Artículo original / Original Article

Is crowd support important in professional football's home advantage? A systematic review based on covid-19 effect

¿Es importante el apoyo del público en la ventaja como local en fútbol profesional? Una revisión sistemática basada en el efecto del COVID-19

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Abstract

The COVID-19 pandemic enabled a natural experiment examining how spectator absence impacted home advantage in football. This systematic review analysed research characterizing home advantage dynamics with no fans present across diverse leagues worldwide. The aim was assessing the profile, trends, methodologies, procedures, and developments in this emerging field. Searches in specialized databases identified 50 relevant studies following PRISMA guidelines. These works were systematically assessed to extract key details related to design, country, competition level, analytic approach, performance variables, and home advantage findings. Overall methodological quality was categorized as excellent. Most research occurred in top European men's leagues, with limited attention to other levels. Predictive (58%) and descriptive (36%) investigations predominated, chiefly utilizing regression and group comparisons. Points, goals, cards, and result were the primary metrics. Results demonstrated home advantage decreases without spectators in most leagues, conforming to social facilitation theories stipulating performance declines minus audience encouragement. Additional research is warranted across female competitions, youth categories, amateur settings, and knockout tournament stages. Maintaining methodological rigor while expanding domains will solidify understanding of this intricate phenomenon to guide teams performing both home and away.

Keywords: home advantage; COVID-19; football; fans; sports performance.

Resumen

La pandemia de COVID-19 permitió un experimento natural examinando el impacto de la ausencia de espectadores en la ventaja de jugar como local en el fútbol. Esta revisión sistemática analizó investigaciones que caracterizan la dinámica de esta ventaja sin público presente en distintas ligas en todo el mundo. El objetivo fue evaluar el perfil, tendencias, metodologías, procedimientos y desarrollos en este campo emergente. Búsquedas en bases de datos especializadas identificaron 50 estudios relevantes siguiendo la metodología PRISMA. Estos trabajos fueron evaluados sistemáticamente para extraer detalles clave relacionados con el diseño, país, nivel de competición, enfoque analítico, variables de rendimiento y resultados sobre la ventaja como local. La calidad metodológica global se categorizó como excelente. La mayor parte de la investigación se realizó en ligas masculinas europeas de élite, con poca atención a otros niveles. Predominaron investigaciones predictivas (58%) y descriptivas (36%), utilizando principalmente regresión y comparaciones de grupo. Puntos, goles, tarjetas y resultados fueron métricas primarias. Los resultados demostraron disminución de ventaja local sin espectadores en la mayoría de las ligas, conforme a teorías de facilitación social que estipulan descensos de rendimiento sin apoyo de audiencia. Se necesita más investigación en competiciones femeninas, categorías juveniles, niveles amateurs y fases eliminatorias de torneos. Mantener rigor metodológico a la vez que se expanden los campos consolidará la comprensión de este complejo fenómeno para guiar a equipos al jugar en sus casas o de visitantes.

Palabras clave: ventaja como local; COVID-19; fútbol; espectadores; rendimiento deportivo.

Introduction

Football is a very popular sport with many people following it around the world (Parrish & Nauright, 2014). In the modern sports, a team's success depends on maximizing performance across all team members including executives, coaching staff, and players (Vestberg, Gustafson, Maurex, Ingvar, & Petrovic, 2012). Obtaining peak individual and team performance is critical in training and competition (Halson, 2014). Therefore, extracting and capitalizing on all available information is vital for favourable development (Ibáñez, Feu, & Cañadas, 2016). Assistants collect real-time data for instant feedback and subsequent analysis to enhance individual and collective functioning (Fernández-Cortés, Escudero-Tena, García-Rubio, & Ibañez, 2020).

Game indicators like fouls, corners, passes, offsides, possession, shots and tackles influence match outcomes, constituting performance markers (Fernández-Cortés, García-Ceberino, García-Rubio, & Ibáñez, 2023; Maneiro-Dios et al., 2017). Moreover, situational factors can impact these markers, such as venue (Caballero, Rubio, & Ibáñez, 2017; Pollard & Gómez, 2014), scoring first (Ibáñez, Pérez-Goye, Courel-Ibáñez, & García-Rubio, 2018; Lago-Peñas, Gómez-Ruano, Megías-Navarro, & Pollard, 2016), opposition strength (García-Rubio, Gómez, Lago-Peñas, & Ibáñez, 2015; Lago & Casáis, 2010; Zhou, Calvo, Robertson, & Gómez, 2021), and exceptional events like the 2020 pandemic (Destefanis, Addesa, & Rossi, 2022).

Venue has been studied across sports over time, demonstrating home advantage (Courneya & Carron, 1992). In the last five years, a historic event impacted global life including sports – the COVID-19 infectious disease that directly threatened health (Grix, Brannagan, Grimes, & Neville, 2021). Professional football adopted safety measures: i) partially suspending competitions in March 2020; ii) establishing health protocols for match safety; iii) holding spectator-less matches during parts of 2019-2020 and 2020-2021 seasons; iv) mandating regular COVID-19 testing; and v) implementing isolation bubbles to minimize transmission risks (Mohr et al., 2022). This drastically altered competitions, enabling gradual resumption without spectators.

COVID-19 created an unprecedented natural experiment examining spectator presence/absence effects, as the international federation introduced policies including: i) full/partial fan restrictions (Leitner & Richlan, 2021a); and ii) increasing substitutions from 3 to 5 (Mota, Santos, & Marocolo, 2021). In terms of game play, visiting teams scored more without spectators, eliminating the home edge in Germany (Hill & Van Yperen, 2021; Jimenez-Sanchez, Lavin, & Endara, 2021). Their fouls and cards also decreased (Bryson, Dolton, Reade, Schreyer, & Singleton, 2021). However, some research found increased home advantage without spectators (e.g. Portugal, Switzerland, Austria), indicating home advantage dynamics are league-specific (Benz & Lopez, 2023). For example, Hill & Van Yperen (2021) found the Spanish, Italian and English leagues home advantage maintain without fans, but it disappears in German league due to the home field advantage turned into a disadvantage in terms of proportion of points won by the home teams. Presently, spectators can pressure referees to make more favourable calls for the home team (Lovell, Newell, & Parker, 2014). To mitigate referee bias, video assistant refereeing (VAR) aims to improve decisions regarding goals, penalties, red cards, and player identity (Spitz, Wagemans, Memmert, Williams, & Helsen, 2021). Several top European leagues showed substantially reduced home advantage (De Angelis & Reade, 2023; Scoppa, 2021). Declines occurred in overall goals (Martins, Duarte, Barbosa, & Souza, 2023) and home goals (Cross & Uhrig, 2023). Home teams secured fewer points while receiving more cards (Leitner & Richlan, 2021a). Italian Serie A and B showed no significant pre/post-pandemic differences in average points (Vandoni et al., 2022).

Many studies are descriptive (Ghahfarokhi, Soroush, & Hasanbeigi, 2022; Matos et al., 2021) and predictive (Lee, Kim, Kim, & Lee, 2022; Leitner & Richlan, 2021a) with limited theoretical work (Webb, 2021) and no diagnostic or prescriptive analyses (Delen & Ram, 2018). In research, theoretical reviews occur when a topic has sufficient investigations. In football, such reviews have focused on injuries (Zech et al., 2022), fitness (Aquino et al., 2020), and skills/tactics (Falcés-Prieto, Marcos-Gutiérrez, & Martín-Barrero, 2021; Plakias et al., 2023) but not playing at home and

COVID-19 across levels. A thorough investigation of the analysed leagues, research phases conducted, and outcomes obtained is essential for determining whether studies exhibit specific biases or can be generalised. Consequently, this research aims to analyse the body of studies on the home advantage in football within the context of COVID-19, examining the research profile, trends, methodological approaches, procedures, and evolution of findings.

Materials and Methods

Study design

The present study is a systematic review analysing the various scientific articles found on home advantage, COVID-19, and football in specialized databases. It is a theoretical analysis presenting the main characteristics proposed by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology (Moher et al., 2015): a) Definition of objectives with explicit, reproducible information. Analyse the different works referring to COVID-19, home advantage and football; b) Systematic search for evidence following eligibility criteria; c) Assessment of the validity of the findings; and d) Systematic presentation and synthesis of the characteristics and findings of the included studies.

Search strategy

Searches were conducted in the Web of Science (WOS), Scopus and PubMed electronic databases. The search was performed in English and Spanish. Three keywords were used: "home advantage", "covid", and "football". The Boolean operator used in the search was "AND" since the objective was to identify the maximum number of articles possible referring to these three terms in an exclusive manner. The "OR" Boolean operator was not used because we were looking for exclusive information on those words, requiring they all meet the inclusion criteria.

An author conducted an electronic search to identify potentially eligible studies for this systematic review and extracted data in a standardized, unblinded fashion. Subsequently, two authors of the research team reviewed the titles, abstracts and reference lists of retrieved articles to identify potentially relevant papers. They further evaluated the full texts of included studies to confirm those meeting predetermined eligibility criteria. Any disagreements on study eligibility between the two reviewers were resolved through discussion and consensus, with arbitration by a third author when required to resolve persistent conflicts. This process of independent screening and consensus-based conflict resolution helped ensure a rigorous methodology for study identification and inclusion.

Inclusion and exclusion criteria

The studies included in this systematic review were required to meet predefined inclusion and exclusion criteria. Inclusion criteria stipulated those eligible documents had to: 1) examine spectator absence/presence in football and professional football; 2) have a version published in English or Spanish; 3) analyse the impact of COVID-19; and 4) specifically address association football. Exclusion criteria specified that studies would not qualify if they: 1) did not cover spectator factors; 2) focused purely on Australian rules football or American gridiron football rather than association football; or 3) could not be properly cited/referenced due to access restrictions. By systematically applying these eligibility and exclusion parameters during the review process, the authors aimed to identify all relevant studies that provided insight into how COVID-19 and associated spectator restrictions impacted home advantage effects uniquely in association football across different leagues worldwide. Two independent reviewers screened candidate articles to evaluate criteria fulfilment before inclusion in the final qualitative synthesis.

Data extraction

The Cochrane Consumers and Communication Review Group data extraction protocol (Moher et al., 2015) was utilized to extract the following information from studies analysing home advantage and COVID in football: study topic, sports (e.g. football, basketball, hockey, baseball, rugby or volleyball, allowing multiple responses), authors, title, journal, document type (article, editorial material or meeting abstract), year of publication (2021, 2022 or 2023), abstract, times

cited, keywords (allowing multiple responses), competitive level (1-Professional, 2-Semi-professional, 3-Amateur, 4-Youth academy, 5-Professional and amateur, 6-Professional and youth academy), matches, gender (1-Male, 2-Female, 3-Mixed), countries (allowing multiple responses), research methodology (1-Descriptive, 2-Diagnostic, 3-Predictive, 4-Prescriptive, 5-Theoretical studies) (Houtmeyers, Jaspers, & Figueiredo, 2021), analysis (allowing multiple responses), variables analyzed (allowing multiple responses), research findings (1-Home advantage decreases without spectators, 2-Home advantage increases without spectators, 3-No home advantage differences with spectator presence or absence, 4-Unclassified, allowing multiple responses), competition type (1-Regular season, 2-Playoffs, 3-Regular season and playoffs) and study quality.

All documents were coded by two coders who received prior training. Subsequently, inter-coder reliability was evaluated using 6 randomly selected studies. Specifically, Cohen's kappa coefficient was calculated with a 95% confidence interval to assess coder agreement, with the following interpretive ranges: <0.20 poor, 0.21-0.40 fair, 0.41-0.60 moderate, 0.61-0.80 good, >0.80 very good (Cohen, 1960). The average coder agreement was categorized as very good with a value of 0.95 (95% CI 0.92-0.98). This process of evaluating inter-coder reliability helped minimize potential bias and errors in the data extraction process. Any disagreements were resolved through discussion and consensus between the authors. The search results were exported from the databases as comma-separated values (CSV) files on a Windows 10 operating system. These exported CSV data were then systematically organized into a customized Microsoft Excel 2021 spreadsheet (Microsoft Corporation, Redmond, WA, USA) to facilitate categorization and characterization of the identified studies for further analysis. Use of this spreadsheet allowed structured data extraction across predefined fields for each study covering key parameters.

Finally, a structured approach was followed for the analyses (Houtmeyers et al., 2021), First, a descriptive analysis of all study variables was performed (frequencies and percentages). This was followed by a multiple response analysis for the following variables with potential repeated values: a) Sports, b) Authors, c) Keywords, d) Countries, e) Analyses, f) Variables, and g) Results. The set of variables allowing multiple responses was defined. Subsequently, the analysis was completed using contingency tables to identify relationships between the different study variables. This combination of descriptive, multiple response and contingency table analyses enabled a detailed characterization of studies examining home advantage, COVID-19, and football.

Quality of the studies

Included studies were evaluated using a 16-item quality assessment form for quantitative studies developed by Law et al., (1998). The tool comprises the following domains: purpose (Q1), background (Q2), design (Q3), sample (Q4 and Q5), informed consent procedure (Q6), outcome measures (Q7 and Q8), method description (Q9), significance of results (Q10), analysis (Q11), practical importance (Q12), dropouts (Q13), conclusions (Q14), practical implications (Q15) and limitations (Q16). This form has been utilized in similar systematic reviews examining accelerometer use in sports and internal/external load analysis in women's basketball (Gómez-Carmona, Bastida-Castillo, Ibáñez, & Pino-Ortega, 2020; Reina, García-Rubio, & Ibáñez, 2020).

The quality evaluation was conducted by three senior researchers holding doctoral degrees in sports science with extensive records of peer-reviewed publications. Any conflicts were resolved by discussion and consensus amongst the reviewers. Extracted data for each included study were compiled into a spreadsheet capturing: article title, assessment scores on the 16 items (rated as binary variables with 0/1 indicating absence/presence of criteria), sum of applicable item scores, and mean/standard deviation values. "Not applicable" was entered for non-relevant items to avoid artificially deflating scores. By dividing by 13-16 applicable items rather than the full 16 items, final percentage ratings reflected only relevant domains. This prevented underrating of studies where certain criteria were inapplicable. Finally, based on percentage assessment score, studies were classified into three quality categories: 1) Low methodological quality (<50%); 2) Good methodological quality (51-75%); or 3) Excellent methodological quality (>75%).

Results

Search results

55 studies were identified from the database search on Web of Science, Scopus, and PubMed. The EndNote reference manager software was used to import and eliminate any duplicates. Then, the full version of all articles was read and five records were excluded from screening for various reasons preventing access to the full text. Finally, 50 studies that evaluate the home advantage in soccer and the influence of COVID-19 were included in this systematic review. A detailed representation of the selection process is illustrated in the flow diagram of Figure 1.

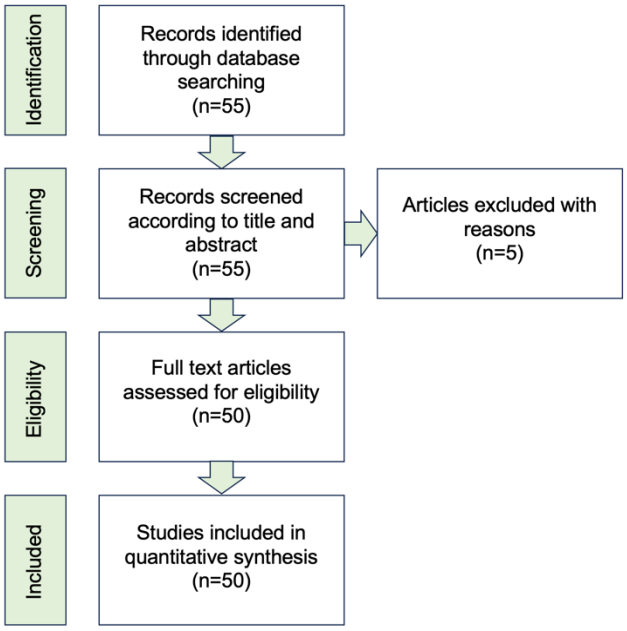

Figure 1. PRISMA flowchart.

Quality of the studies

In order to evaluate the quality of the selected studies, the 16-item assessment form for quantitative studies developed by Law et al., (1998) was employed. Prior to the quality assessment, an inter-coder reliability analysis was conducted, yielding a value of 0.93, indicating a high level of agreement between observers (95% Confidence interval: 0.91 to 0.95). The selected studies demonstrated strong methodological quality overall, with a mean quality score of 78.4% and a standard deviation of 10.6%. No studies achieved perfect scores of 100% or scored below 50%. The majority of studies (33 studies, 70.2%) were rated as having excellent methodology, with scores above 75%. An additional 17 studies (36.2%) received scores between 50-75%, indicating good methodological quality. In summary, the quality assessment showed that most of the selected studies implemented rigorous methodologies, with mean scores in the excellent range (mean = 78.4%, standard deviation = 10.6%). Only a small minority had slightly lower but still good scores between 50-75%. The high mean score and narrow standard deviation signifies consistent and conscientious research practices across the evaluated studies (see Table 1 for more details).

Study outcomes

Table 1 shows the variables authors and year, genre, competitive level, type of competition, countries, analysed variables, effect of home advantage, study design, type of analysis and keywords extracted from the selected studies.

Table 1. Data extraction of selected studies in the present systematic review about the effect of COVID-19 in home advantage in football.

ID	Authors	Genre	Competitive level	Type of competition	Country	Variables	Home Advantage Effect	Study design	Type of analysis	Keywords	Quality Index
1	(Leitner & Richlan, 2021b)	♂	Professional	Regular league	Spain, England, Germany, Italy, Russia, Turkey, Austria, Czech Republic	Result, fouls, cards and reason for card	↓	Predictive	Wilcoxon T Mann-Whitney U Pearson r	Home advantage, yellow cards, fouls, social pressure, referees, football, soccer, sport, psychology, behaviour, performance, supporters, no crowd, no fans, ghost games, covid-19	81.3%
2	(Lee et al., 2022)	♂	Professional	Regular league	Spain, England, Germany, Italy	Points and goals	↓	Predictive	T-test Bayesian of Poisson	COVID-19, Bayesian hierarchical Poisson model, football, match prediction, home advantage	93.3%
3	(McCarrick et al., 2021)	♂	Professional	Regular league	Spain, England, Germany, Italy, Russia, Turkey, Austria, Switzerland, Denmark, Portugal, Greece	Points, cards, goals, corner, shots and fouls	↓	Predictive	Bayesian of Poisson	Home advantage, football, Covid-19, Referees	80%
4	(Matos et al., 2021)	♂	Professional	Regular league	Portugal	Quality of opposition and number of spectators	⇄	Descriptive	ANOVA	Home advantage, attendance, pandemic, football, Portuguese football league	93.3%
5	(Ghahfarokhi et al., 2022)	♂	Professional	Regular league	Spain, England, Germany, Italy, France	Goals	↓	Descriptive	T-test	Covid-19., Football Leagues, Vantagem Casa, Spectators	80%
6	(Fischer & Haucap, 2021)	♂	Professional	Regular league	Germany	Points, location and number of spectators	⇄	Predictive	Regression	Home advantage, Covid-19 pandemic, professional football, stadium occupancy	80%
7	(Destefanis et al., 2022)	♂	Professional	Regular league	Spain, England, Germany, Italy, France	Points, cards, goals, shots, possession, dribbling, tackles, penalties and passes	↓	Predictive	Regression	Technical efficiency, COVID-19, football, home advantage, conditional order-m	81.3%
8	(Sors et al., 2021)	♂	Professional	Regular league	Spain, England, Germany, Italy,	Points, cards, goals, corner, shots, fouls, possession, penalties, extra time and result	↓	Predictive	Bayesian of Poisson T-test Regression	Home advantage, referee bias, football, crowd noise, social pressure	86.7%
9	(Vandoni et al., 2022)	♂	Professional	Regular league	Italy	Points, cards, fouls and penalties	↓	Descriptive	Mann-Whitney U	Home advantage, Italian football, COVID-19 restrictions, crowd influence	66.7%
10	(Higgs & Stavness, 2021)	♂	Professional	Regular league and playoff	North America	Points, goals and result	⇄	Predictive	Bayesian of Poisson	Cross-validation, Poisson, model, overdispersion, competitions	73.3%
11	(Leitner & Richlan, 2021a)	♂	Professional	Regular league	Spain, England, Germany, Italy, Russia, Turkey, Austria Czech Republic	Points, cards, goals, fouls, reason for card, result and number of spectators	↓	Descriptive	T-test Mann-Whitney U	Social pressure, decision making, referees, no fans, ghost games, football, home advantage, COVID-19	93.8%
12	(Nomura, 2022)	♂	Professional	Regular league	Japan	Points, cards, goals, corner, shots, distance run, sprint and changes	↓	Predictive	ANOVA Structural equations	Home advantage, crowd size, football, structural equation modelling, natural experiment	80%

Table 1. Data extraction of selected studies in the present systematic review about the effect of COVID-19 in home advantage in football.

ID	Authors	Genre	Competitive level	Type of competition	Country	Variables	Home Advantage Effect	Study design	Type of analysis	Keywords	Quality Index
13	(Hegarty, 2021)	♂	Professional	Regular league	Spain, England, Germany, Italy	Points, goals and location	↓	Predictive	Regression Descriptives	Market efficiency, COVID-19, home advantage, soccer	53.3%
14	(Wunderlich et al., 2021)	♂	Professional and amateur	Regular league	Spain, England, Germany, Italy, Turkey, Portugal	Points, cards, goals, shots, fouls and betting odds	⇄	Predictive	Regression	ND	86.7%
15	(Ramchandani & Millar, 2023)	♂	Professional	Regular league	Spain, England, Germany, Italy, Portugal	Points	↓	Descriptive	T-test	Football, crowd effects, referee bias, COVID-19, social pressure	73.3%
16	(Nevill et al., 2022)	♂	Professional	Regular league	England	Cards, location and result	↓	Predictive	T-test Regression ANCOVA Christensen test	Soccer, spectators, Premier league, sports officials, crowd immunity	86.7%
17	(Silva et al., 2022)	♂	Professional	Regular league	Brazil	Cards, goals, corner, shots, fouls and possession	⇄	Predictive	Chi square ANOVA Correlation Criteria assumption Welch T-test	Home-field advantage, performance analysis, COVID-19, football, disciplinary aspects	86.7%
18	(Webb, 2021)	♂ ♀	Professional and training	Regular league	ND	Referee bias	✕	Theoretical studies	No analysis	Home advantage, crowd noise, decisions, experience	53.3%
19	(Rovetta & Abate, 2021)	♂	Professional	Regular league	Italy	Points, cards, fouls and penalties	↓	Predictive	T-test Correlation	Sport psychology, covid-19, home advantage, lockdown, audience	80%
20	(Santana et al., 2021)	♂	Professional	Regular league	Germany	Goals, shots, fouls, distance run and sprint	↓	Descriptive	ANOVA	Home advantage, football, coronavirus pandemic, match analysis	86.7%
21	(Macedo-Rego, 2022)	♂	Professional	Regular league	Brazil	Points, location, result and number of spectators	↓ ⇄	Descriptive	ANOVA	attendance, behaviour, fan, match outcome, performance, player, SARS-CoV-2, soccer	86.7%
22	(Meier et al., 2021)	♂	Professional	Regular league	Spain, England, Germany, Italy	Location and number of spectators	↓	Predictive	Regression	Sports betting market, market efficiency, home advantage, COVID-19	68.8%
23	(Bryson et al., 2021)	♂	Professional	Regular league	Spain, England, Germany, Italy, Austria, Portugal, Greece, Poland, Denmark, Hungary, Ukraine, Slovenia, Albania, Romania, Serbia, Costa Rica, Australia	Cards and goals	↓	Descriptive	Descriptive	Attendance, Coronavirus, Covid-19, home advantage, natural experiments, referee bias, social pressure	66.7%
24	(Chiu & Chang, 2022)	♂	Professional	Regular league	North America	Points, location and result	⇄	Predictive	ANOVA Regression	Football, perceptions, sports, soccer, fans, nba	86.7%
25	(Wilkesmann, 2022)	♂	Professional	Regular league	Germany	No variables	✕	Predictive	Regression Descriptive	Advantage, soccer	73.3%
26	(Almeida & Leite, 2021)	♂	Professional	Regular league	Spain, England, Germany, Italy, Portugal	Shots, tackles and passes	↓ ↑	Descriptive	T-test Wilcoxon Criteria assumption	Soccer, Match location, team performance, crowd support, coronavirus	80%

Table 1. Data extraction of selected studies in the present systematic review about the effect of COVID-19 in home advantage in football.

ID	Authors	Genre	Competitive level	Type of competition	Country	Variables	Home Advantage Effect	Study design	Type of analysis	Keywords	Quality Index
27	(Sedeaud et al., 2021)	♂	Professional	Regular league	Spain, England, Germany, Italy, France, Belgium, Scotland, Greece, Portugal, Turkey	Result		Descriptive	T-test Correlations Chi square Lineal general univariate model	Home advantage, soccer, football, rugby union, COVID-19 impact, empty stadium	73.3%
28	(Jiménez Sánchez & Lavín, 2021)	♂	Professional	Regular league	Spain, England, Germany, Italy, Austria	Points, goals and result		Predictive	Chi square	Performance, testosterone, decisions, football	80%
29	(Hill & Van Yperen, 2021)	♂	Professional	Regular league	North America	Points, cards, goals, shots, fouls and possession		Descriptive	Chi square	Social facilitation, social support, sport performance, spectators and fans, bootstrapping analysis, randomness	80%
30	(Link & Anzer, 2022)	♂	Professional	Regular league	Germany	Cards, distance run, sprint and result		Descriptive	T-test Descriptives	Covid-19, sport analytics, performance analysis, match performance, home advantage, contact time, referee bias	66.7%
31	(Jiang et al., 2021)	♂	Professional	Regular league	China	More than 20 variables		Descriptive	T-test	Soccer, match location, behind closed doors, spectators, home advantage	86.7%
32	(Correia-Oliveira & Andrade-Souza, 2022)	♂	Professional	Regular league	Spain, England, Germany, Italy,	Points, goals, location, result and quality of opposition		Predictive	ANOVA Correlations Descriptive	Crowd support, SARS-CoV-2, home team, soccer, referee bias	86.7%
33	(Steinfeldt et al., 2022)	♂	Professional	Regular league and playoff	North America	Location, result and number of spectators		Predictive	Regression	attendance, betting odds, COVID-19, natural experiment, NBA basketball data	62.5%
34	(Fazackerley et al., 2022)	♂	Professional	Regular league	Australia	Shots, fouls, possession, tackles, distance run and passes		Predictive	Mixed lineal model	COVID-19, Football, Home advantage, Performance, Noise, Audience	87.5%
35	(Piancastelli et al., 2023)	♂	Professional	Regular league	England	Goals and result		Predictive	Bayesian of Poisson	Bayesian inference, Conway-Maxwell-Poisson distribution, Exchange algorithm, Multivariate count data, Pseudo-marginal Monte Carlo, Thermodynamic integration	73.3%
36	(Szabó, 2022)	♂	Professional	Regular league and playoff	North America	Points, penalties, location, result and number of spectators		Predictive	Regression Descriptives	Home advantage, social pressure, North American sports leagues, attendance, referee bias	80%
37	(Gouveia & Pereira, 2021)	♂	Professional	Regular league	Portugal	No variables		Theoretical studies	No analysis	Home advantage	53.3%
38	(Sánchez et al., 2021)	♂	Professional	Regular league	Spain, England, Germany, Italy, Austria	Points, cards, goals, corner, shots, fouls, possession, tackles, location and budget		Predictive	T-test Correlations Chi square Descriptives Mixed lineal model	Social facilitation, football, referees, playing components, fans.	80%
39	(Levental et al., 2022)	♂	Professional	Regular league	Israel	Goals, result and number of spectators		Descriptive	ANOVA	Home advantage, football, basketball, COVID-19, crowd, geographic region	80%

Table 1. Data extraction of selected studies in the present systematic review about the effect of COVID-19 in home advantage in football.

ID	*Authors*	*Genre*	*Competitive level*	*Type of competition*	*Country*	*Variables*	*Home Advantage Effect*	*Study design*	*Type of analysis*	*Keywords*	*Quality Index*
40	(Han et al., 2022)	♂	Professional	Regular league	China	More than 20 variables	↓	Predictive	Regression	Home advantage, match location, neutral venue, performance analysis, performance indicators, predictive statistic, situational variables, team sports	80%
41	(Singleton et al., 2023)	♂	Professional	Regular league	Egypt	Points, cards, goals, location, result and number of spectators	↓	Predictive	Bayesian of Poisson Regression	Attendance, COVID-19, Football, Home advantage, Natural experiments, Referee Bias, Social pressure	80%
42	(Richlan et al., 2023)	♂	Professional	Regular league	Austria	No variables	✕	Theoretical studies	No analysis	Home Advantage; Sport Competitions; Performance; Validation; Scale	81.3%
43	(van Meurs, Rehr, Raue-Behlau, & Strauss, 2023)	♂ ♀	Professional	Regular league and playoff	Germany	Points, location, result and number of spectators	⇆	Predictive	Regression Descriptives Multilevel logistic regression	Home Advantage, Logistic multilevel model, COVID-19, gender-specific, spectator influence	73.3%
44	(Magee & Wolaver, 2023)	♂	Professional	Regular league	North America	Cards, goals, penalties and location	↓	Descriptive	T-test Descriptives	Home advantage, referee bias, COVID-19, natural experiment, social pressure	53.3%
45	(Magistro & Wack, 2023)	♂	Professional	Regular league	Italy	Cards, fouls and tackles	✕	Predictive	Bayesian of Poisson Regression	bias, fans, football, Italy, race, racism, referees, Serie A, skin tone, sports	73.3%
46	(Dufner, Schütz, & Hill, 2023)	♂	Professional	Regular league	Germany	Points, cards, goals, fouls, penalties, location and result	↓	Descriptive	T-test Descriptives	Decision making, referee bias, soccer, COVID-19	86.7%
47	(Dellagrana, Nunes, & Silva, 2023)	♂	Professional	Regular league	Brazil	Points, goals, location, result, quality of opposition and number of spectators	↓	Descriptive	T-test ANOVA Mann-Whitney U Criteria assumption	soccer, professional teams, audience, COVID-19, performance	86.7%
48	(Bordigon & Neto, 2022)	♂	Professional	Regular league	Brazil	Points, cards, goals, shots, fouls, possession, penalties, changes and passes	↓	Descriptive	T-test	Football, Covid-19, Home advantage, performance analysis	73.3%
49	(Fernández-Cortés et al., 2022)	♂	Professional	Regular league	Spain	Cards, corner, shots, fouls, possession, passes, free kicks, offside, saves, attacks and dangerous attacks	↓	Predictive	ANOVA Descriptives General multivariant regression	Notational analysis, performance indicators, COVID, home advantage, result	93.3%
50	(Szabó & Kerényi, 2023)	♀	Professional	Regular league	England, Germany, France and Sweden	Points, cards and goals	⇆	Predictive	Regression	Home advantage, women´s sports, gender differences, social pressure, referee bias	93.3%

Note. *ND: No data;* ♂ *: male players;* ♀ *: female players. Effect of home advantage without fans:* ↑ *: positive effect;* ↓ *: negative effect;* ⇆ *: no effect;* ✕ *: not classified.*

Descriptive analysis

A total of 73 unique keywords were identified, with the most frequently used being 'Home Advantage' (13.3%), 'COVID-19' (11%), and 'football' (8.4%), while other keywords each constituted approximately 5% or less. In total, 263 keyword references were made. The research encompassed 22 different national league populations (Figure 2). The most studied country competitions were Germany (48%), Italy (40%), England (40%) and Spain (36%). Other nations obtained less research as Portugal (14%), Austria (12%), North America (10%), Turkey (10%), France (8%) or Brazil, and 21 countries (Belgium, Scotland, Switzerland, Denmark, Sweden, Greece, Czech Republic, Albania, Romania, Hungary, Serbia, Slovenia, Poland, Ukraine, Russia, Israel, Egypt, Japan, China, Australia and Costa Rica) individually accounted for less than 5% each. Notably, 4 studies (8%) analyzed more than 8 countries (Leitner & Richlan, 2021a, 2021b; McCarrick et al., 2021; Sedeaud et al., 2021). Only one study not reported the analyzed countries (Webb, 2021).

Regarding study design, the research was predominantly predictive (58%), followed by descriptive (36%). A minority of 3 studies (6%) were theoretical studies. No diagnostic or prescriptive analyses were identified. The key statistical approaches employed were regression (17.4%), t-test (16.3%), descriptive analysis (12%), and ANOVA (10.9%), while other models, like Bayesian Poisson, each constituted less than 6%.

As Figure 2 shows, the most utilized performance variables were points (52%), goals (50%), cards (44%), result (38%), fouls (32%) and location (30%), while other metrics each represented less than 30%. The predominant finding was a decrease in home advantage without spectators (63.1%). In 22.8% of cases, no difference in home advantage was detected with or without fans. A single study (1.8%) found an increase minus spectators, while 12.3% were unclassified.

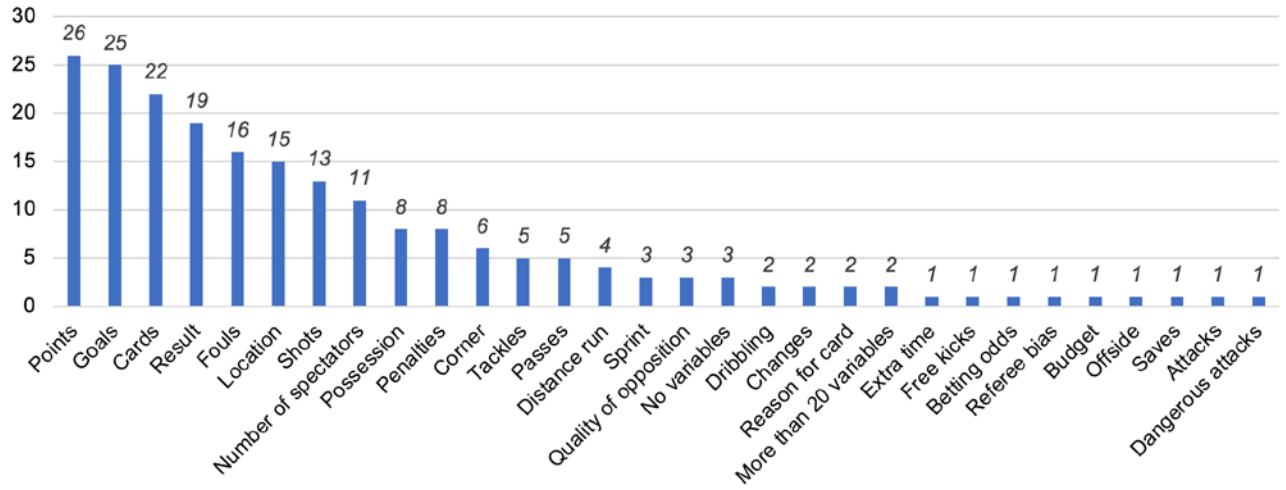

Figure 2. Key performance variables used to evaluate the effect of home advantage in football.

Regarding competition level and type, 92% of research was in professional men's leagues, 2% in professional women's football (Szabó & Kerényi, 2023), 2% in professional mixed-sex leagues (van Meurs et al., 2023), 2% in professional and amateur men's categories (Wunderlich et al., 2021) and 2% in professional and youth mixed competitions (Webb, 2021). Moreover, 88% of studies were conducted in professional regular season leagues, 8% in professional regular season plus knockout playoff leagues (Higgs & Stavness, 2021; Steinfeldt et al., 2022; Szabó, 2022; van Meurs et al., 2023), and 2% each in professional/amateur regular season and professional/youth regular season respectively (Webb, 2021; Wunderlich et al., 2021).

Methodologies of the selected studies

Figure 3 shows the investigation phases, type of analysis and quality index of the selected studies. Descriptive studies primarily employ comparison of two groups (t-test) (18%) and comparison of multiple groups (ANOVA) (10%), as well as descriptive statistics (mean and standard deviation) (8%).

Predictive studies, in addition to performing descriptive analysis (14%), conducted group comparisons (t-test) (12%), Bayesian Poisson (14%) and regression (32%). There were various analyses that stood out, including ANOVA and correlations, each with 10%. The theoretical studies did not perform data analysis since they were systematic reviews or journalistic studies (6%).

A large percentage of descriptive studies (34%) examine differences between various variables or indicators, and 8% solely perform descriptive analysis types for each variable. Approximately half of predictive studies perform predictive analysis (46%), 24% examine differences between variables or groups, and 14% seek existing relationships or descriptive analysis. We found three theoretical studies (6%) that did not perform any analysis (Figure 3). The quality of descriptive works was found to be high (20%) or very high (14%). Predictive studies were similar to descriptive ones, obtaining high (32%) and very high (24%) quality. Finally, theoretical studies were classified as medium (4%) and very high (2%) quality (Figure 3).

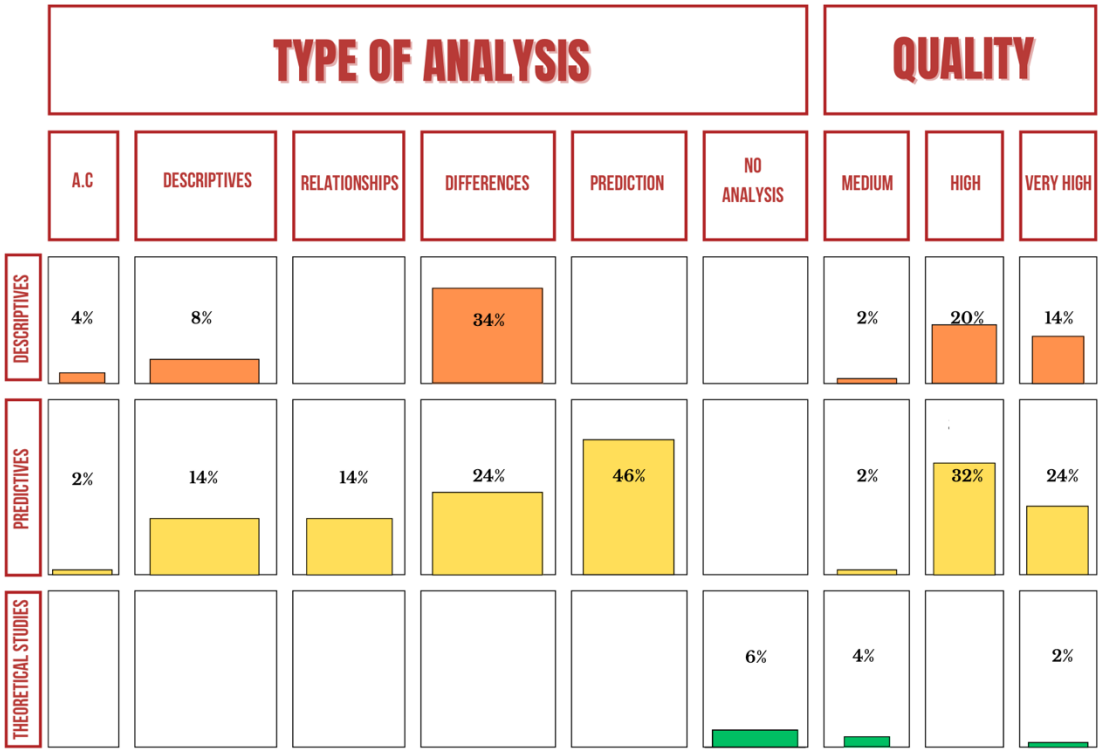

Figure 3. Distribution of selected studies based on investigation phases, type of analysis and quality index.

Variation of Home Advantage after COVID-19

Table 3 classifies the selected studies by the observed effect on home advantage without fans and the research phase examined. Examining the descriptive phase studies, 32% (n=15) found a decrease in home advantage with no spectators, while only 4% (n=2) found no differences in home advantage (Macedo-Rego, 2022; Matos et al., 2021). In the predictive phase, a sizeable proportion (40%, n=12) similarly demonstrated decreased home advantage, but a higher percentage (22%, n=7) evidenced no fan-based differences. Among the theoretical works, three studies were unclassified since they did not include original data analysis (Gouveia & Pereira, 2021; Richlan et al., 2023; Webb, 2021). Overall, there were only 7 total studies (14.9%) that could not be classified by research phase and home

advantage effect (Gouveia & Pereira, 2021; Jiang et al., 2021; Magistro & Wack, 2023; Richlan et al., 2023; Steinfeldt et al., 2022; Webb, 2021; Wilkesmann, 2022), highlighting that the vast majority of works clearly assessed impacts on home advantage. By integrating research phase and quantifying observed effects, Table 3 provides greater specificity regarding trends in findings than considering these dimensions individually. The broad distribution of decreased home advantage results emphasizes this effect's prevalence, though a non-negligible subset shows no fan-related differences.

Table 3. Distribution of selected studies based on investigation phases and effect of home advantage without fans.

			Effect of no-crowd support in home advantage			
			Decreases	*Increases*	*No differences*	*Unclassified*
Investigation phases	*Descriptive*	*n*	16	1	2	1
		% of total cases	32%	2%	4%	2%
	Predictive	*n*	20	0	11	3
		% of total cases	40%	0,0%	22%	6%
	Theoretical studies	*n*	0	0	0	3
		% of total cases	0,0%	0,0%	0,0%	6%
TOTAL		*n*	36	1	13	7
		% of total cases	72%	2%	26%	14%

Note. *n: Number of cases.*

Table 4 classifies studies according to the type of analysis conducted and the observed impact on home advantage without fans. A key finding is that 32% (*n*=16) of articles using difference analysis demonstrated decreased home advantage with no spectators present. Additionally, a substantial percentage (40%, *n*=20) of predictive modelling studies showed reduced home advantage without fans, though a smaller proportion (22%, *n*=11) evidenced no fan-related differences in home advantage. In total, approximately half of the articles across analytical approaches indicated declines in home advantage in the absence of fans. This emphasizes that fan attendance is an integral component linked to improved team performance, regardless of the precise statistical techniques used. Quantifying the distribution of results for the two analysis types specifies the prevalence of findings that align with the overall trend of lower home advantage without spectators.

Table 4. Distribution of selected studies based on type of analysis and effect of home advantage without fans.

			Effect of no-crowd support in home advantage			
			Decreases	*Increases*	*No differences*	*Unclassified*
Type of analysis	*Assumption of criteria*	*n*	2	1	1	0
		%	4%	2%	2%	0%
	Descriptive	*n*	8	0	4	1
		%	16%	0%	8%	2%
	Relations	*n*	6	0	4	0
		%	12%	0%	8%	0%
	Differences	*n*	25	1	7	1
		%	50%	2%	14%	2%
	Prediction	*n*	15	0	9	3
		%	30%	0%	18%	6%
	No analysis	*n*	0	0	0	3
		%	0%	0%	0%	6%

Note. *n: Number of cases; %: percentage of total cases.*

Table 5 shows results across different leagues and genders. Notable results show that within professional leagues, 72% had a decrease in home advantage without fans and 24% had no differences in home advantage when fans were present or absent. Within men's leagues specifically, 72% found a decrease in home advantage without fans and 22% found no differences. Whereas in women's leagues and mixed leagues, there was one article showing no differences in home advantage with or without fans for each respective league (van Meurs et al., 2023; Wunderlich et al., 2021). Moreover, within regular leagues, 70% of studies found a decrease in home advantage without fans, while there were no differences in home advantage with or without fans in 20% of studies (Chiu & Chang, 2022; Correia-Oliveira & Andrade-Souza, 2022; Fischer & Haucap, 2021; Jimenez-Sanchez et al., 2021; Macedo-Rego, 2022; Matos et al., 2021; Sánchez

et al., 2021; Silva et al., 2022; Szabó & Kerényi, 2023; Wunderlich et al., 2021). Overall, the extensive analysis across professional, gendered, and standardized leagues provides consistent evidence that removing fans conspicuously lowers or eliminates the home advantage effect within football to varying degrees.

Table 5. Influence of competitive level, genre and type of competition on the home advantage without fans.

Effect of no-crowd support in home advantage		*Competitive level*			*Genre*			*Type of competition*	
		Professional	*Professional and amateur*	*Professional and training*	*Male*	*Mixed*	*Female*	*Regular league*	*Regular league and playoff*
Decreases	*n*	36	0	0	36	0	0	35	1
	%	72	0	0	72	0	0	70	2
Increases	*n*	1	0	0	1	0	0	1	0
	%	2	0	0	2	0	0	2	0
No differences	*n*	12	1	0	11	1	1	10	3
	%	24	2	0	22	2	2	20	6
Unclassified	*n*	6	0	1	6	1	0	6	1
	%	12	0	2	12	2	0	12	2

Note. *n: Number of cases; %: percentage of total cases.*

To conclude the results, the analysis revealed some interesting country-specific findings related to changes in home advantage without fans. Germany (38% of articles), England (34%), Italy (34%), and Spain (32%) had the highest percentages of articles showing a decrease. However, one article encompassing Spain, Italy, England, Germany, and Portugal demonstrated an increase in home advantage in the absence of fans. Additional analysis indicated no differences in home advantage by fan presence in some cases: 14% of articles in Germany and 10% articles in England found no impact of absent fans. An additional 7 articles were unable to be conclusively classified based on the home advantage findings. This country-level analysis provides extra insight into the nuances of how losing fan support may or may not influence home advantage across various professional football leagues.

Discussion

The objective of this systematic review was to analyse the production of studies on Home Advantage in football with respect to COVID-19. This was done by examining the research profile, research trends, methodological approach, research procedures, and developments in results. The main results show that professional male football has been the most studied, therefore more research is needed in the female gender and at different levels.

Researchers follow a meticulous process of analysis in their investigations. As a result, the findings can be extrapolated to the sports context due to the rigor of the authors. The quality of this research is similar to other sports review investigations, such as in basketball (García-Santos, Gómez-Ruano, Vaquera, & Ibáñez, 2020), alternative invasion team sports (Calle, Antúnez, Ibáñez, & Feu, 2023), or accelerometry (Gómez-Carmona et al., 2020).

The quality of the studies was very high in descriptive (14%), predictive (24%) and theoretical (2%) works, high in descriptive (20%) and predictive (32%) studies, and medium in theoretical studies (4%). Very high quality descriptive (Leitner & Richlan, 2021a) and high quality (Bordigon & Neto, 2022) studies were found, as well as very high quality predictive (Sors et al., 2021) and high quality studies (Wilkesmann, 2022). Medium quality theoretical (Webb, 2021) and very high quality (Richlan et al., 2023) studies were also found. An average number of good quality studies was found, but research should continue in different genders and categories to obtain greater variety and maintain study quality.

The decrease in Home Advantage was mainly highlighted in countries like Germany, England, Italy and Spain. Destefanis et al. (2022) found significant differences with or without the presence of fans, determining a decrease in

home advantage without spectators. Similar results were found in England (Hegarty, 2021), Italy (Hill & Van Yperen, 2021) and Spain (Fernández-Cortés et al., 2022). These findings support the social facilitation theory (Zajonc, 1965), where crowd presence enhances player performance. There is an important basis for understanding the behaviour teams in these leagues should adopt when facing a match under these circumstances. However, it is necessary to investigate other levels, including semi-professional or amateur, to analyze whether the number of fans is essential for this advantage.

The words used in the research of this review were "Home Advantage", "Covid-19" and "football". The results indicate a diversity of studies in different competitions based on the presence or absence of fans in the same year due to the natural context offered by the Covid-19 pandemic (Germany, Italy, England and Spain) (Fernández-Cortés et al., 2022). These countries have high-level European and global leagues (UEFA Ranking) (Almeida & Leite, 2021). These teams will have greater knowledge that they can use to improve their results. Scientific knowledge should expand studies in different countries and categories in order to determine overall results on the importance of fan attendance or absence. It should be noted that the best leagues worldwide have a small number of teams and players with respect to all the academy and grassroots clubs that can be found.

Most of the research has been predictive or descriptive, with very few theoretical studies identified and none diagnostic or prescriptive. The mathematical models most used were regression, t-test, descriptive, ANOVA and Bayesian Poisson. Houtmeyers et al. (2021) indicate that research should go from descriptive analysis to know what is happening, to diagnostic analysis to know why it happened, followed by predictive analysis to indicate what can happen, and finally prescriptive analysis to show how to make it happen. These four phases will be accompanied by different types of analyses, and that diversity will confirm whether there are similar results or not through different tests. Having a high percentage of research that analyses individualized data and makes predictions of what can happen helps in training all teams. However, the process indicated above must be followed for an investigation to be completed and provide answers.

The studies show a decrease in HA without fans. These results indicate the importance of the fans when playing at home, above travel, familiarity with the facility (García-Rubio et al., 2015). The findings support social facilitation theories (Zajonc, 1965), where crowd support enhances player performance, or territoriality (Rovetta & Abate, 2021). The most used variables (performance indicators) in the studies were points, goals and cards. These performance indicators are more related to the final result of the match (points and goals) than to the teams' playing styles (Lee et al., 2022). These indicators are more important when establishing home advantage than those related to playing style. In fact, cards shown can indicate a team's aggressiveness, but also how referees are influenced by the crowd in their decisions (Nevill et al., 2022).

The descriptive studies mainly used comparisons of two and multiple groups. The predictive studies mostly performed regression analysis and the theoretical studies did not perform any analysis. Although these analyses are the most used in studies such as Ramchandani & Millar (2023) and Han et al. (2022), it is necessary to evolve by using the different research phases to diagnose, predict and even prescribe results.

In the descriptive articles, a large percentage of studies analyse differences between variables. In predictive studies, predictive analysis (46%) is performed along with analysing differences (24%) between variables. Three theoretical studies were found that did not perform any analysis. Various studies corroborate these results (Dellagrana et al., 2023; Fernández-Cortés et al., 2022; Gouveia & Pereira, 2021). There is a need to conduct more varied studies and analysis types across all research phases in order to obtain comprehensive results and verify if the findings obtained are similar to previous research.

In both descriptive and predictive studies, the notable results were the decrease in Home Advantage without fans. Home advantage decreased in descriptive (Hill & Van Yperen, 2021) and predictive studies (Fernández-Cortés et al., 2022). However, there were different articles where no differences were found with or without fans, in descriptive (Matos

et al., 2021) and predictive studies (Szabó & Kerényi, 2023). These results highlight the need to analyse through other research phases to determine if the results are consistent.

The majority of studies showing a decrease in Home Advantage are produced in professional male regular leagues. These studies reproduce the current sports model which places more importance on this context over others where more people play, such as non-professional football (Wunderlich et al., 2021), or development categories (Webb, 2021). With such clear results, it is essential to increase research in amateur and youth categories, as well as women's football and playoffs, in order to obtain comprehensive global football results and draw conclusions about the home advantage in football.

Finally, the results of this systematic review have provided a global overview of home advantage in football, taking into account multiple factors such as competitive level, gender, countries, research phases, analyses, variables, type of competition and outcome. However, some limitations exist. Only studies from the Web of Science, PubMed and Scopus databases were included, thus potentially overlooking some articles from other databases. Among the keywords used, “Covid-19” could be excluded to identify all documents referring to football and home advantage, even from different eras. The inclusion of more sports would provide an even more comprehensive global vision of home advantage.

Future research should focus on continuing to explore home advantage in football utilizing all phases of investigation - descriptive, diagnostic, predictive and prescriptive analyses. Particularly, more studies are warranted across amateur levels, youth categories, women’s football, and tournament play to complement the current emphasis on professional men’s leagues. Broadening the sporting scope to incorporate additional disciplines beyond just football can also advance understanding of this complex phenomenon. Sample sizes must also be expanded through multi-country collaborations to yield more representative and generalized conclusions. In summary, despite inevitable constraints, this systematic analysis substantially furthered existing knowledge on the intricate relationship between fan support and home advantage. However, persistently enhancing rigor and diversity in analytical design and execution remains necessary to fully capture the nuances around competitors’ performance in their native environment across the sporting world.

Conclusions

The aim of this systematic review was to analyse the body of research on home advantage in football with regards to COVID-19. This was achieved by examining the profile of studies, research trends, methodological approaches, research procedures, and developments in findings. A broad understanding of the home advantage effect in football has been established, considering the natural experiment of the COVID-19 pandemic. In professional men's leagues, there is extensive knowledge showing that home advantage markedly decreased without spectators. However, there is limited research in knockout stages, youth and amateur settings, and instances of no difference in home advantage with or without fans. Only one women's study and two mixed-sex studies analysing both men's and women's categories were found. These findings highlight the need for further research across women's leagues and various competitions to provide robust and globally generalisable conclusions. This review appraised study quality, affirming the importance of maintaining high or very high quality in future investigations. It is vital teams understand the challenges posed when playing home or away, with or without spectators, to strategize situations and optimise performance accordingly. In summary, COVID-19 has enabled insightful research but with restricted breadth. Expanding methodologies and domains, upholding rigour, and disseminating applied findings should persist as priorities moving forward. This will push the home advantage knowledge base toward completeness, assisting football codes universally.

Practical applications

The practical implications of the extensive research into home advantage without spectators during COVID-19 are multifaceted for coaches and researchers alike. Understanding how the absence of a crowd influences home advantage enables coaching staff to adapt tactical preparations and team talks to account for these altered dynamics. They can

place greater emphasis on fostering players' intrinsic motivation before behind-closed-doors matches and simulate spectator-free environments in training. Similarly, match analysts should adjust predictions based on the proven effects on home advantage across various competitions. Preparing teams strategically for fan-free scenarios builds resilience, as empty stadiums due to sanctions remain likely. For some squads, the lack of an ingrained home crowd disrupted performance, so training concentration amidst silence is key. Without the boost of vocal support, home advantage decreases to near neutrality, demanding tactical flexibility whether hosting or travelling. When spectators are present, the disparity grows substantially, and distinct home and away game plans become essential again. For researchers, priorities include expanding methodologies, ensuring rigour, representing women's football and lower leagues, and clearly communicating applied recommendations. Well-designed studies on maximising behind-closed-doors performance and capitalising when opponents lack home fans will further guide practitioners. Continuing to further this field delivers well-rounded benefits – from preparing teams for fluctuating environments to realising full potential both home and away.

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