27] There were no significant differences between seasons in goals and fouls. Therefore, the teams that remained in the Spanish *LaLiga* also showed a performance stability in these variables throughout the period studied.

In the case of the collective tactical behaviour variables, seasons had a significant effect on length and GkDef. From the fifth season (from 2015–2016 to 2018–2019) lower values of length were found. The eight teams that remained in the Spanish *LaLiga* between 2011–2012 and 2018–2019 showed the same width values but less length, increasing the density of the effective playing space (same players in less space). From the fourth season (from 2014–2015 to 2018–2019) lower values of GkDef were found. This finding could be explained by the fact that the goalkeepers are required to play a greater role in the offensive phase of the game, initiating or continuing an attack with the players closest to their own goal, such as centre-backs,[10] or that teams have been able to adopt a more defensive style of play due to less ball possession during matches.

Regarding the physical variable, seasons had a significant effect on TD. The values of this variable decreased significantly from the third season (from 2013–2014 to 2018–2019). This result could be explained by the change in the way teams in this league play over the years, giving less priority to total distance covered. Vales-Vázquez et al.[28] realised that the performance rate variables of a technical-tactical nature have a greater influence than those of a conditional nature when determining the difference between the most successful teams in the championship. In this line, Castellano[20] found that the total distance covered is not related to the success achieved by the teams of the Spanish men's top and second professional football divisions at the end of the championship. Coinciding with the results of the present study, Lago-Peñas et al.[12] observed a decrease in the total distance covered as the seasons passed in the Spanish *LaLiga*. Pons et al.[13] also found in the Spanish *LaLiga* a decrease in the total distance covered in the 2018–2019 season compared to the previous three. These authors analysed just four consecutive seasons, so the conclusions are not clear. Nevertheless, Barnes et al.[8] observed a stability in the total distance covered by the English *Premier League* teams during seven seasons (from 2006–2007 to 2012–2013). Allen et al.,[7] for their part, found small increases in the last season analysed (2018–2019) compared to the first (2014–2015), and from season to season (i.e. 2016–2017 > 2015–2016 and 2017–2018 > 2016–2017). However, these findings were not consistently significant, so it can be concluded that the

total distance covered by the English *Premier League* players remained stable over five seasons (from 2014–2015 to 2018–2019).

The information provided in this study, especially due to the inclusion of a large volume of performances by the teams ($n = 2212$) that remained in the Spanish *LaLiga* for eight seasons, makes it possible to have reference values that have characterised the performance of the teams in the variables studied. Nevertheless, it should be noted that the stability shown over the years must be construed with caution, because the specific needs of each match could differ from a team's standard performance. Furthermore, this work is not without limitations. Firstly, the performance of the teams was calculated using the means of the variables predefined by the *Mediacoach* software, without having the option of the authors' obtaining different variables by calculating them by accessing the raw data. Secondly, this investigation did not consider moments with or without the ball. It is known that the physical[29] and tactical[30,31] responses of the teams differ when the team has or does not have possession of the ball. This subject, distinguishing the attack and defence phase, is suggested for future research. Thirdly, and for future studies, situational variables (e.g. change of coach, period of the season, playing a game at home or away and the rival's level of competition) should be considered,[21,32,33] with which to explain the variability and stability of the results described in this work. Fourth and finally, it is worth mentioning that the inclusion of other technical-tactical and physical variables (e.g. recoveries, duels, types of passes, accumulated distance at high-speed and number of accumulated sprints) could help refine possible inferences on players' behaviour, maintaining stable performances over the years. In addition, proposing this type of study in other leagues or countries could help to better understand the evolution of the game on a more global level.

The main conclusion of this study is that, within the variability/adaptability of the teams on a match-by-match basis, the eight teams that remained in the Spanish *LaLiga* have shown stable performance over the eight seasons analysed. This finding is interesting as it allows to have reference values of the variables studied, having had a stable positive result over time (i.e. remaining in the highest tier). Within the framework of this performance stability, it should be noted that the top teams performed their gameplay in a space with greater density (same width, but less length), playing with the goalkeeper closer to the nearest defender of his team (less distance in the variable GkDef) and covering less total distance by all the team's players as the seasons passed.

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8.4. Anexo 4: Estudio 4

Errekagorri, I., Fernandez-Navarro, J., López-Del Campo, R., Resta, R., & Castellano, J. (2024). An eight-season analysis of the teams' performance in the Spanish LaLiga according to the final league ranking. *PLOS ONE*, *19*(2), e0299242. https://doi.org/10.1371/journal.pone.0299242

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RESEARCH ARTICLE

An eight-season analysis of the teams' performance in the Spanish LaLiga according to the final league ranking

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Abstract

This study aimed to analyse the performance of 5,518 collective observations of the Spanish *LaLiga* teams for eight consecutive seasons (from 2011–12 to 2018–19), considering the final league ranking. The teams were divided into four groups: Europe (from 1st to 6th), Upper-Middle (from 7th to 11th), Lower-Middle (from 12th to 17th) and Relegation (from 18th to 20th). The variables recorded were: Passes, Successful Passes, Crosses, Shots, Goals, Corners, Fouls, Width, Length, Height, distance from the goalkeeper to the nearest defender (GkDef), total distance covered (TD) and number of points accumulated. The main results were that: 1) Europe, being superior to the rest of the groups, showed lower values of Length from 2015–16, and lower values of GkDef from 2014–15; 2) Upper-Middle showed lower values of Length from 2015–16; 3) Lower-Middle showed fewer Shots from 2013–14, and lower values of Length, GkDef and TD from 2014–15; and, 4) Relegation barely showed significant differences between seasons in any variable. The study concludes that the teams of the Europe, Upper-Middle and Relegation groups showed quite stable performance, while the teams of the Lower-Middle group presented a worsening in different dimensions as the seasons progressed. The information provided in this study makes it possible to have reference values that have characterized the performance of the teams for each group.

Introduction

With the development of technology in sports and particularly in football, it has been possible to carry out more precise and objective studies about the performance of football players and teams during competition [1]. Nowadays, tracking systems (e.g., global navigation satellite systems or global positioning systems, local positioning systems, and semi-automatic video cameras) allow the analysis of kinematic variables (e.g., displacements, accelerations), as well as individual (e.g., heat maps) and collective (e.g., average positioning of the players) tactical

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variables of a team (e.g., distances between players and/or spaces covered by a group of players) based on the recorded positioning data [2–4]. The use of variables measuring physical and tactical aspects and covering individual player and teams' units is essential to evaluate the performance of players and teams in competition [5], and even to carry out longitudinal monitoring.

Previous studies explored the development of the game of football throughout the years [6–13]. Considering this longitudinal viewpoint, several studies have focused on analysing physical aspects [6, 7, 9, 10, 12]. In this regard, previous studies analysed the evolution of the English *Premier League* teams throughout seven seasons [7], considering the specific position of players [10] or the final ranking of teams at the end of the season [9]. Barnes et al. [7] reported that the distance covered by the teams in the English *Premier League* had not changed much throughout the seven years, this way increasing the number of high-intensity actions and accumulated distance, as well as the number of sprints and accumulated distance. Bradley et al. [9] showed that all the English *Premier League* teams increased the high-intensity distance covered when they were not in possession of the ball throughout the seven seasons. However, teams that finished fifth to eighth by the end of the season showed a slight increase in the short distance covered in high intensity when in possession of the ball compared to other teams. The teams ranked fifth to eighth also showed a significant increase in the distance covered while sprinting compared to other teams. Regarding the Spanish *LaLiga*, a recent study [12] showed a small decrease in the total distance covered by the teams throughout eight seasons. However, the Spanish *LaLiga* teams performed a higher number of high-intensity efforts as the seasons progressed, and the Upper-Middle ranked teams (from 6^{th} to 10^{th}) and Lower ranked teams (from 16^{th} to 20^{th}) covered a greater distance at high-intensity [12].

Nevertheless, the technical-tactical dimension has also received considerable attention in the scientific literature [7–13]. Thus, Barreira et al. [8] observed and recorded 45 matches and 6,791 attacks in the semi-finals and finals of the *UEFA Euro Championship* and the *FIFA World Cup* from 1982 to 2010. They concluded that similar attacks led by top-tier football teams had moved away from a more individualised behaviour, such as dribbling and feints in the centre of the pitch, to a more group-based performance, such as short passes and crosses into the box. Wallace & Norton [13] analysed the evolution of game-play in international competitions (*FIFA World Cups*) throughout a 44-year period. These researchers indicated that the speed of football had increased due to a significant boost in the number of passes in the last few years. As for domestic leagues, there has been an increase in the number of passes and their effectiveness in the English *Premier League* over seven seasons, mainly short and medium-distance passes [7]. During the seven-season period analysed in the study, the Tier A teams (from 1^{st} to 4^{th}) in the English *Premier League* demonstrated the greatest number of technical events and the highest levels of technical performance (i.e., number of passes and successful passes) [9]. However, the greatest increases in the technical parameters of passes made and received were shown by the Tier B teams (from 5^{th} to 8^{th}). On the other hand, a recent study [12] found that the Spanish *LaLiga* technical performance evolution throughout an eight-season period is dependent on the level of the teams. Top (from 1^{st} to 5^{th}), Upper-Middle (from 6^{th} to 10^{th}), and Lower-Middle (from 11^{th} to 15^{th}) ranked teams showed the greatest changes in different technical parameters as the seasons progressed (e.g., fewer shots, tackles or clearances, and more short passes, long passes, or aerial duels). On the contrary, Lower ranked (from 16^{th} to 20^{th}) teams showed more stable technical performance.

Nevertheless, it could be interesting to have more information about the evolution of the teams' performance in the Spanish men's top professional football division according to the final league ranking, especially the evolution of the teams' technical-tactical and physical performance [14]. Therefore, the present study aimed to analyse the Spanish *LaLiga* teams'

performance taking some key competitive performance variables into account over a continuous period of eight seasons according to the final league ranking.

Materials and methods

Sample

For the aim of this study, all teams' performances in the Spanish *LaLiga* across eight consecutive seasons (from 2011–12 to 2018–19) were analysed. All matches where the information required was not available were excluded, as well as matches where one or more players were sent off. As a result, out of a possible 6,080 performances (20 teams, each playing 38 matches throughout the eight seasons), a total of 5,518 performances were analysed, representing 90% of all the possible matches. During the eight-season period, 32 teams participated in the men's top professional football division from Spain. All the teams were divided into four groups according to the final league ranking each season: Europe (from 1st to 6th; n = 1,642), Upper-

Table 1. Definitions of the variables for each dimension.

Dimensions	Variables	Definitions
Technical-Tactical	Passes	An intentional played ball from one player to another with any part of the body that is allowed in the rules of the game. When calculating this variable, the total number of successful and unsuccessful actions made by the team per match are considered.
	Successful Passes	A successful pass is one that reaches its recipient. To calculate this variable, the total number of successful exchanges of the ball between two players of the same team per match are considered.
	Crosses	Balls sent into the rival team's penalty box from a side area of the football pitch. When calculating this variable, the total number of successful and unsuccessful actions made by the team per match are considered.
	Shots	Attempt to score a goal, made with any part of the body that is allowed in the rules of the game. When calculating this variable, the total number of actions made by the team per match are considered.
Set Piece	Goals	Total number of points scored by each team per match.
	Corners	A kick that is performed on a set piece from the corner of the football pitch nearest to where the ball went out of the playing area. When calculating this variable, the total number of actions taken by the team per match are considered.
	Fouls	Any infringement that is penalised as foul play by the referee. When calculating this variable, the total number of actions received by the team per match are considered.
Collective Tactical Behaviour	Width	Mean team amplitude per match, considered as the distance (in m) between the two furthest-apart players of the same team along the amplitude of the pitch. To calculate this variable, the times in which the ball is out of play and the goalkeeper's activity are excluded.
	Length	Mean team depth per match, considered as the distance (in m) between the two furthest-apart players of the same team along the depth of the pitch. To calculate this variable, the times in which the ball is out of play and the goalkeeper's activity are excluded.
	Height	Mean team defence depth per match, considered as the distance (in m) between the furthest back player and the goal line he is defending. To calculate this variable, the times in which the ball is out of play and the goalkeeper's activity are excluded.
	GkDef	Mean distance (in m) from the goalkeeper to the nearest defender of the same team per match. To calculate this variable, the times in which the ball is out of play is excluded.
Physical	TD	Total distance covered (in m) by all the team's players that participated in the match, including the goalkeeper's activity.

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Middle (from 7th to 11th; n = 1,389), Lower-Middle (from 12th to 17th; n = 1,656) and Relegation (from 18th to 20th; n = 831). The data to carry out this study was collected in June 2019, after the end of the 2018–2019 season.

Data were obtained from the Spanish *Professional Football League*, which authorised the use of the variables included in this investigation. Following its ethical guidelines, this investigation does not include information that identifies football players. Data were treated in accordance with the Declaration of Helsinki, having been approved by the Ethics Committee on Humans (CEISH) of the *University of the Basque Country* (UPV/EHU).

Variables

The variables used in this work were grouped into four dimensions: Technical-Tactical (Passes, Successful Passes, Crosses and Shots), Set Piece (Goals, Corners and Fouls), Collective Tactical Behaviour (Width, Length, Height and distance from the goalkeeper to the nearest defender (GkDef)) and Physical (total distance covered (TD)). Table 1 shows the definitions of these variables for each dimension. The number of points accumulated by the Spanish *LaLiga* teams was also calculated in each of the eight seasons.

Procedures

Location and motion data were obtained using the computerised multi-camera tracking system *TRACAB* (*ChyronHego*, New York, USA), and events were obtained by the data company *OPTA* (*Opta Sports*, London, UK), both using *Mediacoach* software (*LaLiga*, Madrid, Spain). The reports were generated using *Mediacoach*, for the predefined performance indicators. The reliability of the *OPTA* system has been previously proved [15], and the reliability of the multi-camera tracking system *TRACAB* has also been tested for positioning and physical performance of the players [16]. The generated reports were exported into a *Microsoft Excel* spreadsheet (*Microsoft Corporation*, Washington, USA) to configure a matrix.

Statistical analysis

The statistical analysis was conducted using the software *jamovi 2.4.8* [17] for *Windows*. A linear mixed model was carried out for each dependent variable in order to analyse the differences in teams' match performance according to the group and season. Group and season were considered as fixed effects and team as random effect. The Akaike information criterion (AIC) [18] and a likelihood ratio test [19] were used to select the model that best fitted each variable. The maximum likelihood (ML) estimation was used for model comparison and for the final model of each variable the best model again using restricted maximum likelihood (REML) estimation was refitted [19]. Marginal and conditional R^2 metrics [20] were provided for each linear mixed model as a measure of effect sizes. Marginal R^2 is concerned with variance explained by fixed effects, and conditional R^2 is concerned with variance explained by both fixed and random effects [20]. The level of significance was set at $p<0.05$.

Results

Table 2 shows the effects of season for each group and the effects of group on the variables of the Technical-Tactical dimension. In the Europe group, the teams showed fewer Crosses in 2017–18 (-6.309; p = 0.008) and 2018–19 (-4.559; p = 0.051) compared to the 2011–12 season. In the Upper-Middle, the teams showed fewer Crosses in 2018–19 (-4.835; p = 0.050) compared to the 2011–12 season. In the Lower-Middle, the teams showed fewer Crosses in 2016–17 (-3.563; p = 0.048) compared to the 2011–12 season, and fewer Shots in 2013–14 (-1.646;

Table 2. Effects of season for each group and effects of group on the variables of the Technical-Tactical dimension.

		Passes			Successful Passes			Crosses			Shots		
Europe	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	538.655	15.464	<0.001	431.582	16.736	<0.001	19.401	0.569	<0.001	14.072	0.416	<0.001
	2012–13–2011–12	0.272	61.799	0.997	3.004	66.889	0.964	0.016	2.267	0.994	-0.406	1.657	0.808
	2013–14–2011–12	-21.646	62.008	0.729	-16.619	67.084	0.806	-0.663	2.304	0.775	-0.719	1.676	0.670
	2014–15–2011–12	-25.669	61.811	0.680	-21.100	66.901	0.754	-0.061	2.270	0.979	-1.206	1.659	0.471
	2015–16–2011–12	5.243	61.802	0.933	6.999	66.892	0.917	-3.567	2.268	0.124	-1.570	1.658	0.349
	2016–17–2011–12	14.796	61.796	0.812	24.839	66.886	0.712	-4.202	2.267	0.071	-0.822	1.657	0.623
	2017–18–2011–12	18.224	61.845	0.770	36.547	66.932	0.588	-6.309	2.277	0.008	-1.193	1.662	0.477
	2018–19–2011–12	-19.907	61.808	0.749	-10.282	66.898	0.879	-4.559	2.269	0.051	-1.745	1.658	0.299
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	105.858	11,205.967	0.559	114.765	13,170.924	0.598	3.667	13.445	0.162	2.748	7.551	0.237
	Residual	94.116	8,857.737		94.160	8,866.170		8.348	69.687		4.934	24.340	
	Marginal R^2 / Conditional R^2	0.012 / 0.564			0.015 / 0.604			0.062 / 0.214			0.010 / 0.244		
Upper-Middle	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	459.217	9.719	<0.001	341.609	10.231	<0.001	20.644	0.593	<0.001	12.054	0.242	<0.001
	2012–13–2011–12	-21.570	38.886	0.583	-9.211	40.930	0.823	-1.710	2.375	0.477	0.790	0.970	0.422
	2013–14–2011–12	-10.837	38.899	0.782	7.659	40.942	0.853	-0.348	2.378	0.884	0.132	0.972	0.893
	2014–15–2011–12	15.168	38.895	0.699	21.233	40.938	0.608	0.617	2.377	0.797	-0.383	0.971	0.696
	2015–16–2011–12	7.179	38.853	0.855	20.329	40.900	0.623	-1.881	2.370	0.433	-0.965	0.967	0.326
	2016–17–2011–12	-15.707	38.864	0.689	-4.711	40.911	0.909	-1.118	2.372	0.641	-0.872	0.968	0.374
	2017–18–2011–12	-16.655	38.895	0.671	-4.112	40.938	0.921	-1.523	2.377	0.526	-0.532	0.971	0.588
	2018–19–2011–12	15.618	38.869	0.691	41.143	40.916	0.322	-4.835	2.373	0.050	-0.771	0.968	0.432
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	59.789	3,574.740	0.336	63.190	3,992.937	0.373	3.470	12.039	0.145	1.329	1.765	0.080
	Residual	83.994	7,054.980		81.879	6,704.184		8.428	71.024		4.496	20.213	
	Marginal R^2 / Conditional R^2	0.018 / 0.348			0.024 / 0.388			0.028 / 0.169			0.014 / 0.093		
Lower-Middle	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	443.980	7.579	<0.001	327.795	7.953	<0.001	19.481	0.437	<0.001	11.540	0.141	<0.001
	2012–13–2011–12	-6.686	30.305	0.827	-8.816	31.799	0.783	0.791	1.745	0.653	-1.035	0.564	0.074
	2013–14–2011–12	-30.866	30.351	0.315	-25.131	31.840	0.435	0.248	1.752	0.888	-1.646	0.570	0.006
	2014–15–2011–12	-36.742	30.305	0.233	-30.793	31.799	0.339	0.669	1.745	0.704	-2.044	0.564	<0.001
	2015–16–2011–12	-36.629	30.282	0.234	-31.578	31.779	0.326	-2.117	1.741	0.231	-2.128	0.561	<0.001
	2016–17–2011–12	20.206	30.304	0.509	34.296	31.798	0.287	-3.563	1.745	0.048	-1.432	0.564	0.015
	2017–18–2011–12	-8.580	30.382	0.779	6.796	31.868	0.832	-2.438	1.757	0.173	-1.792	0.573	0.003
	2018–19–2011–12	-20.031	30.287	0.512	-7.966	31.783	0.803	-0.583	1.742	0.739	-1.038	0.561	0.072
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	50.556	2,555.895	0.271	53.358	2,847.104	0.306	2.690	7.234	0.099	0.644	0.415	0.022
	Residual	83.011	6,890.763		80.298	6,447.696		8.107	65.729		4.319	18.653	
	Marginal R^2 / Conditional R^2	0.036 / 0.297			0.045 / 0.337			0.031 / 0.127			0.022 / 0.043		

(*Continued*)

Table 2. (Continued)

Relegation	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	426.731	8.684	<0.001	311.694	9.130	<0.001	19.791	0.465	<0.001	11.304	0.217	<0.001
	2012–13–2011–12	-7.955	34.753	0.822	-3.391	36.533	0.927	3.855	1.864	0.055	1.393	0.869	0.129
	2013–14–2011–12	12.839	34.719	0.716	11.991	36.503	0.747	5.675	1.857	0.008	-0.120	0.865	0.892
	2014–15–2011–12	-33.577	34.733	0.348	-32.347	36.516	0.389	2.297	1.860	0.235	-1.752	0.867	0.061
	2015–16–2011–12	20.363	34.734	0.566	21.135	36.517	0.571	3.759	1.860	0.060	0.766	0.867	0.390
	2016–17–2011–12	-23.200	34.715	0.514	-17.768	36.500	0.633	-0.758	1.857	0.689	-1.391	0.865	0.128
	2017–18–2011–12	39.490	34.744	0.272	51.978	36.525	0.174	0.643	1.862	0.734	-0.022	0.868	0.980
	2018–19–2011–12	-1.156	34.753	0.974	13.005	36.533	0.727	2.685	1.864	0.169	0.143	0.869	0.872
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	40.113	1,609.042	0.188	42.584	1,813.360	0.219	1.789	3.201	0.044	0.749	0.561	0.028
	Residual	83.324	6,942.861		80.406	6,465.090		8.300	68.889		4.428	19.609	
	Marginal R^2 / Conditional R^2	0.054 / 0.232			0.065 / 0.270			0.055 / 0.097			0.044 / 0.071		
All seasons	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	467.184	5.770	<0.001	353.206	6.201	<0.001	19.826	0.302	<0.001	12.245	0.151	<0.001
	Upper-Middle—Europe	-79.536	15.016	<0.001	-90.069	16.137	<0.001	1.250	0.785	0.114	-2.030	0.394	<0.001
	Lower-Middle—Europe	-94.736	14.320	<0.001	-103.856	15.389	<0.001	0.089	0.749	0.905	-2.541	0.376	<0.001
	Relegation—Europe	-112.009	17.532	<0.001	-119.975	18.842	<0.001	0.400	0.917	0.663	-2.779	0.460	<0.001
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	68.529	4,696.183	0.384	73.938	5,466.775	0.430	3.380	11.424	0.143	1.666	2.777	0.117
	Residual	86.747	7,524.955		85.055	7,234.320		8.289	68.715		4.570	20.883	
	Marginal R^2 / Conditional R^2	0.135 / 0.467			0.152 / 0.517			0.003 / 0.145			0.051 / 0.162		

Note: SE is Standard Error; SD is Standard Deviation; ICC is Intraclass Correlation Coefficient. Statistical significance set at $p<0.05$.

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Table 3. Effects of season for each group and effects of group on the variables of the Set Piece dimension.

		Goals			**Corners**			**Fouls**		
Europe	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	2.008	0.097	<0.001	5.691	0.132	<0.001	14.326	0.174	<0.001
	2012–13–2011–12	0.007	0.385	0.985	-0.426	0.524	0.421	-0.280	0.688	0.687
	2013–14–2011–12	0.063	0.391	0.872	0.152	0.539	0.780	-0.688	0.711	0.339
	2014–15–2011–12	0.021	0.385	0.957	-0.685	0.525	0.200	-0.355	0.690	0.609
	2015–16–2011–12	-0.122	0.385	0.752	-0.650	0.524	0.223	-1.585	0.689	0.027
	2016–17–2011–12	0.041	0.385	0.915	-1.338	0.523	0.015	-0.478	0.687	0.491
	2017–18–2011–12	-0.043	0.387	0.913	-1.039	0.529	0.057	-1.390	0.696	0.052
	2018–19–2011–12	-0.427	0.385	0.274	-0.876	0.525	0.103	-1.189	0.690	0.092
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	0.618	0.382	0.148	0.757	0.573	0.061	0.960	0.921	0.050
	Residual	1.481	2.193		2.971	8.829		4.197	17.616	
	Marginal R^2 / Conditional R^2	0.009 / 0.156			0.022 / 0.082			0.016 / 0.065		

(*Continued*)

Table 3. (Continued)

Upper-Middle	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	1.190	0.032	<0.001	5.146	0.141	<0.001	14.132	0.183	<0.001
	2012–13–2011–12	0.314	0.128	0.020	-0.012	0.566	0.984	0.118	0.732	0.873
	2013–14–2011–12	0.189	0.129	0.152	-0.279	0.567	0.626	0.100	0.734	0.892
	2014–15–2011–12	0.143	0.129	0.276	-0.007	0.567	0.990	0.412	0.733	0.578
	2015–16–2011–12	0.097	0.126	0.448	-0.440	0.564	0.441	0.676	0.728	0.360
	2016–17–2011–12	0.312	0.127	0.020	-0.754	0.564	0.191	-0.821	0.729	0.269
	2017–18–2011–12	0.118	0.129	0.365	-0.327	0.567	0.568	-0.330	0.733	0.656
	2018–19–2011–12	0.157	0.127	0.226	-1.113	0.565	0.057	0.402	0.730	0.586
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	0.070	0.005	0.004	0.766	0.587	0.074	0.915	0.838	0.046
	Residual	1.115	1.243		2.711	7.350		4.151	17.228	
	Marginal R^2 / Conditional R^2	0.008 / 0.012			0.017 / 0.090			0.011 / 0.057		
Lower-Middle	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	1.131	0.028	<0.001	4.847	0.090	<0.001	13.862	0.190	<0.001
	2012–13–2011–12	-0.221	0.113	0.059	0.107	0.358	0.766	-0.925	0.758	0.229
	2013–14–2011–12	-0.323	0.115	0.008	-0.000	0.361	0.999	-0.527	0.763	0.494
	2014–15–2011–12	-0.368	0.113	0.002	-0.365	0.358	0.314	-0.696	0.758	0.364
	2015–16–2011–12	-0.117	0.112	0.302	-0.620	0.356	0.089	-1.258	0.756	0.104
	2016–17–2011–12	-0.034	0.113	0.766	-0.734	0.358	0.047	0.577	0.758	0.451
	2017–18–2011–12	-0.092	0.116	0.434	-0.595	0.363	0.109	-0.633	0.765	0.412
	2018–19–2011–12	-0.093	0.112	0.415	-0.460	0.356	0.204	-1.887	0.757	0.017
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	0.062	0.004	0.003	0.429	0.184	0.026	1.123	1.261	0.073
	Residual	1.096	1.200		2.631	6.921		4.007	16.058	
	Marginal R^2 / Conditional R^2	0.013 / 0.016			0.013 / 0.038			0.028 / 0.099		
Relegation	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	0.973	0.036	<0.001	4.822	0.137	<0.001	13.518	0.329	<0.001
	2012–13–2011–12	0.187	0.144	0.213	0.744	0.549	0.194	-1.099	1.318	0.416
	2013–14–2011–12	-0.007	0.143	0.961	1.444	0.547	0.018	-2.555	1.316	0.070
	2014–15–2011–12	-0.115	0.143	0.436	-0.338	0.548	0.546	-2.003	1.317	0.148
	2015–16–2011–12	0.175	0.143	0.240	0.440	0.548	0.434	-2.240	1.317	0.108
	2016–17–2011–12	0.021	0.143	0.886	-0.528	0.547	0.349	-3.033	1.315	0.035
	2017–18–2011–12	-0.146	0.144	0.325	0.105	0.549	0.851	-1.126	1.317	0.405
	2018–19–2011–12	0.137	0.144	0.356	-0.286	0.549	0.609	-2.237	1.318	0.109
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	0.069	0.005	0.005	0.512	0.262	0.039	1.447	2.094	0.107
	Residual	0.950	0.902		2.552	6.512		4.186	17.526	
	Marginal R^2 / Conditional R^2	0.015 / 0.020			0.053 / 0.090			0.041 / 0.144		
All seasons	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	1.325	0.032	<0.001	5.123	0.070	<0.001	13.959	0.110	<0.001
	Upper-Middle—Europe	-0.820	0.084	<0.001	-0.538	0.181	0.004	-0.196	0.285	0.494
	Lower-Middle—Europe	-0.877	0.080	<0.001	-0.837	0.173	<0.001	-0.469	0.272	0.087
	Relegation—Europe	-1.037	0.098	<0.001	-0.859	0.212	<0.001	-0.813	0.333	0.016
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	0.331	0.109	0.070	0.705	0.497	0.062	1.131	1.278	0.070
	Residual	1.209	1.462		2.745	7.534		4.128	17.037	
	Marginal R^2 / Conditional R^2	0.098 / 0.161			0.016 / 0.077			0.004 / 0.074		

Note: SE is Standard Error; SD is Standard Deviation; ICC is Intraclass Correlation Coefficient. Statistical significance set at $p<0.05$.

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p = 0.006), 2014–15 (-2.044; p<0.001), 2015–16 (-2.128; p<0.001), 2016–17 (-1.432; p = 0.015) and 2017–18 (-1.792; p = 0.003) compared to the 2011–12 season. In the Relegation group, the teams showed more Crosses in 2013–14 (5.675; p = 0.008) compared to the 2011–12 season. Likewise, Europe showed more Passes than Upper-Middle (79.536; p<0.001), Lower-Middle (94.736; p<0.001) and Relegation (112.009; p<0.001), more Successful Passes than Upper-Middle (90.069; p<0.001), Lower-Middle (103.856; p<0.001) and Relegation (119.975; p<0.001), and more Shots than Upper-Middle (2.030; p<0.001), Lower-Middle (2.541; p<0.001) and Relegation (2.779; p<0.001) during the whole period analysed.

Table 3 shows the effects of season for each group and the effects of group on the variables of the Set Piece dimension. In the Europe group, the teams showed fewer Corners in 2016–17 (-1.338; p = 0.015) compared to the 2011–12 season, and fewer Fouls in 2015–16 (-1.585; p = 0.027) and 2017–18 (-1.390; p = 0.052) compared to the 2011–12 season. In the Upper-Middle, the teams showed more Goals in 2012–13 (0.314; p = 0.020) and 2016–17 (0.312; p = 0.020) compared to the 2011–12 season. In the Lower-Middle, the teams showed fewer Goals in 2013–14 (-0.323; p = 0.008) and 2014–15 (-0.368; p = 0.002) compared to the 2011–12 season, fewer Corners in 2016–17 (-0.734; p = 0.047) compared to the 2011–12 season, and fewer Fouls in 2018–19 (-1.887; p = 0.017) compared to the 2011–12 season. In the Relegation group, the teams showed more Corners in 2013–14 (1.444; p = 0.018) compared to the 2011–12 season, and fewer Fouls in 2016–17 (-3.033; p = 0.035) compared to the 2011–12 season. Likewise, Europe showed more Goals than Upper-Middle (0.820; p<0.001), Lower-Middle (0.877; p<0.001) and Relegation (1.037; p<0.001), more Corners than Upper-Middle (0.538; p = 0.004), Lower-Middle (0.837; p<0.001) and Relegation (0.859; p<0.001), and more Fouls than Relegation (0.813; p = 0.016) during the whole period analysed.

Table 4 shows the effects of season for each group and the effects of group on the variables of the Collective Tactical Behaviour dimension. In the Europe group, the teams showed lower values of Length in 2015–16 (-1.665; p = 0.015), 2016–17 (-1.613; p = 0.019), 2017–18 (-1.930; p = 0.006) and 2018–19 (-2.276; p = 0.001) compared to the season 2011–12, and lower values of GkDef in 2014–15 (-3.190; p = 0.001), 2015–16 (-3.169; p = 0.001), 2016–17 (-2.722; p = 0.005), 2017–18 (-2.633; p = 0.007) and 2018–19 (-2.487; p = 0.010) compared to the season 2011–12. In the Upper-Middle group, the teams showed lower values of Length in 2015–16 (-1.622; p = 0.001), 2016–17 (-2.706; p<0.001), 2017–18 (-2.463; p<0.001) and 2018–19 (-1.952; p<0.001) compared to the season 2011–12. In the Lower-Middle group, the teams showed lower values of Length in 2014–15 (-1.218; p = 0.040), 2015–16 (-1.660; p = 0.006), 2016–17 (-1.609; p = 0.008), 2017–18 (-2.211; p<0.001) and 2018–19 (-2.542; p<0.001) compared to the season 2011–12, lower values of Height in 2014–15 (-1.407; p = 0.040) compared to the season 2011–12, and lower values of GkDef in 2014–15 (-2.002; p<0.001), 2015–16 (-1.668; p = 0.002), 2016–17 (-1.839; p<0.001), 2017–18 (-1.747; p = 0.001) and 2018–19 (-1.371; p = 0.009) compared to the season 2011–12. In the Relegation group, the teams showed lower values of Length in 2016–17 (-1.851; p = 0.006) and 2018–19 (-1.263; p = 0.044) compared to the 2011–12 season, lower values of Height in 2014–15 (-1.893; p = 0.043) compared to the 2011–12 season, and lower values of GkDef in 2014–15 (-3.638; p<0.001) and 2015–16 (-2.506; p = 0.009) compared to the 2011–12 season. Likewise, Europe showed higher values of Width than Upper-Middle (0.928; p = 0.009), Lower-Middle (1.010; p = 0.003) and Relegation (1.373; p = 0.001), higher values of Length than Upper-Middle (0.667; p = 0.010), Lower-Middle (0.756; p = 0.002) and Relegation (1.055; p<0.001), higher values of Height than Upper-Middle (1.164; p<0.001), Lower-Middle (1.412; p<0.001) and Relegation (1.726; p<0.001), and higher values of GkDef than Upper-Middle (1.175; p<0.001), Lower-Middle (0.985; p = 0.002) and Relegation (0.871; p = 0.026) during the whole period analysed.

Table 4. Effects of season for each group and effects of group on the variables of the Collective Tactical Behaviour dimension.

		Width			Length			Height			GkDef		
Europe	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	44.250	0.321	<0.001	37.475	0.165	<0.001	38.402	0.313	<0.001	25.730	0.230	<0.001
	2012–13–2011–12	0.335	1.283	0.795	-0.285	0.657	0.667	-0.311	1.251	0.805	0.326	0.919	0.724
	2013–14–2011–12	-0.219	1.288	0.866	-0.716	0.662	0.286	-0.509	1.262	0.688	-0.718	0.924	0.442
	2014–15–2011–12	-0.679	1.284	0.600	-1.056	0.658	0.116	-2.192	1.251	0.087	-3.190	0.919	0.001
	2015–16–2011–12	-0.218	1.283	0.866	-1.665	0.657	0.015	-1.411	1.251	0.266	-3.169	0.919	0.001
	2016–17–2011–12	0.892	1.283	0.491	-1.613	0.657	0.019	-1.277	1.250	0.313	-2.722	0.919	0.005
	2017–18–2011–12	0.509	1.284	0.694	-1.930	0.658	0.006	-2.043	1.253	0.111	-2.633	0.920	0.007
	2018–19–2011–12	-0.599	1.284	0.643	-2.276	0.658	0.001	-1.369	1.251	0.280	-2.487	0.919	0.010
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	2.199	4.834	0.561	1.110	1.232	0.354	2.098	4.401	0.301	1.560	2.433	0.411
	Residual	1.944	3.780		1.499	2.246		3.199	10.233		1.866	3.483	
	Marginal R^2 / Conditional R^2	0.030 / 0.574			0.143 / 0.447			0.036 / 0.326			0.241 / 0.553		
Upper-Middle	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	43.324	0.263	<0.001	36.807	0.116	<0.001	37.234	0.266	<0.001	24.552	0.201	<0.001
	2012–13–2011–12	0.376	1.051	0.723	-0.196	0.463	0.675	-0.122	1.065	0.909	0.120	0.802	0.882
	2013–14–2011–12	0.729	1.051	0.493	-0.737	0.463	0.121	0.045	1.066	0.966	0.692	0.802	0.395
	2014–15–2011–12	-0.086	1.051	0.935	-0.786	0.463	0.099	-0.110	1.066	0.918	-0.944	0.802	0.248
	2015–16–2011–12	0.171	1.050	0.871	-1.622	0.462	0.001	-0.170	1.064	0.874	-0.881	0.802	0.280
	2016–17–2011–12	-0.518	1.050	0.625	-2.706	0.462	<0.001	0.352	1.065	0.743	-0.691	0.802	0.395
	2017–18–2011–12	-0.075	1.051	0.943	-2.463	0.463	<0.001	0.392	1.066	0.716	-0.240	0.802	0.767
	2018–19–2011–12	0.479	1.050	0.651	-1.952	0.462	<0.001	-0.066	1.065	0.951	-1.341	0.802	0.104
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	1.623	2.633	0.374	0.674	0.454	0.141	1.611	2.594	0.236	1.237	1.531	0.364
	Residual	2.099	4.404		1.665	2.771		2.896	8.386		1.636	2.677	
	Marginal R^2 / Conditional R^2	0.019 / 0.386			0.222 / 0.331			0.004 / 0.239			0.085 / 0.418		
Lower-Middle	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	43.241	0.206	<0.001	36.718	0.144	<0.001	36.987	0.166	<0.001	24.744	0.126	<0.001
	2012–13–2011–12	-1.264	0.825	0.133	-0.914	0.574	0.119	0.048	0.661	0.943	-0.564	0.502	0.268
	2013–14–2011–12	-0.362	0.826	0.664	-0.855	0.575	0.145	-0.085	0.664	0.898	-0.105	0.503	0.836
	2014–15–2011–12	-1.187	0.825	0.158	-1.218	0.574	0.040	-1.407	0.661	0.040	-2.002	0.502	<0.001
	2015–16–2011–12	-0.621	0.824	0.456	-1.660	0.573	0.006	-0.262	0.660	0.694	-1.668	0.502	0.002
	2016–17–2011–12	0.413	0.825	0.619	-1.609	0.574	0.008	-0.211	0.661	0.751	-1.839	0.502	<0.001
	2017–18–2011–12	-0.468	0.827	0.574	-2.211	0.576	<0.001	-0.408	0.666	0.543	-1.747	0.504	0.001
	2018–19–2011–12	-0.951	0.824	0.256	-2.542	0.573	<0.001	-0.056	0.660	0.932	-1.371	0.502	0.009
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	1.382	1.911	0.298	0.949	0.900	0.229	1.036	1.073	0.115	0.824	0.680	0.203
	Residual	2.123	4.507		1.741	3.032		2.879	8.291		1.632	2.664	
	Marginal R^2 / Conditional R^2	0.044 / 0.329			0.127 / 0.327			0.021 / 0.133			0.146 / 0.319		

(*Continued*)

Table 4. (Continued)

Relegation	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	42.877	0.212	<0.001	36.419	0.145	<0.001	36.672	0.216	<0.001	24.856	0.212	<0.001
	2012–13–2011–12	-0.574	0.848	0.508	-0.042	0.579	0.943	1.395	0.863	0.125	0.737	0.847	0.397
	2013–14–2011–12	0.127	0.848	0.883	0.159	0.578	0.787	0.427	0.861	0.627	-0.436	0.847	0.613
	2014–15–2011–12	-0.544	0.848	0.530	-0.114	0.579	0.846	-1.893	0.862	0.043	-3.638	0.847	<0.001
	2015–16–2011–12	-0.077	0.848	0.928	-0.943	0.579	0.123	0.105	0.862	0.904	-2.506	0.847	0.009
	2016–17–2011–12	-0.284	0.848	0.742	-1.851	0.578	0.006	0.469	0.861	0.593	-1.662	0.846	0.067
	2017–18–2011–12	0.648	0.848	0.456	-0.636	0.579	0.288	0.461	0.863	0.600	-1.266	0.847	0.154
	2018–19–2011–12	0.707	0.848	0.417	-1.263	0.579	0.044	-0.519	0.863	0.556	-1.569	0.847	0.083
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	0.979	0.958	0.187	0.641	0.411	0.115	0.939	0.881	0.098	0.996	0.992	0.255
	Residual	2.041	4.167		1.780	3.169		2.846	8.099		1.702	2.895	
	Marginal R^2 / Conditional R^2	0.038 / 0.218			0.113 / 0.215			0.082 / 0.172			0.306 / 0.483		
All seasons	**Fixed Effects**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
	Intercept	43.423	0.135	<0.001	36.854	0.098	<0.001	37.323	0.133	<0.001	24.969	0.127	<0.001
	Upper-Middle—Europe	-0.928	0.352	0.009	-0.667	0.254	0.010	-1.164	0.346	<0.001	-1.175	0.331	<0.001
	Lower-Middle—Europe	-1.010	0.336	0.003	-0.756	0.242	0.002	-1.412	0.330	<0.001	-0.985	0.316	0.002
	Relegation—Europe	-1.373	0.411	0.001	-1.055	0.297	<0.001	-1.726	0.404	<0.001	-0.871	0.387	0.026
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	1.607	2.582	0.380	1.153	1.329	0.326	1.531	2.345	0.209	1.520	2.309	0.439
	Residual	2.053	4.214		1.659	2.753		2.977	8.864		1.716	2.946	
	Marginal R^2 / Conditional R^2	0.036 / 0.402			0.034 / 0.349			0.037 / 0.239			0.042 / 0.463		

Note: SE is Standard Error; SD is Standard Deviation; ICC is Intraclass Correlation Coefficient. Statistical significance set at p<0.05.

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Table 5 shows the effects of season for each group and the effects of group on the variable of the Physical dimension. In the Europe group, the teams showed lower values of TD in 2018–19 (-3,200.245; p = 0.050) compared to the 2011–12 season. In the Lower-Middle group, the teams showed lower values of TD in 2014–15 (-3,741.391; p = 0.011), 2015–16 (-3,278.483;

Table 5. Effects of season for each group and effects of group on the variable of the Physical dimension.

		TD		
Europe	**Fixed Effects**	**Estimate**	**SE**	**p**
	Intercept	109,316.536	395.921	<0.001
	2012–13–2011–12	-664.549	1,580.860	0.676
	2013–14–2011–12	-240.763	1,591.088	0.880
	2014–15–2011–12	-2,306.592	1,581.493	0.153
	2015–16–2011–12	-1,503.857	1,581.014	0.347
	2016–17–2011–12	-1,196.475	1,580.702	0.454
	2017–18–2011–12	-1,728.212	1,583.236	0.282
	2018–19–2011–12	-3,200.245	1,581.420	0.050
	Random Effects	**SD**	**Variance**	**ICC**
	Team	2,677.165	7,167,211.081	0.381
	Residual	3,411.303	11,636,987.536	
	Marginal R^2 / Conditional R^2	0.050 / 0.412		

(*Continued*)

Table 5. (Continued)

Upper-Middle	**Fixed Effects**	**Estimate**	**SE**	**p**
	Intercept	110,839.230	417.130	<0.001
	2012–13–2011–12	-899.901	1,668.878	0.593
	2013–14–2011–12	-952.604	1,669.421	0.572
	2014–15–2011–12	-2,835.551	1,669.253	0.099
	2015–16–2011–12	-2,892.991	1,667.468	0.092
	2016–17–2011–12	-2,118.098	1,667.958	0.213
	2017–18–2011–12	-2,984.391	1,669.250	0.083
	2018–19–2011–12	-3,191.599	1,668.314	0.065
	Random Effects	**SD**	**Variance**	**ICC**
	Team	2,566.647	6,587,675.591	0.338
	Residual	3,588.856	12,879,889.799	
	Marginal R^2 / Conditional R^2	0.016 / 0.379		
Lower-Middle	**Fixed Effects**	**Estimate**	**SE**	**p**
	Intercept	109,912.326	349.425	<0.001
	2012–13–2011–12	22.669	1,397.123	0.987
	2013–14–2011–12	-1,846.974	1,399.127	0.194
	2014–15–2011–12	-3,741.391	1,397.098	0.011
	2015–16–2011–12	-3,278.483	1,396.099	0.024
	2016–17–2011–12	-3,793.554	1,397.074	0.010
	2017–18–2011–12	-2,090.699	1,400.508	0.143
	2018–19–2011–12	-2,863.177	1,396.528	0.047
	Random Effects	**SD**	**Variance**	**ICC**
	Team	2,335.007	5,452,259.170	0.281
	Residual	3,735.540	13,954,255.658	
	Marginal R^2 / Conditional R^2	0.097 / 0.351		
Relegation	**Fixed Effects**	**Estimate**	**SE**	**p**
	Intercept	109,480.764	454.954	<0.001
	2012–13–2011–12	-1,185.242	1,820.500	0.524
	2013–14–2011–12	-1,144.610	1,819.133	0.538
	2014–15–2011–12	-4,244.181	1,819.716	0.033
	2015–16–2011–12	669.433	1,819.756	0.718
	2016–17–2011–12	-1,653.588	1,818.975	0.377
	2017–18–2011–12	-2,233.729	1,820.138	0.238
	2018–19–2011–12	-1,771.906	1,820.500	0.345
	Random Effects	**SD**	**Variance**	**ICC**
	Team	2,130.215	4,537,816.447	0.234
	Residual	3,854.597	14,857,921.804	
	Marginal R^2 / Conditional R^2	0.090 / 0.303		
All seasons	**Fixed Effects**	**Estimate**	**SE**	**p**
	Intercept	109,885.411	216.473	<0.001
	Upper-Middle—Europe	1,527.654	563.405	0.007
	Lower-Middle—Europe	600.019	537.319	0.266
	Relegation—Europe	169.865	657.800	0.797
	Random Effects	**SD**	**Variance**	**ICC**
	Team	2,556.585	6,536,128.037	0.332
	Residual	3,623.655	13,130,876.084	
	Marginal R^2 / Conditional R^2	0.018 / 0.344		

Note: SE is Standard Error; SD is Standard Deviation; ICC is Intraclass Correlation Coefficient. Statistical significance set at $p<0.05$.

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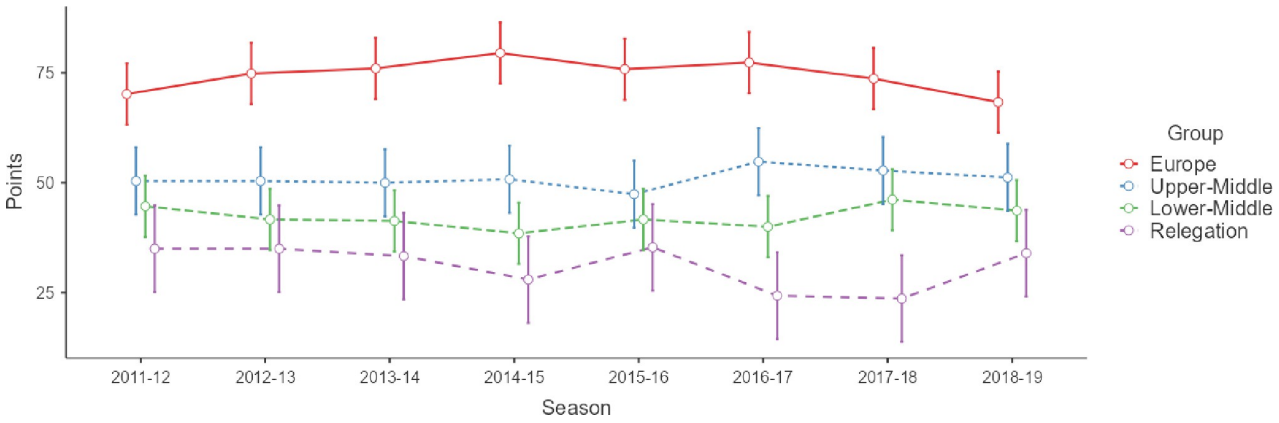

Fig 1. Effects of season for each group and effects of group on the number of points accumulated. Data represent the means and 95% confidence intervals.

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p = 0.024), 2016–17 (-3,793.554; p = 0.010) and 2018–19 (-2,863.177; p = 0.047) compared to the 2011–12 season. In the Relegation group, the teams showed lower values of TD in 2014–15 (-4,244.181; p = 0.033) compared to the 2011–12 season. Likewise, Europe showed lower values of TD than Upper-Middle (-1,527.654; p = 0.007) during the whole period analysed.

Fig 1 shows the effects of season for each group and the effects of group on the number of points accumulated. In the Upper-Middle group, the teams showed more points in 2016–17 (5.018; p = 0.046) compared to the 2011–12 season. In the Lower-Middle group, the teams showed fewer points in 2014–15 (-5.855; p<0.001) and 2016–17 (-4.027; p = 0.022) compared to the 2011–12 season. In the Relegation group, the teams showed fewer points in 2016–17 (-10.667; p = 0.029) and 2017–18 (-11.333; p = 0.021) compared to the 2011–12 season. Likewise, Europe showed more points than Upper-Middle (13.474; p<0.001), Lower-Middle (21.795; p<0.001) and Relegation (32.177; p<0.001) during the whole period analysed.

Discussion

The objective of this study was to analyse the performance of the Spanish *LaLiga* teams over a continuous period of eight seasons, considering the final league ranking. The main results of the study were that: 1) the Europe group showed significantly higher values compared to the other groups in most of the variables during the eight-season period; 2) the Europe group teams showed lower values of Length from the fifth season (from 2015–16 to 2018–19), and lower values of GkDef from the fourth season (from 2014–15 to 2018–19); 3) the Upper-Middle group teams showed lower values of Length from the fifth season (from 2015–16 to 2018–19); 4) the Lower-Middle group teams showed fewer Shots from the third season (from 2013–14 to 2018–19), and lower values of Length, GkDef and TD from the fourth season (from 2014–15 to 2018–19); and, 5) the Relegation group barely showed significant differences between seasons in any variable.

Regarding the Technical-Tactical dimension, the season factor had a significant effect on Crosses for Europe, Upper-Middle, Lower-Middle and Relegation, and a significant effect on Shots for Lower-Middle. The group factor also had a significant effect on Passes, Successful Passes and Shots. The distribution in these variables performed by the teams of the four groups implied greatly a performance stability throughout the analysed period. In relation to Passes and Successful Passes, the results of this work are similar to those of a recently published study about the evolution of physical and technical parameters in the Spanish *LaLiga* between the

2012–13 and 2019–20 seasons [12]. These researchers found no clear trend in the total passes as seasons progressed for any of the four groups but did find an upward trend in passing accuracy for the Top (ranked from 1st to 5th) and Lower-Middle (ranked from 11th to 15th) teams. However, the effect size of the differences between seasons was small. Therefore, it is worth mentioning that the study by Lago-Peñas et al. [12] also showed stability in the passes made during the analysed seasons. Bradley et al. [9], for their part, observed an increase in passes and successful passes made by the teams in the English *Premier League* over seven seasons (from 2006–07 to 2012–13). Tier A (teams ranked from 1st to 4th) and Tier C (teams ranked from 9th to 14th) teams significantly increased passes and successful passes made with a small effect size, Tier D (teams ranked from 15th to 20th) teams with a moderate effect size and Tier B (teams ranked from 5th to 8th) teams with a large effect size. A possible explanation for this could be that the teams located at the top of the ranking have been able to maintain a high and stable performance over the years, far from the more unstable performance of the rest of the teams located at the bottom of the ranking, whose annual objective is usually the one to maintain the category season after season. Another possible explanation could be that the technical-tactical dimension prevailed over the physical dimension throughout the seasons in the English *Premier League*. However, the results of the present work differ from those obtained by Bradley et al. [9].

With regard to the Crosses, it should be noted that the Europe teams showed fewer actions of this performance indicator in 2017–18 and 2018–19 compared to the 2011–12 season. Nevertheless, just like for the other three groups, the trend of Crosses over the eight seasons was quite stable for the Europe group. In the case of Shots, significant differences between seasons were only found for the Lower-Middle group. The teams of this group showed fewer Shots from the 2013–14 season. Lago-Peñas et al. [12], for their part, observed a significant decrease in the 2019–20 season compared to the 2012–13 season for the Top (from 1st to 5th) and Upper-Middle (from 6th to 10th) teams of the Spanish *LaLiga*. However, the effect size of these differences was small, and no trend was observed for any group as years passed. Therefore, the trend of the shots in the work of Lago-Peñas et al. [12] was quite stable throughout the period studied. When comparing the Technical-Tactical variables between groups throughout the period studied (the eight seasons together), Europe group obtained significantly higher values than the other three groups in Passes, Successful Passes and Shots. It seems that the frequency and effectiveness of shots and passes are some of the performance indicators that differentiate the most successful teams from the rest [21]. According to some works [22, 23], a high ball possession and, therefore, a high number of accumulated passes seem to be of great importance in the victory of football teams. In addition, a study that aimed to identify the statistics of the matches that best explain the success of football in the Spanish *LaLiga* using eight seasons as a sample (from 2010–11 to 2017–18), concluded that the two variables that best determine the success of a team are the effectiveness of the shots and the total number of shots made [24]. Therefore, the Europe group stood out for showing high values in the variables of the Technical-Tactical dimension that are most related to success.

With regard to the Set Piece dimension, the season factor had a significant effect on Corners and Fouls for Europe and Relegation, a significant effect on Goals for Upper-Middle, and a significant effect on Goals, Corners and Fouls for Lower-Middle. The group factor also had a significant effect on Goals, Corners and Fouls. The distribution in these variables performed by the teams of the four groups also represents a performance stability throughout the analysed period. It is worth noting that the Lower-Middle teams showed fewer Goals in 2013–14 and 2014–15 compared to the 2011–12 season. In these two seasons the teams of this group, in addition to showing fewer Shots, they showed less effectiveness in front of the rival goal. However, the trend of Goals over the eight seasons was quite stable for Lower-Middle. When

comparing the Set Piece variables between groups throughout the period studied, the Europe group showed significantly higher values than the other three groups in Goals and Corners. The key factor that can determine the result in a football match, and therefore the success of a team, is the goal. Castellano [25] found that the goals scored had a very high relationship with the achievement of a greater number of points at the end of the league competition in the Spanish *LaLiga* in the 2013–14 and 2014–15 seasons. It should also be noted that corner is a performance indicator related to attacking actions that, after the effectiveness of the shots and the total number of shots taken, can best determine the success of a team, since the action occurs near the rival goal [24]. A characteristic of the best-ranked teams in a league is that they often tend to get more set pieces such as corners after maintaining high ball possession [25], especially when possession occurs in the last third of the field, close to the opponent's goal [26]. Consequently, the success of the teams in the Europe group could be due to the fact that they also stood out for showing high values in variables that best explain the success of a team such as the goal and corner.

Regarding the Collective Tactical Behaviour dimension, the season factor had a significant effect on Length and GkDef for Europe, a significant effect on Length for Upper-Middle, and a significant effect on Length, Height and GkDef for Lower-Middle and Relegation. The group factor also had a significant effect on Width, Length, Height and GkDef. A significant decrease in Length values was found from the 2015–16 season for the Europe and Upper-Middle groups, and from the 2014–15 season for the Lower-Middle group. It seems that the teams of these groups increased the density of the effective playing space (same players in less space) as the seasons progressed. Furthermore, a significant decrease was found in GkDef values from the 2014–15 season for the Europe and Lower-Middle groups. This could be explained by the fact that the goalkeepers of these groups' teams are demanded to play a greater role in the offensive phase of the game, requiring his participation in initiating or continuing an attack with the players closest to him, such as with his centre-backs [10]. It could also be that these teams have been able to adopt a more defensive style of play due to less ball possession during matches. For its part, Relegation group showed a stable trend in this dimension over the eight seasons. Probably low values in the Collective Tactical Behaviour variables, represented in this group with low performance [25], may be one of the reasons that justify the stability in the collective behaviour described. When comparing the Collective Tactical Behaviour variables between groups throughout the period studied, the Europe group showed significantly higher values than the other groups in Width, Length, Height and GkDef. According to a previous study [25], a greater width, length and height of the defence was associated with the teams that accumulated the highest number of points at the end of the season in the Spanish *LaLiga* (in the 2013–14 and 2014–15 seasons). It seems, therefore, that the playing style of the most successful teams (e.g., higher positions in the final ranking) have higher values in the variables that represent the collective use of space as a trait.

In relation to the Physical dimension, the season factor had a significant effect on TD for Europe, Lower-Middle and Relegation. The group factor also had a significant effect on TD. Lower-Middle showed lower values of TD from the 2014–15 season. The teams in this group probably changed the way they played over the seasons, deploying lower total distance covered. However, the teams of the other three groups showed a stability in the total distance covered throughout the eight seasons. Lago-Peñas et al. [12] found a significant decrease in the total distance covered for different groups (Top, Upper-Middle, Lower-Middle and Lower) of the Spanish *LaLiga* over the eight seasons analysed (from 2012–13 to 2019–20). When comparing the Physical variable between groups throughout the period studied, Upper-Middle was the group that obtained the highest values in this physical variable, but it only showed significantly higher values than the Europe group. It is worth mentioning that some authors [27] indicate

that performance indicators of a technical-tactical nature have a greater influence than those of a conditional nature when determining the difference between the most successful teams in the championship. This is in line with the results presented by Castellano [25], who found that the total distance covered is not related to the success achieved by the teams (in this case of the Spanish men's top and second professional football division) at the end of the championship.

The trend in the number of points accumulated by the teams in the different groups of the Spanish *LaLiga* from 2011–12 to 2018–19 was stable. English authors [9] ensured that the teams in Tier A (from 1st to 4th) and Tier C (from 9th to 14th) groups of the *Premier League* accumulated, on average, 0.43 and 0.31 fewer points season after season (from 2006–07 to 2012–13), respectively, and for their part, the teams in Tier B (from 5th to 8th) and Tier D (from 15th to 20th) groups 0.32 and 0.20 more points, respectively. It seems that, throughout the seven seasons analysed by these researchers, the English teams in the Tier B group (from 5th to 8th) were closing the points gap with those that qualified for European competitions. However, this point difference between the English teams' season after season was minimal, so it is worth mentioning that the trend in the number of points accumulated in the English *Premier League* was also stable.

The main conclusion of the study is that the teams of the Europe, Upper-Middle and Relegation groups showed a quite stable performance, while the teams of the Lower-Middle group presented a worsening in different dimensions throughout the eight seasons analysed. It could be said that the Spanish football is in a plateau period in the performance of the best teams, which showed the ability to play in spaces with high player density as the seasons passed. Furthermore, they showed higher values in variables associated with success such as Passes, Success Passes, Shots and Corners, and in variables representative of the collective use of space (Width, Length, Height and GkDef) during the whole period studied. However, this does not detract from the fact that the teams that qualify in the less good half try to propose strategies that allow them in some cases to stay in the category, playing with the goalkeepers closer and closer to their defensive line. The information provided in the present study makes it possible to have reference values that have characterized the performance of the teams for each group.

The information provided in this study, especially due to the inclusion of a large volume of performances by the Spanish *LaLiga* teams (n = 5,518) over eight seasons, makes it possible to have reference values that have characterised the performance of the teams in the dimensions and variables studied based on league ranking at the end of each season. In addition, to the authors' knowledge, this is the first work to analyse the evolution of variables of the collective dimension (e.g., Width, Length, Height and GkDef) according to the final classification of the teams in a top-level football league over world level such as the Spanish *LaLiga*. However, the present study is not without limitations. Firstly, the performance of the teams was calculated using the means of the variables predefined by *Mediacoach*, without having the option of the authors' obtaining different variables by calculating them by accessing the raw data. Secondly, ball possessions were not considered in this study. The physical [28] and tactical [29] responses of the teams differ when the team has possession of the ball or not. This subject, distinguishing the attack and defence phase, is suggested for future research. Thirdly, the inclusion of other technical-tactical and physical variables (e.g., recoveries, duels, types of passes, accumulated distance at high-speed, number of accumulated sprints, etc.) and contextual variables such as the change of coach, the period of the season, playing at home or away or the level of the opponent [30–32], among others, could help refine possible inferences about the performance of the teams and to better explain their variability and stability over the years. Therefore, future studies should consider different technical-tactical and physical variables and different contextual variables. Finally, it should be noted that despite the fact that eight seasons in a national league (Spanish *LaLiga*) were studied in this study, caution must be taken when extrapolating

these league results to other countries or competitions with different characteristics [33]. Nevertheless, proposing this type of studies in other leagues or countries could help to better understand the evolution of the game on a more global level.

Author Contributions

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Writing – original draft: Ibai Errekagorri.

Writing – review & editing: Ibai Errekagorri, Javier Fernandez-Navarro, Julen Castellano.

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8.5. Anexo 5: Estudio 5

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Performance Analysis of the Spanish Men's Top and Second Professional Football Division Teams during Eight Consecutive Seasons

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Abstract: The present study aimed to analyse the performance of the Spanish men's top (*LaLiga1*) and second (*LaLiga2*) professional football division teams for eight consecutive seasons (from 2011–2012 to 2018–2019). The variables recorded were Passes, Successful Passes, Crosses, Shots, Goals, Corners, Fouls, Width, Length, Height, distance from the goalkeeper to the nearest defender (GkDef) and total distance covered (TD). The main results were that (1) *LaLiga1* teams showed lower values of Length from 2013–2014, and lower values of GkDef and TD from 2014–2015; (2) *LaLiga2* teams showed fewer Passes and lower values of GkDef and TD from 2014–2015, and fewer Goals and lower values of Length from 2015–2016; and (3) *LaLiga1* teams showed more Passes, Successful Passes, Shots and Goals and higher values of TD compared to *LaLiga2* teams during the eight-season period. This study concludes that *LaLiga1* teams showed fewer final offensive actions, *LaLiga2* teams showed fewer Passes and Goals and the teams of both leagues played in a space with greater density (meters by player), covering less distance as the seasons passed. The information provided in this study makes it possible to have reference values that have characterised the performance of the teams.

Keywords: team sport; match analysis; collective behaviour; evolution; mixed model

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1. Introduction

The era of technology has allowed sports such as football to carry out more precise and objective studies about the performance of players and teams during competition [1]. Tracking systems technology (global navigation satellite systems or global positioning systems, local positioning systems and semi-automatic video cameras) has been allowed in sports in general and in football in particular, based on the recorded positioning data, either in geographic coordinates (latitude and longitude) or Cartesian (x and y axes), the analysis of kinematic variables (e.g., displacements, accelerations), as well as individual (e.g., heat maps) and collective (e.g., average positioning of the players) tactical variables of a team (distances between players and/or spaces covered by a group of players) [2–4]. The use of performance indicators obtained from this technology is essential to evaluate the performance of players and teams in competition [5], and even to carry out longitudinal monitoring.

Previous studies have explored the development of the game of football throughout the years [6–14]. The physical performance has received close attention regarding this longitudinal viewpoint [6–9,11,13]. Some authors have studied the physical performance evolution of the English *Premier League* teams throughout seven seasons [7], bearing in mind the specific position of players [9], or considering how teams ended up at the end of the season [8]. Barnes et al. [7] reported that the distance covered by the teams in the

English *Premier League* had not changed much throughout the seven years (from 2006–2007 to 2012–2013), this way increasing the number of high-intensity actions and accumulated distance, as well as the number of sprints and accumulated distance. Moreover, the accumulated distance at high intensity and the number of high-intensity and sprint actions significantly increased in all player positions in the English *Premier League* teams throughout this period [9]. Bradley et al. [8], for their part, found that all the English Premier League teams increased the accumulated distance at high intensity when they did not have the ball. Nevertheless, those teams that finished fifth through eighth at the end of the season showed a slight increase in short distance covered at high intensity in ball possession compared to other teams, and a significant increase in accumulated sprint distance compared to other teams. Regarding the Spanish *LaLiga1* (men's top professional football division), a recent study [11] has also analysed the physical performance evolution of the teams throughout eight seasons, in addition to the physical performance evolution of the players considering their playing position and the physical performance evolution of the teams taking the final league ranking into account. Lago-Peñas et al. [11] observed a small decrease in the total distance covered by the teams of the Spanish *LaLiga1* with a higher number of high-intensity efforts as the seasons progressed, specifically from 2012–2013 to 2019–2020. Furthermore, these authors observed an increase in the number of actions at high intensity for all positions analysed, in addition to observing a decrease in the total distance covered and an increase in the distance covered at high intensity for almost all positions. Finally, they found that the Spanish *LaLiga1* teams made a higher number of high-intensity efforts as the seasons progressed, and the Upper-Middle ranked teams (from 6th to 10th) and Lower ranked teams (from 16th to 20th) covered a greater distance at high intensity.

The technical–tactical performance has also received considerable attention in the scientific literature [7–12,14]. Some works have analysed the technical–tactical performance evolution of the teams in the English *Premier League* [7], in addition to the technical–tactical performance evolution of the teams considering the final league ranking [8], and the technical–tactical performance evolution of the players according to their position [9]. Barnes et al. [7] found that in the English *Premier League,* there was an increase in the number of passes and their effectiveness throughout seven seasons (from 2006–2007 to 2012–2013), with a notable increase in short- and medium-distance passes. However, Bush et al. [9] analysed the evolution of physical and technical performance parameters in the English *Premier League* between 2006–2007 and 2012–2013 and observed moderate–large-magnitude increases in the total number of passes performed and moderate increases in the pass success rate for central defenders and central midfielders. Bradley et al. [8] observed that during the seven seasons analysed, the first four teams classified in the English *Premier League* demonstrated the highest levels of technical performance (i.e., number of Passes and Successful Passes), but the greatest increases in the technical parameters of Passes made and received were shown by the teams classified between the fifth and eighth positions. In the Spanish *LaLiga1*, for its part, Lago-Peñas et al. [11] have also recently analysed the technical–tactical performance evolution of the teams, of the players taking their playing position into account and of the teams considering the final league ranking. These authors observed a small increase throughout the eight-season period in technical variables such as passes, long passes, passing accuracy, aerial duels and interceptions. Furthermore, they found a slight decrease during this period in technical variables such as Shots, tackles and clearances. However, Lago-Peñas et al. [11] observed that the teams classified between the first and fifteenth positions showed fewer shots, tackles and clearances, and more short passes, long passes and aerial duels as the seasons progressed. Finally, these researchers also investigated the evolution of the technical parameters considering playing positions, and they found that external midfielders and forwards significantly decreased the Shots performed in the last seasons analysed.

To the knowledge of the authors, no investigation has analysed the evolution of the technical–tactical and physical performance of the two professional Spanish football leagues and the comparison between them over a long period. Therefore, this study aimed

to analyse the Spanish men's top (*LaLiga1*) and second (*LaLiga2*) professional football division teams' performance considering some key competitive performance variables over a continuous period of eight seasons.

2. Materials and Methods

2.1. Sample

For the objective of this study, all teams' performances in the Spanish *LaLiga1* and *LaLiga2* across eight consecutive seasons (from 2011–2012 to 2018–2019) were analysed. All matches where the information required was not available were excluded, as well as matches where one or more players were sent off. As a result, out of a possible 13,472 performances (6080 in the Spanish *LaLiga1*: 20 teams, each playing 38 matches throughout the eight seasons; and 7392 in the Spanish *LaLiga2*: 22 teams, each playing 42 matches throughout the eight seasons), a total of 11,019 performances (5518 in the Spanish *LaLiga1* and 5501 in the Spanish *LaLiga2*) were analysed, representing 82% of all the possible matches. The data to carry out this study were collected for convenience.

Data were obtained from the Spanish *Professional Football League*, which authorised the use of the variables included in this investigation. Following its ethical guidelines, this investigation does not include information that identifies football players. This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the *University of the Basque Country* (UPV/EHU).

2.2. Variables

The variables used in this work were grouped into four dimensions: Technical–Tactical (Passes, Successful Passes, Crosses and Shots), Set Piece (Goals, Corners and Fouls), Collective Tactical Behaviour (Width, Length, Height and distance from the goalkeeper to the nearest defender (GkDef)), and Physical (total distance covered (TD)). Table 1 shows the definitions of the variables for each dimension.

Table 1. Definitions of the variables for each dimension.

Dimensions	Variables	Definitions
Technical–Tactical	Passes	An intentionally played ball from one player to another with any part of the body that is allowed in the laws of the game. To calculate this variable, the total number of successful and unsuccessful passes made by the team per match is considered.
	Successful Passes	A successful pass is one that reaches its recipient. To calculate this variable, the total number of successful exchanges of the ball between two players of the same team per match is considered.
	Crosses	Any ball sent into the rival team's penalty box from a wide position. To calculate this variable, the total number of successful and unsuccessful Crosses made by the team per match is considered.
	Shots	An attempt to score a goal is made with any part of the body that is allowed in the laws of the game, either on or off the goal. To calculate this variable, the total number of shots made by the team per match is considered.

Table 1. *Cont.*

Dimensions	Variables	Definitions
Set Piece	Goals	Total number of goals scored by the team per match.
	Corners	A kick that is performed on a set piece from the corner of the field of play nearest to where the ball went out. To calculate this variable, the total number of corners taken by the team per match is considered.
	Fouls	Any infringement that is penalised as foul play by the referee. To calculate this variable, the total number of fouls received by the team per match is considered.
Collective Tactical Behaviour	Width	Mean team width per match, considered as the distance (in m) between the two furthest-apart players of the same team across the width of the pitch. To calculate this variable, the time in which the ball is out of play and the goalkeeper's activity is excluded.
	Length	Mean team length per match, considered as the distance (in m) between the two furthest-apart players of the same team along the length of the pitch. To calculate this variable, the time in which the ball is out of play and the goalkeeper's activity is excluded.
	Height	Mean team defence depth per match, considered as the distance (in m) between the furthest back player and the goal line he is defending. To calculate this variable, the time in which the ball is out of play and the goalkeeper's activity is excluded.
	GkDef	Mean distance (in m) from the goalkeeper to the nearest defender of the same team per match. To calculate this variable, the time in which the ball is out of play is excluded.
Physical	TD	Total distance covered (in m) by all the team's players that participated in the match, including the goalkeeper's activity.

2.3. Procedures

Location and motion data were obtained by the computerised multi-camera tracking system *TRACAB* (*ChyronHego*, New York, NY, USA) and events were obtained by the data company *OPTA* (*Opta Sports*, London, UK), both using *Mediacoach* software (*LaLiga*, Madrid, Spain). The reports were generated using *Mediacoach*, for the predefined performance indicators. The reliability of the *OPTA* system has been previously proved [15] and the reliability of the multi-camera tracking system *TRACAB* has also been tested for positioning and physical performance of the players [16]. The generated reports were exported into a *Microsoft Excel* spreadsheet (*Microsoft Corporation*, Washington, DC, USA) to configure a matrix.

2.4. Statistical Analysis

The statistical analysis was conducted using the software *jamovi 2.4.8* [17] for *Windows*. A linear mixed model was carried out for each dependent variable in order to analyse the differences in teams' match performance according to the league and season. League and season were considered as fixed effects and team as random effect. The Akaike information criterion (AIC) [18] and a likelihood ratio test [19] were used to select the model that best fitted each variable. The maximum likelihood (ML) estimation was used for model comparison and, for the final model of each variable, the best model again using restricted maximum likelihood (REML) estimation was refitted [19]. Marginal and conditional R^2 metrics [20] were provided for each linear mixed model as a measure of effect sizes. Marginal R^2 is concerned with the variance explained by fixed effects, and conditional R^2

is concerned with the variance explained by both fixed and random effects [20]. The level of significance was set at $p < 0.05$.

3. Results

Table 2 shows the effects of season for each league and the effects of league on the variables of the Technical–Tactical dimension. On the one hand, the Spanish *LaLiga1* teams showed fewer Crosses in 2016–2017 (−2.720; $p = 0.013$), 2017–2018 (−2.907; $p = 0.008$) and 2018–2019 (−2.348; $p = 0.032$) compared to the 2011–2012 season, and fewer Shots in 2014–2015 (−1.327; $p = 0.052$) compared to the 2011–2012 season. On the other hand, the Spanish *LaLiga2* teams showed fewer Passes in 2014–2015 (−33.205; $p = 0.031$), 2015–2016 (−37.535; $p = 0.015$), 2016–2017 (−32.181; $p = 0.036$), 2017–2018 (−31.649; $p = 0.038$) and 2018–2019 (−30.408; $p = 0.046$) compared to the 2011–2012 season, and fewer Successful Passes in 2014–2015 (−35.293; $p = 0.037$) and 2015–2016 (−41.131; $p = 0.015$) compared to the 2011–2012 season. Likewise, the Spanish *LaLiga2* teams showed fewer Passes (−28.445; $p < 0.001$), Successful Passes (−36.810; $p < 0.001$) and Shots (−0.808; $p < 0.001$) compared to the Spanish *LaLiga1* teams during the whole period analysed. See Figure 1 to facilitate the interpretation of the Technical–Tactical variables' results when comparing the seasons with each other and one league with the other.

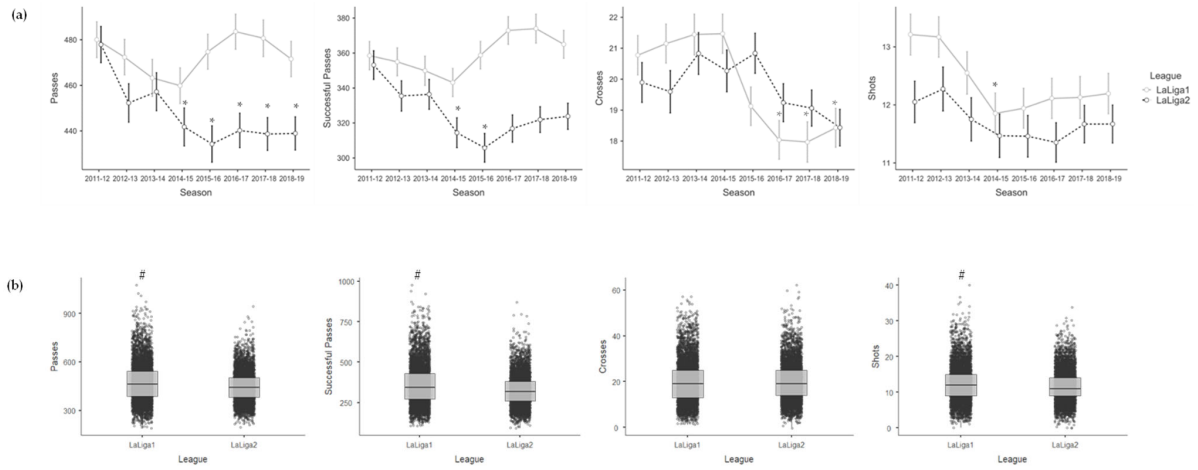

Figure 1. Mean and error bar (95% confidence interval) of the Technical–Tactical variables for each season and league (**a**), and boxplot with median values, interquartile ranges and outliers of the Technical–Tactical variables for each league considering the eight seasons together (**b**). * is >2011–2012 (**a**) and # is >*LaLiga2* (**b**) for a significance level of $p < 0.05$.

Table 3 shows the effects of season for each league and the effects of league on the variables of the Set Piece dimension. On the one hand, the Spanish *LaLiga1* teams showed fewer Corners in 2016–2017 (−0.886; $p = 0.001$), 2017–2018 (−0.560; $p = 0.042$) and 2018–2019 (−0.721; $p = 0.009$) compared to the 2011–2012 season, and fewer Fouls in 2015–2016 (−1.019; $p = 0.017$), 2017–2018 (−0.859; $p = 0.044$) and 2018–2019 (−1.160; $p = 0.007$) compared to the 2011–2012 season. On the other hand, the Spanish *LaLiga2* teams showed fewer Goals in 2015–2016 (−0.210; $p = 0.009$), 2016–2017 (−0.225; $p = 0.004$), 2017–2018 (−0.181; $p = 0.019$) and 2018–2019 (−0.207; $p = 0.008$) compared to the 2011–2012 season, and fewer Corners in 2014–2015 (−0.562; $p = 0.005$) compared to the 2011–2012 season. Likewise, the Spanish *LaLiga2* teams showed fewer Goals (−0.195; $p < 0.001$) and more Fouls (0.880; $p < 0.001$) compared to the Spanish *LaLiga1* teams during the eight seasons analysed. See Figure 2 to facilitate the interpretation of the Set Piece variables' results when comparing the seasons with each other and one league with the other.

Table 2. Effects of season for each league and effects of league on the variables of the Technical–Tactical dimension.

		Passes			Successful Passes			Crosses			Shots		
	Fixed Effects	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***
	Intercept	473.602	6.612	<0.001	359.966	7.122	<0.001	19.795	0.272	<0.001	12.392	0.169	<0.001
	2012–2013 - 2011–2012	−8.417	26.439	0.751	−4.479	28.481	0.875	0.396	1.085	0.716	−0.010	0.677	0.988
	2013–2014 - 2011–2012	−16.667	26.480	0.530	−8.931	28.519	0.755	0.649	1.093	0.553	−0.686	0.680	0.315
	2014–2015 - 2011–2012	−19.928	26.441	0.452	−15.075	28.483	0.597	0.681	1.086	0.532	−1.327	0.677	0.052
	2015–2016 - 2011–2012	−4.502	26.433	0.865	0.930	28.476	0.974	−1.608	1.084	0.140	−1.228	0.676	0.071
LaLiga1	2016–2017 - 2011–2012	3.168	26.435	0.905	13.961	28.477	0.625	−2.720	1.085	0.013	−1.092	0.676	0.108
	2017–2018 - 2011–2012	4.818	26.456	0.856	19.915	28.497	0.486	−2.907	1.089	0.008	−1.040	0.679	0.127
	2018–2019 - 2011–2012	−8.205	26.437	0.757	6.801	28.479	0.812	−2.348	1.085	0.032	−1.004	0.676	0.140
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	82.297	6772.867	0.474	88.898	7902.914	0.522	3.130	9.800	0.125	1.994	3.977	0.160
	Residual	86.745	7524.762		85.054	7234.107		8.289	68.712		4.569	20.880	
	Marginal R^2/Conditional R^2		0.005/0.467			0.008/0.526			0.027/0.148			0.010/0.168	
	Fixed Effects	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***
	Intercept	445.255	3.805	<0.001	323.227	4.197	<0.001	19.631	0.215	<0.001	11.605	0.113	<0.001
	2012–2013 - 2011–2012	−21.909	15.344	0.155	−13.436	16.907	0.428	−0.173	0.876	0.843	0.161	0.459	0.726
	2013–2014 - 2011–2012	−16.308	15.256	0.287	−12.058	16.819	0.474	0.925	0.869	0.289	−0.312	0.455	0.494
	2014–2015 - 2011–2012	−33.205	15.253	0.031	−35.293	16.816	0.037	0.373	0.868	0.668	−0.619	0.455	0.176
	2015–2016 - 2011–2012	−37.535	15.225	0.015	−41.131	16.791	0.015	1.095	0.864	0.207	−0.658	0.452	0.148
LaLiga2	2016–2017 - 2011–2012	−32.181	15.185	0.036	−30.524	16.754	0.070	−0.456	0.857	0.596	−0.728	0.448	0.107
	2017–2018 - 2011–2012	−31.649	15.142	0.038	−22.756	16.716	0.175	−0.569	0.850	0.504	−0.268	0.445	0.547
	2018–2019 - 2011–2012	−30.408	15.152	0.046	−19.636	16.725	0.242	−1.213	0.852	0.156	−0.326	0.446	0.465
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	48.274	2330.387	0.279	53.688	2882.391	0.325	2.457	6.036	0.090	1.267	1.605	0.081
	Residual	77.583	6019.187		77.372	5986.445		7.817	61.098		4.273	18.256	
	Marginal R^2/Conditional R^2		0.015/0.290			0.017/0.336			0.008/0.097			0.004/0.085	
	Fixed Effects	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***
	Intercept	459.380	3.705	<0.001	341.562	4.024	<0.001	19.696	0.180	<0.001	11.988	0.101	<0.001
All seasons	*LaLiga2 - LaLiga1*	−28.445	7.411	<0.001	−36.810	8.048	<0.001	−0.189	0.361	0.600	−0.808	0.202	<0.001
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	66.182	4380.008	0.393	72.182	5210.253	0.441	2.972	8.833	0.120	1.676	2.808	0.126
	Residual	82.298	6772.938		81.308	6611.072		8.056	64.900		4.423	19.564	
	Marginal R^2/Conditional R^2		0.018/0.404			0.028/0.456			0.000/0.120			0.007/0.132	

Notes: SE is Standard Error; SD is Standard Deviation; ICC is Intraclass Correlation Coefficient. Statistical significance set at $p < 0.05$.

Table 3. Effects of season for each league and effects of league on the variables of the Set Piece dimension.

		Goals			Corners			Fouls		
	Fixed Effects	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***
	Intercept	1.383	0.046	<0.001	5.168	0.068	<0.001	14.016	0.106	<0.001
	2012–2013 - 2011–2012	0.043	0.182	0.812	0.017	0.271	0.950	−0.495	0.422	0.242
	2013–2014 - 2011–2012	−0.046	0.183	0.801	0.177	0.274	0.519	−0.736	0.426	0.086
	2014–2015 - 2011–2012	−0.086	0.182	0.638	−0.368	0.271	0.177	−0.514	0.422	0.225
	2015–2016 - 2011–2012	−0.020	0.182	0.914	−0.424	0.270	0.119	−1.019	0.421	0.017
LaLiga1	2016–2017 - 2011–2012	0.085	0.182	0.640	−0.886	0.270	0.001	−0.632	0.421	0.135
	2017–2018 - 2011–2012	−0.034	0.183	0.852	−0.560	0.272	0.042	−0.859	0.424	0.044
	2018–2019 - 2011–2012	−0.095	0.182	0.602	−0.721	0.271	0.009	−1.160	0.421	0.007
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	0.538	0.290	0.166	0.718	0.516	0.064	1.135	1.287	0.070
	Residual	1.209	1.461		2.745	7.534		4.128	17.037	
	Marginal R^2/Conditional R^2		0.002/0.167			0.015/0.078			0.006/0.076	
	Fixed Effects	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***
	Intercept	1.203	0.020	<0.001	5.021	0.049	<0.001	14.900	0.095	<0.001
	2012–2013 - 2011–2012	−0.060	0.081	0.459	0.090	0.200	0.654	0.516	0.386	0.183
	2013–2014 - 2011–2012	−0.135	0.080	0.095	−0.015	0.198	0.941	0.227	0.383	0.553
	2014–2015 - 2011–2012	−0.061	0.080	0.444	−0.562	0.198	0.005	0.080	0.383	0.836
	2015–2016 - 2011–2012	−0.210	0.079	0.009	−0.070	0.196	0.723	−0.343	0.380	0.367
LaLiga2	2016–2017 - 2011–2012	−0.225	0.078	0.004	−0.306	0.193	0.114	−0.338	0.375	0.370
	2017–2018 - 2011–2012	−0.181	0.077	0.019	−0.166	0.189	0.383	0.051	0.371	0.890
	2018–2019 - 2011–2012	−0.207	0.077	0.008	−0.338	0.190	0.078	0.637	0.372	0.089
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	0.167	0.028	0.023	0.413	0.171	0.023	0.986	0.972	0.052
	Residual	1.097	1.203		2.711	7.347		4.191	17.565	
	Marginal R^2/Conditional R^2		0.005/0.028			0.005/0.028			0.006/0.058	
	Fixed Effects	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***
	Intercept	1.286	0.024	<0.001	5.084	0.044	<0.001	14.455	0.072	<0.001
	LaLiga2 - LaLiga1	−0.195	0.048	<0.001	−0.164	0.088	0.063	0.880	0.143	<0.001
All seasons	**Random Effects**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	0.393	0.155	0.104	0.641	0.411	0.052	1.082	1.171	0.063
	Residual	1.154	1.332		2.727	7.435		4.159	17.300	
	Marginal R^2/Conditional R^2		0.006/0.110			0.001/0.053			0.010/0.073	

Notes: SE is Standard Error; SD is Standard Deviation; ICC is Intraclass Correlation Coefficient. Statistical significance set at $p < 0.05$.

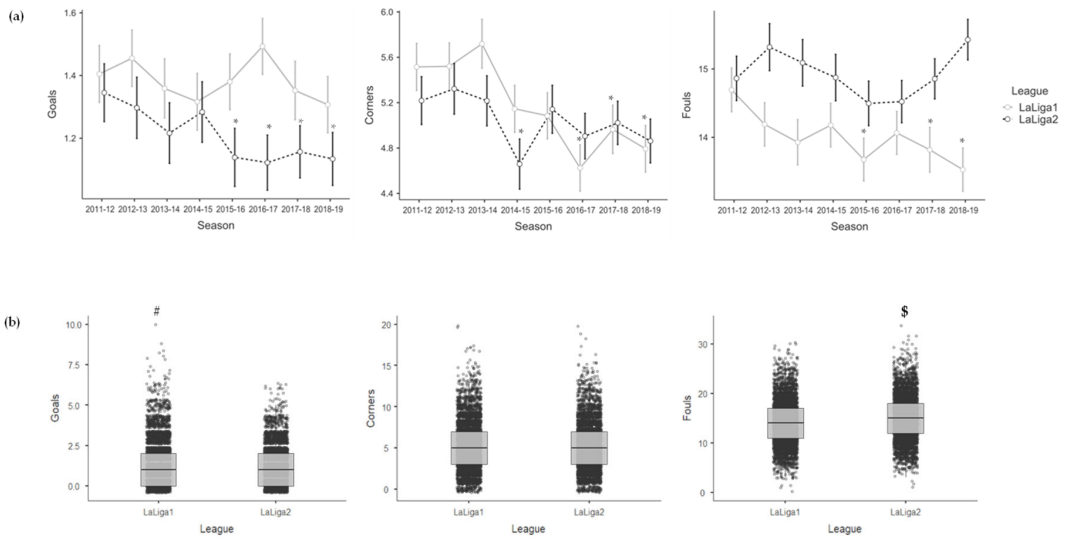

Figure 2. Mean and error bar (95% confidence interval) of the Set Piece variables for each season and league (**a**), and boxplot with median values, interquartile ranges and outliers of the Set Piece variables for each league considering the eight seasons together (**b**). * is >2011–2012 (**a**), # is >*LaLiga2* (**b**) and $ is >*LaLiga1* (**b**) for a significance level of $p < 0.05$.

Table 4 shows the effects of season for each league and the effects of league on the variables of the Collective Tactical Behaviour dimension. On the one hand, the Spanish *LaLiga1* teams showed lower values of Length in 2013–2014 (−0.629; $p = 0.049$), 2014–2015 (−0.895; $p = 0.005$), 2015–2016 (−1.544; $p < 0.001$), 2016–2017 (−1.919; $p < 0.001$), 2017–2018 (−1.954; $p < 0.001$) and 2018–2019 (−2.122; $p < 0.001$) compared to the 2011–2012 season, lower values of Height in 2014–2015 (−1.390; $p = 0.011$) compared to the 2011–2012 season, and lower values of GkDef in 2014–2015 (−2.339; $p < 0.001$), 2015–2016 (−2.047; $p < 0.001$), 2016–2017 (−1.790; $p < 0.001$), 2017–2018 (−1.565; $p < 0.001$) and 2018–2019 (−1.728; $p < 0.001$) compared to the 2011–2012 season. On the other hand, the Spanish *LaLiga2* teams showed lower values of Width in 2014–2015 (−1.557; $p = 0.002$), 2015–2016 (−1.557; $p = 0.002$) and 2016–2017 (−0.951; $p = 0.054$) compared to the 2011–2012 season, lower values of Length in 2015–2016 (−0.977; $p < 0.001$), 2016–2017 (−0.532; $p = 0.051$), 2017–2018 (−0.555; $p = 0.038$) and 2018–2019 (−0.915; $p < 0.001$) compared to the 2011–2012 season, lower values of Height in 2014–2015 (−1.017; $p = 0.009$), 2016–2017 (−1.070; $p = 0.006$) and 2017–2018 (−0.761; $p = 0.047$) compared to the 2011–2012 season, and lower values of GkDef in 2014–2015 (−1.655; $p < 0.001$), 2015–2016 (−1.229; $p < 0.001$), 2016–2017 (−1.392; $p < 0.001$), 2017–2018 (−1.298; $p < 0.001$) and 2018–2019 (−1.162; $p < 0.001$) compared to the 2011–2012 season. See Figure 3 to facilitate the interpretation of the Collective Tactical Behaviour variables' results when comparing the seasons with each other and one league with the other.

Table 5 shows the effects of season for each league and the effects of league on the variable of the Physical dimension. On the one hand, the Spanish *LaLiga1* teams showed lower values of TD in 2014–2015 (−3160.020; $p < 0.001$), 2015–2016 (−2057.377; $p = 0.011$), 2016–2017 (−2273.371; $p = 0.005$), 2017–2018 (−2227.386; $p = 0.006$) and 2018–2019 (−2882.185; $p < 0.001$) compared to the 2011–2012 season. On the other hand, the Spanish *LaLiga2* teams showed lower values of TD in 2014–2015 (−3214.570; $p < 0.001$), 2015–2016 (−3387.602; $p < 0.001$), 2016–2017 (−4099.113; $p < 0.001$), 2017–2018 (−3278.626; $p < 0.001$) and 2018–2019 (−4262.594; $p < 0.001$) compared to the 2011–2012 season. Likewise, the Spanish *LaLiga2* teams showed lower values of TD (−698.705; $p = 0.016$) compared to the Spanish *LaLiga1* teams during the whole period analysed. See Figure 4 to facilitate the interpretation of the Physical variable's results when comparing the seasons with each other and one league with the other.

Table 4. Effects of season for each league and effects of league on the variables of the Collective Tactical Behaviour dimension.

		Width			Length			Height			GkDef		
	Fixed Effects	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***
	Intercept	43.510	0.136	<0.001	36.923	0.079	<0.001	37.424	0.135	<0.001	25.008	0.106	<0.001
	2012–2013 - 2011–2012	−0.269	0.545	0.622	−0.413	0.316	0.194	0.104	0.541	0.848	0.070	0.423	0.868
	2013–2014 - 2011–2012	0.028	0.546	0.959	−0.629	0.317	0.049	−0.114	0.543	0.833	−0.144	0.424	0.735
	2014–2015 - 2011–2012	−0.662	0.545	0.226	−0.895	0.316	0.005	−1.390	0.541	0.011	−2.339	0.423	<0.001
	2015–2016 - 2011–2012	−0.220	0.545	0.688	−1.544	0.316	<0.001	−0.526	0.540	0.332	−2.047	0.423	<0.001
LaLiga1	2016–2017 - 2011–2012	0.221	0.545	0.686	−1.919	0.316	<0.001	−0.285	0.540	0.598	−1.790	0.423	<0.001
	2017–2018 - 2011–2012	0.092	0.546	0.867	−1.954	0.317	<0.001	−0.569	0.542	0.295	−1.565	0.423	<0.001
	2018–2019 - 2011–2012	−0.238	0.545	0.663	−2.122	0.316	<0.001	−0.521	0.540	0.337	−1.728	0.423	<0.001
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	1.689	2.852	0.404	0.960	0.921	0.251	1.633	2.666	0.231	1.305	1.702	0.366
	Residual	2.053	4.214		1.659	2.753		2.977	8.864		1.716	2.946	
	Marginal R^2/Conditional R^2		0.009/0.409			0.134/0.351			0.017/0.244			0.157/0.466	
	Fixed Effects	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***
	Intercept	43.534	0.123	<0.001	36.922	0.067	<0.001	37.326	0.096	<0.001	24.885	0.087	<0.001
	2012–2013 - 2011–2012	−0.114	0.495	0.817	0.016	0.270	0.952	−0.037	0.387	0.923	−0.014	0.350	0.968
	2013–2014 - 2011–2012	−0.240	0.492	0.627	−0.401	0.268	0.136	−0.016	0.384	0.967	0.121	0.348	0.729
	2014–2015 - 2011–2012	−1.557	0.492	0.002	−0.391	0.268	0.146	−1.017	0.384	0.009	−1.655	0.348	<0.001
	2015–2016 - 2011–2012	−1.557	0.492	0.002	−0.977	0.267	<0.001	−0.664	0.383	0.085	−1.229	0.348	<0.001
LaLiga2	2016–2017 - 2011–2012	−0.951	0.491	0.054	−0.523	0.267	0.051	−1.070	0.381	0.006	−1.392	0.347	<0.001
	2017–2018 - 2011–2012	−0.459	0.489	0.349	−0.555	0.266	0.038	−0.761	0.379	0.047	−1.298	0.346	<0.001
	2018–2019 - 2011–2012	−0.484	0.490	0.324	−0.915	0.266	<0.001	−0.599	0.380	0.117	−1.162	0.347	<0.001
	Random Effects	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	1.576	2.484	0.344	0.839	0.705	0.237	1.167	1.363	0.165	1.114	1.240	0.333
	Residual	2.178	4.744		1.506	2.268		2.629	6.910		1.576	2.484	
	Marginal R^2/Conditional R^2		0.041/0.371			0.037/0.265			0.020/0.181			0.106/0.403	
	Fixed Effects	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***	**Estimate**	**SE**	***p***
	Intercept	43.521	0.093	<0.001	36.919	0.060	<0.001	37.371	0.084	<0.001	24.944	0.080	<0.001
	LaLiga2 - LaLiga1	0.023	0.186	0.902	−0.005	0.119	0.967	−0.105	0.167	0.530	−0.126	0.160	0.430
All seasons	**Random Effects**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**	**SD**	**Variance**	**ICC**
	Team	1.659	2.753	0.381	1.053	1.109	0.306	1.444	2.085	0.209	1.435	2.060	0.431
	Residual	2.116	4.478		1.585	2.511		2.809	7.889		1.648	2.716	
	Marginal R^2/Conditional R^2		0.000/0.381			0.000/0.306			0.000/0.209			0.001/0.432	

Notes: SE is Standard Error; SD is Standard Deviation; ICC is Intraclass Correlation Coefficient. Statistical significance set at $p < 0.05$.

Table 5. Effects of season for each league and effects of league on the variable of the Physical dimension.

			TD	
	Fixed Effects	**Estimate**	**SE**	***p***
	Intercept	109,899.711	198.923	<0.001
	2012–2013 - 2011–2012	−595.480	795.136	0.455
	2013–2014 - 2011–2012	−1040.822	797.418	0.194
	2014–2015 - 2011–2012	−3160.020	795.275	<0.001
	2015–2016 - 2011–2012	−2057.377	794.793	0.011
LaLiga1	2016–2017 - 2011–2012	−2273.371	794.905	0.005
	2017–2018 - 2011–2012	−2227.386	796.154	0.006
	2018–2019 - 2011–2012	−2882.185	795.086	<0.001
	Random Effects	**SD**	**Variance**	**ICC**
	Team	2437.959	5,943,646.440	0.312
	Residual	3623.584	13,130,363.010	
	Marginal R^2/Conditional R^2		0.054/0.349	
	Fixed Effects	**Estimate**	**SE**	***p***
	Intercept	109,215.122	162.056	<0.001
	2012–2013 - 2011–2012	−873.847	654.515	0.184
	2013–2014 - 2011–2012	−1206.071	650.338	0.065
	2014–2015 - 2011–2012	−3214.570	650.183	<0.001
	2015–2016 - 2011–2012	−3387.602	648.641	<0.001
LaLiga2	2016–2017 - 2011–2012	−4099.113	646.466	<0.001
	2017–2018 - 2011–2012	−3278.626	644.275	<0.001
	2018–2019 - 2011–2012	−4262.594	644.702	<0.001
	Random Effects	**SD**	**Variance**	**ICC**
	Team	2028.913	4,116,489.842	0.226
	Residual	3750.620	14,067,152.080	
	Marginal R^2/Conditional R^2		0.110/0.311	
	Fixed Effects	**Estimate**	**SE**	***p***
	Intercept	109,549.497	143.778	<0.001
	LaLiga2 - LaLiga1	−698.705	287.555	0.016
All seasons	**Random Effects**	**SD**	**Variance**	**ICC**
	Team	2546.513	6,484,726.698	0.323
	Residual	3687.301	13,596,189.014	
	Marginal R^2/Conditional R^2		0.006/0.327	

Notes: SE is Standard Error; SD is Standard Deviation; ICC is Intraclass Correlation Coefficient. Statistical significance set at $p < 0.05$.

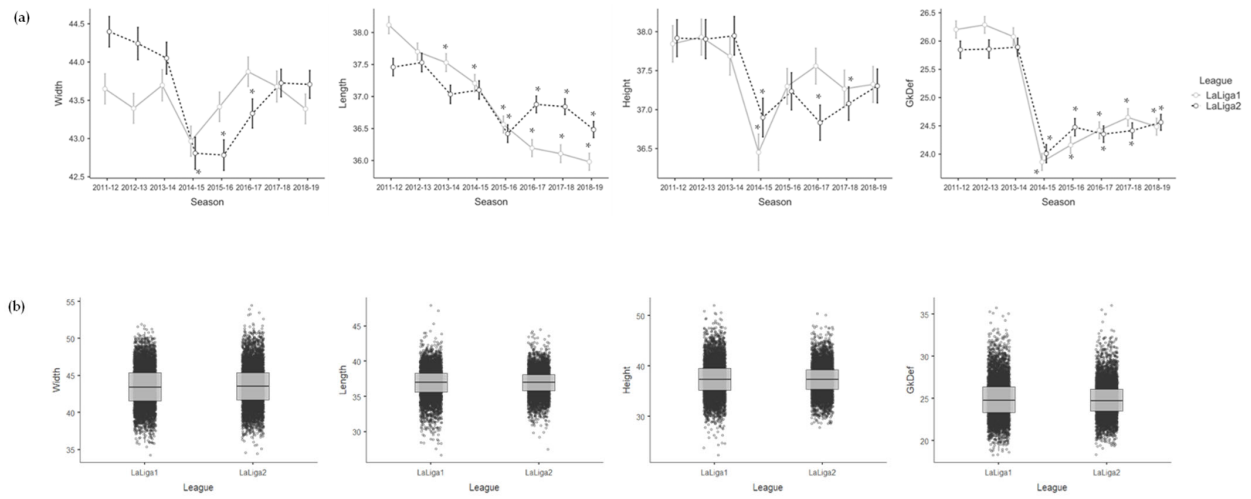

Figure 3. Mean and error bar (95% confidence interval) of the Collective Tactical Behaviour variables for each season and league (**a**), and boxplot with median values, interquartile ranges and outliers of the Collective Tactical Behaviour variables for each league considering the eight seasons together (**b**). * is >2011–12 (**a**) for a significance level of $p < 0.05$.

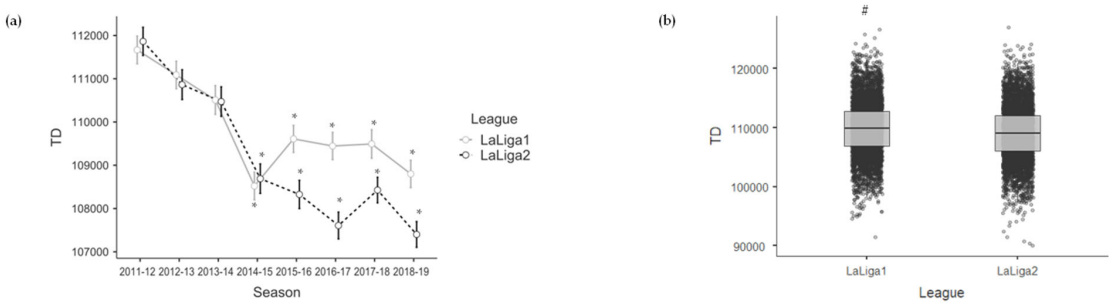

Figure 4. Mean and error bar (95% confidence interval) of the Physical variable for each season and league (**a**), and boxplot with median values, interquartile ranges and outliers of the Physical variable for each league considering the eight seasons together (**b**). * is >2011–2012 (**a**) and # is >*LaLiga2* (**b**) for a significance level of $p < 0.05$.

4. Discussion

The aim of this study was to analyse the performance of the Spanish professional teams (*LaLiga1* and *LaLiga2*) over a continuous period of eight seasons (from 2011–2012 to 2018–2019). The main results of this study were that (1) the Spanish *LaLiga1* teams showed lower values of Length from the third season (from 2013–2014 to 2018–2019), and lower values of GkDef and TD from the fourth season (from 2014–2015 to 2018–2019); (2) the Spanish *LaLiga2* teams showed fewer Passes and lower values of GkDef and TD from the fourth season (from 2014–2015 to 2018–2019), and fewer Goals and lower values of Length from the fifth season (from 2015–2016 to 2018–2019); and (3) the Spanish *LaLiga1* teams showed more Passes, Successful Passes, Shots, Goals and higher values of TD compared to *LaLiga2* teams during the eight-season period.

Regarding the Technical–Tactical dimension, the distribution in the variables such as Passes and Successful Passes made by the teams of the Spanish *LaLiga1* represents a performance stability throughout the period analysed, coinciding with a previous study [11] performed also in the Spanish *LaLiga1* a few years earlier. Barnes et al. [7] found in the English *Premier League* a significant increase in the total and Successful Passes in the last two seasons analysed (2011–2012 and 2012–2013) compared to the first season (2006–2007),

with a moderate effect size. These differences described between the English and Spanish leagues may be due to the fact that the periods were consecutive, making it likely that this progression has been slowed in the last 15 years. On the contrary, the results of the present study showed that the Spanish *LaLiga2* teams significantly decreased the total number of Passes from the 2014–2015 season. These results coincide with the greater prominence of the defensive phase of the game in the second division [21], which could be related to better performance in competition.

In the case of Crosses, it is worth mentioning that *LaLiga1* teams performed fewer actions of this variable from the 2016–2017 season. With regard to the Shots, both leagues showed a stable trend over the eight seasons. Again, these results are similar to those of Lago-Peñas et al. [11] and Barnes et al. [7]. Therefore, it is worth noting that the trend of the Shots in these two works was also quite stable throughout the period studied. Considering the difficulty of describing the way teams play in competition based on a few variables [22], it seems that as the seasons passed, the Spanish *LaLiga1* teams showed a lower degree of effective offensive play, represented by a similar number of Passes and fewer Crosses. However, it seems that the Spanish *LaLiga2* teams were characterised by a direct style of play as the seasons passed, represented by a smaller number of Passes and similar Crosses and Shots. Additionally, although the teams of *LaLiga2* decreased the number of Passes, they showed similar accuracy throughout the eight seasons (i.e., a similar number of Successful Passes).

When comparing the Technical–Tactical variables between leagues during the period studied, the Spanish *LaLiga1* obtained significantly higher values than the Spanish *LaLiga2* in Passes, Successful Passes and Shots. These results are similar to those of Castellano and Casamichana [21]. However, it should be noted that these authors qualify that it was actually the top 10 teams in the first division that showed significantly higher values in Shots, total Passes and Successful Passes (measured as a percentage) than the other three groups. In English football, some researchers [23] found that the players in the English *Premier League* performed more total and Successful passes than the players in the English *Championship* (the second division of England's league system) and *League 1* (the third division of England's league system). According to different studies published previously [24–26], it seems that Passes, Successful Passes or Shots made, among other variables, are directly related to success or a higher competitive level of the teams. In addition, Castellano [27] found that variables such as Passes, Successful Passes or Shots had a strong relationship with the final classification in the Spanish men's professional football division, while they did not have it in the Spanish men's second professional football division. However, this study only analysed two seasons, thus not allowing any trend to be established. Therefore, it is worth mentioning that the Spanish *LaLiga1* teams stood out for showing high values in the variables of the Technical–Tactical dimension that are most related to success.

With regard to the Set Piece Dimension, the Spanish *LaLiga1* teams showed fewer Corners in the last three seasons analysed (from 2016–2017 to 2018–2019). It has already been mentioned previously that caution must be used to describe the way teams play in competition considering certain variables, but this could be another indicator that *LaLiga1* teams showed a lower degree of effective offensive play as the seasons passed. Fewer Fouls made were also found in the Spanish *LaLiga1* in 2015–2016, 2017–2018 and 2018–2019 compared to the 2011–2012 season. It seems that *LaLiga1* teams showed more cautious and conservative defensive strategies as the seasons passed [28]. However, the Spanish *LaLiga2* teams showed fewer Goals from the 2015–2016 season. Although the teams of this league showed a similar number of Shots throughout the seasons, their efficacy decreased over time. This result, together with the reduction in the number of Passes accumulated per game, could be interpreted as a reduction in the quality of the teams in this category. When comparing the Set Piece variables between leagues during the eight-season period, on the one hand, the Spanish *LaLiga1* showed significantly higher values in Goals. This seems to support the idea suggested by Castellano [27] when he found that goals scored

had a very strong relationship with the achievement of a higher number of points at the end of the league competition in the Spanish *LaLiga1*, in the sense that scoring goals brings teams closer to success. On the other hand, the Spanish *LaLiga2* showed significantly higher values for Fouls. Added to the lower number of goals per game, this could indicate that the defensive aspect tends to be more relevant in this league, in the sense that not conceding goals brings teams closer to success [27].

Regarding the Collective Tactical Behaviour dimension, similar values of Width but lower values of Length were found from the 2013–2014 season for the Spanish *LaLiga1* teams. It seems that they increased the density of the effective playing space (the same number of players in less area) as the seasons progressed. In *LaLiga2,* this was more remarkable, reducing both Width and Length as the seasons progressed. With regard to the Height variable, the Spanish *LaLiga2* teams showed lower values in 2014–2015, 2016–2017 and 2017–2018 compared to the 2011–2012 season. Therefore, it is worth mentioning that *LaLiga2* teams played closer to their own goal line during some seasons. A significant decrease in GkDef values was also found from the 2014–2015 season for both leagues. This could be explained by the fact that the goalkeepers of the teams in the Spanish professional football are required to play a greater role in the offensive phase of the game, demanding his participation in initiating or continuing an attack with the players closest to him, such as with his centre-backs [9], or that the teams have been able to adopt a more defensive style of play due to less ball possession during matches. It should be noted that no significant differences were found between the leagues in the eight seasons analysed. Contrary to these results, Castellano and Casamichana [21] observed higher values in the variable Width for the top-ranking teams compared to the bottom-ranking teams for both Spanish *LaLiga1* and *LaLiga2*.

Finally, in relation to the Physical dimension, the Spanish *LaLiga1* and *LaLiga2* teams showed lower values of TD from the 2014–2015 season. One reason for this may be the reduction in the effective playing time of the matches, which is known to have an outstanding effect on the physical performance accumulated by the players [29]. Lago-Peñas et al. [11] also observed a small decrease in the total distance covered from 2014–2015 to 2019–2020 compared to the 2012–2013 season. Another study [13] also found a decrease in the total distance covered by the teams of the Spanish *LaLiga1* in the 2018–2019 season compared to the previous three. Anyway, these authors analysed just four consecutive seasons, so the conclusions are not clear. On the contrary, Barnes et al. [7] observed that the total distance covered by the English *Premier League* teams remained stable during seven seasons (from 2006–2007 to 2012–2013). Allen et al. [6], for their part, observed small increases in the English *Premier League* in the last season analysed (2018–2019) compared to the first (2014–2015), and from season to season (i.e., 2016–2017 > 2015–2016 and 2017–2018 > 2016–2017). Nevertheless, these findings were not consistently significant, so it can be concluded that the total distance covered by the English *Premier League* players also remained stable over five seasons (from 2014–2015 to 2018–2019). Regarding the differences between leagues, Spanish *LaLiga1* showed significantly higher values than Spanish *LaLiga2* during the eight-season period, similar to that described by Pons et al. [13]. A greater number of Set Pieces (e.g., Fouls) in *LaLiga2*, with a greater importance of the defensive phase, could limit the time available to play (e.g., shorter effective playing time) and, consequently, reduce the accumulated distance [29]. Bradley et al. [23] found that the teams of the English *Championship* and *League 1* covered a greater total distance than the teams of *Premier League*. On this matter, it should be noted that each domestic league or country is characterised by having a particular demand of the game [30].

5. Limitations

The information provided in this study, especially due to the inclusion of a large volume of performances by the Spanish professional teams over eight seasons, makes it possible to have reference values that have characterised the performance of the teams in the dimensions and variables studied. In addition, to the authors' knowledge, this is

the first work to analyse the evolution of variables of the Technical–Tactical, Set Piece and Collective Tactical Behaviour dimensions of the Spanish *LaLiga2* (the men's second professional football division). However, the present study is not without limitations. Firstly, possible differences motivated by changes in video-tracking cameras over the years that have been made must be considered [16]. Secondly, the averages of the variables were calculated to evaluate the performance of the teams, but it should be noted that the stability shown by these throughout the seasons must be interpreted with care since the inherent variability of the game makes the performances of the teams span a wide range. Thirdly, if ball possessions had been calculated [29], they would have helped to better interpret the differences in the play of the teams over the years. This subject, distinguishing the attack and defence phase, is suggested for future research. Fourth, the inclusion of other Technical–Tactical and Physical variables (e.g., recoveries, duels, types of passes, accumulated distance in high-speed running and sprint, number of accumulated high-speed runs and sprints...) and contextual variables such as the change of coach, the period of the season, the match venue or the rival's level [31–33] could help refine possible inferences about the performance of the teams and to better explain their variability/stability over the years. Fifth and finally, it should be noted that although a sample of eight seasons was used in this study, caution must be taken when extrapolating these league results to other countries or competitions, since they represent the specific characteristics of the two main national leagues from Spain. Therefore, proposing this type of study in other leagues or countries could help to better understand the evolution of the game on a more global level.

6. Conclusions

The main conclusion of this study is that the teams for both Spanish *LaLiga1* and *LaLiga2* presented some changes in different dimensions throughout the eight seasons analysed. It should be noted that the Spanish *LaLiga1* teams showed fewer final offensive actions such as Crosses and Corners throughout the years, while the Spanish *LaLiga2* teams showed fewer Passes and Goals. The teams of both leagues displayed their Collective Tactical Behaviour in a space with greater density, playing with the goalkeepers closer and closer to their defensive line and deploying less distance covered as the seasons passed. Finally, the Spanish *LaLiga1* stood out for obtaining higher values than *LaLiga2* in variables associated with success, such as Passes, Successful Passes, Shots and Goals during the whole period studied. The information provided in the present study makes it possible to have reference values that have characterised the performance of the teams.

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Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

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8.6. Anexo 6: Resolución del Comité de Ética

GIZAKIEKIN ETA HAUEN LAGIN ETA DATUEKIN EGINDAKO IKERKETEI BURUZKO ETIKA BATZORDEAREN (GIEB-UPV/EHU) TXOSTENA

Mª Jesús Marcos Muñoz andreak, Universidad del País Vasco/Euskal Herriko Unibertsitateko (UPV/EHU) GIEBeko idazkari gisa,

ZIURTATZEN DU

Ezen gizakiekin egindako ikerkuntzaren etika batzorde honek, GIEB-UPV/EHU, (2014/2/17ko 32. EHAA)
Balioetsi duela ondoko ikertzailearen proposamen hau:
Julen Castellano Paulis andreak, M10_2019_099, honako ikerketa proiektu hau egiteko:
"Mixed method approach on performance analysis (of training and competition) in elite and academy sport"

Eta aintzat hartuta ezen

1. Ikerketa justifikatuta dago, bere helburuei esker jakintza areagotu eta gizarteari onura ekarriko baitio, ikerlanak lekartzakeen eragozpen eta arriskuak arrazoizko izanik.
2. Ikertzaile taldearen gaitasuna eta erabilgarri dituzten baliabideak aproposak dira proiektua gauzatzeko.
3. Ikerketaren planteamendua bat dator era honetako ikerkuntza egin ahal izateko baldintza metodologiko eta etikoekin, ikerkuntza zientifikoaren praktika egokien irizpideei jarraiki.
4. Indarreko arauak betetzen ditu, ikerketa egin ahal izateko baimenak, akordioak edo hitzarmenak barne.

Aldeko Txostena eman du 2019ko apirilaren 11an egin duen bileran (112/2019akta) aipatutako ikerketa proiektua ondoko ikertzaileek osatutako taldeak egin dezan:

Julen Castellano Paulis
Ibon Etxeazarra
Jesús Cámara
Javier Yanci
Asier Los Arcos
Ibai García
Eneko Fernández
Aitor Iturricastillo

MARIA JESUS MARCOS MUÑOZ
Firmado digitalmente por MARIA JESUS MARCOS MUÑOZ
Fecha: 2019.05.27 11:40:48 +02'00'

GIEB-UPV/EHUko idazkari teknikoa
Secretaria Técnica del CEISH-UPV/EHU

Eta halaxe sinatu du Leioan, 2019ko maiatzaren 27an

INFORME DEL COMITÉ DE ÉTICA PARA LAS INVESTIGACIONES CON SERES HUMANOS, SUS MUESTRAS Y SUS DATOS (CEISH-UPV/EHU)

Mª Jesús Marcos Muñoz como Secretaria del CEISH de la Universidad del País Vasco/Euskal Herriko Unibertsitatea (UPV/EHU)

CERTIFICA

Que este Comité de Ética para la Investigación con Seres Humanos, CEISH-UPV/EHU, BOPV 32, 17/2/2014,
Ha evaluado la propuesta del investigador:
D. Julen Castellano Paulis, M10_2019_099, para la realización del proyecto de investigación: *"Mixed method approach on performance analysis (of training and competition) in elite and academy sport"*

Y considerando que,

1. La investigación está justificada porque sus objetivos permitirán generar un aumento del conocimiento y un beneficio para la sociedad que hace asumibles las molestias y riesgos previsibles.
2. La capacidad del equipo investigador y los recursos disponibles son los adecuados para realizarla.
3. Se plantea según los requisitos metodológicos y éticos necesarios para su ejecución, según los criterios de buenas prácticas de la investigación científica.
4. Se cumple la normativa vigente, incluidas las autorizaciones, acuerdos o convenios necesarios para llevarla a cabo.
5.

Ha emitido en la reunión celebrada el 11 de abril de 2019 (acta 112/2019), **INFORME FAVORABLE** a que dicho proyecto de investigación sea realizado, por el equipo investigador:

Julen Castellano Paulis
Ibon Etxeazarra
Jesús Cámara
Javier Yanci
Asier Los Arcos
Ibai García
Eneko Fernández
Aitor Iturricastillo

Lo que firmo en Leioa, a 27 de mayo de 2019

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