Home advantage and the influence of officiating decisions: A current review of the literature and strategies for reducing referee bias


ABSTRACT

Even after decades of research, it is largely unclear how the various factors that cause the home advantage act and interact with one another. This paper provides an updated narrative review of the home advantage in sports, with a particular interest in the impact of refereeing. We used multiple sources for data collection and limited our search to peer-reviewed journals. Detailed information was extracted and documented from each of the retrieved articles. Bibliometric data were also calculated and assessed to evaluate the evolution of research in this field. The findings of this review show that home advantage is elevated in certain type of sports and due to properties of the crowd. In particular, the social pressure of the home crowds has direct and indirect effects on both home advantage and referee bias. Studies on games played in empty stadiums provided significant evidence for a reduced referee bias, and a decline in athlete-related variables. Several potential directions for future research emerged from this review. More research on the home advantage in women’s sports, in individual sports, and at lower levels of play is warranted. These efforts will contribute to further extend our understanding of this fascinating phenomenon.

Keywords: Home advantage, Referee bias, Sport performance, Crowd effects, Officiating decisions.
INTRODUCTION

Officials play an important role in most competitive sports. Over the past two decades, research on sports officiating has greatly increased, covering a range of aspects relating to the officials' development, training, and performance. Notably, an expanding body of research has focused on the judgment and decision making of sport officials (e.g. Helsen et al., 2019; Raab et al., 2020; Samuel et al., 2021), due to the potential impact of their decisions on match outcomes.

While officials are expected to avoid making erroneous decisions, it is inevitable that mistakes occur. Errors can arise from internal factors related to the competitors and the referees themselves, as well as external situational factors (Plessner & Haar, 2006). These sources of error include individual heuristics, limited information, contextual influences, emotional factors, time pressure, and cognitive load. Research has extensively addressed issues of visibility, such as referees' on-field positioning, and visual perceptions, such as attention and distracting cues, and how these factors contribute to referee errors (e.g. Hüttermann et al., 2018; Spitz et al., 2016). In some sports, being in an optimal position or being able to move to the best position is of the utmost importance when picking up on information about the actual situation (e.g. offside judgments in soccer; Oudejans et al., 2000).

Biased referee judgments could also stem from various factors, including the reputation, nationality, physical appearance, uniform colour, and stereotyping of athletes or teams (e.g. McCarrick et al., 2020; Price & Wolfers, 2010; Souchon et al., 2009; Stone et al., 1997). Other documented bias-based decisions were impacted by the current status of the match, with favouritism being shown towards the more successful team (e.g. Erikstad & Johansen, 2020; Lago-Peñas & Gómez-López, 2016). Even prior decisions made by referees could impact their subsequent decisions in a game – as they attempt to convey consistency in their enforcing of the rules and ensure the flow of the game (Unkelbach & Memmert, 2008).

This literature review focuses on a specific type of referee bias known as home bias, which is proved to be one of the main causes of the home advantage (HA). The HA is the consistent and robust phenomenon in sports whereby the home team or athlete wins more often (> 50%) than the visiting opponent when competing in their home ground (Courneya & Carron, 1992; Pollard, 1986, 2008). An early publication from one hundred years ago (Luehring, 1923) suggested that officials were biased towards the home team when officiating a match between basketball teams from the east and west of the United States. The pioneering paper by Schwartz & Barsky (1977) further confirmed the existence of HA in organized sports, attributing it to factors such as travel, familiarity with the playing field, and the presence of home fans. Subsequent studies across various sports and a recently published book by Gómez-Ruano et al. (2021) have provided extensive evidence on the HA effect, exploring its causes and impact on performance.

This study offers a useful summary of a research area that has recently received increasing attention, in light of the COVID-19 pandemic that rendered numerous sport events to take place behind closed doors (e.g. Alonso et al., 2022; Bryson et al., 2021; Endrich & Gesche, 2020; Fischer & Haucap, 2021; Gong, 2022; Sors et al., 2023). Expanding on recent reviews (Dohmen & Sauermann, 2016: biased behaviour of sports referees; Leitner et al., 2022: the HA in soccer during ghost games in the 2020-2021 season; also see the Introduction by Reade et al., 2022), this paper further refines and extends that existing knowledge in a number of ways. First, this review provides an extensive and updated overview of the literature on the HA in general.

1 Home advantage should not be confused with home performance. In order to be of relevance to HA, home performance has to be compared with away performance.
and about referee bias in particular, spanning almost five decades of research (1977-2022) and a range of sports. As such, the study addresses the still-emerging literature stream regarding the impact of empty stadiums on refereeing decisions during the COVID pandemic, pulling all scientific published papers throughout the entire period. In addition, it incorporates concise bibliometric information to trace the evolution of research in this field and its resulting outputs. Second, this review draws the attention to the perspectives of key stakeholders involved in this phenomenon, an aspect largely overlooked in existing literature, which may affect the formation and degree of the HA. Third, drawing upon the classical conceptual framework initially introduced by Courneya and Carron (1992), and later refined by Pollard (2008), the study proposes a modified version of the HA model that accounts for both the direct and indirect effects of the crowd through its influence on sports officials (see Figure 2). Finally, the study discusses strategies for reducing referee bias to improve the quality of decisions and outlines possible paths for future research.

METHODS

Approach to secondary research
Previous reviews on the HA used a rigorous and systematic methodology, mainly aiming to minimize reviewer bias. However, recent critiques have challenged the traditional hierarchy, questioning the superiority of systematic reviews over unsystematic or narrative reviews (e.g. Collins & Fauser, 2005; Greenhalgh, 2012; Greenhalgh et al., 2018). Calls have been made to strike a balance between these two typical review types, leveraging the strengths of each approach.

In line with these contemporary perspectives, this study applied a narrative synthesis approach to consolidate previously published information. Since no strict published guidelines prescribe precisely what should or should not be included in a quality narrative overview, we have followed recommendations that are generally acceptable in many journals (e.g., Green et al., 2006).

Data sources and search strategy
We searched the databases Web of Science (WOS), SPORT Discus, and Google Scholar using the key terms home advantage and referee bias. These databases are widely recognized as comprehensive bibliographic data sources in the social sciences and sports. In order to ensure inclusiveness, we considered various denominations of the HA construct, such as home field, home court, home team, home ground, and home site advantage. These terms were combined with specific queries related to sports, including team sports, sport performance, performance analysis, and decision making. The search was conducted within the title, abstract, and keywords of the articles indexed. We collected studies available in these databases up until October 2022, which served as the cutoff date for data retrieval for this review. References lists of the obtained articles were searched by hand.

Eligibility criteria
For this review, we exclusively included original studies published in peer-reviewed journals due to their adherence to scientific rigor and credibility standards. We excluded articles with incomplete full-text availability, those not written in English, and those classified as grey literature. Dissertations were also excluded from consideration, as many of them are subsequently published in journals. Additionally, we removed studies that were not relevant to the focused purpose of the present study (e.g. Fuxjager et al., 2009: winner effects and hormone changes).

After several rounds of manual screening and duplicate checks, a total of 426 articles were deemed suitable for review. Most of these articles involved empirical investigations of the phenomenon, while a few were
purely descriptive. To ensure consistency, the same reviewer (the author of this article) re-evaluated the selected articles a few weeks later, establishing intra-rater reliability.

Clearly, not all articles could be cited due to their sheer quantity. However, to ensure citation breadth, we have cited a comprehensive range of literature (158 items), and the studies cited are representative of those available.

Data extraction
We read through each of the retrieved articles and noted down their basic information (year, authorship, journal) and the following specific details pertaining to their properties: study's objectives, research design or methods employed, type of sport (individual vs. team sport), specific sport, analysed league(s), level of competition (e.g. professional, collegiate), analysed factors (e.g. win ratio, goals, fouls, cards), statistics used, and key findings and conclusions. We used Excel spreadsheets to collect the data extracted from each paper reviewed.

RESULTS
Our dataset shows that studies have been conducted in 16 different team sports and about twice that number of individual sports, including the Olympic summer and winter sports. Several studies used data from multiple sports (e.g. Gómez et al., 2011; Pollard, 2002). Notably, soccer emerged as one of the most extensively researched sports, accounting for about 50% of the studies, likely attributed to the popularity of men's soccer globally. In contrast, only 18 studies in our dataset examined the HA in women's sports, some of which compared women's and men's leagues.

Our review develops as follows: we start with the description of some bibliometric data. Then, we review the literature on the HA in competitive sports and its causes. Finally, we present the research findings on the crowd effects and referee bias.

Bibliometric characteristics
Our final dataset comprised 426 papers authored by 207 researchers, affiliated with 206 institutions, and from 49 countries/regions. The countries of the corresponding authors with the highest number of articles were the United States (107), England (89), Spain (63), Australia (41), and Germany (34). Brazil, Canada, and Portugal follow these countries with over 20 publications each. Of these 426 papers, 16 were published during 1977-1994, 25 during 1995-2000, 93 during 2001-2010, and 205 during 2011-2020. In addition, 87 articles were published or assigned to an issue during 2021-2022, mainly on matches held without spectators following the outbreak of the COVID-19 pandemic in early 2020.

The distribution of publications by year is displayed in Figure 1, and it reflects the evolution of production in this field over the past 46 years (Prieto, 2021). The graph shows the growing interest in HA research, especially since 2005. In April 2005, the Journal of Sports Sciences published a special issue on the HA, featuring articles from leading authors in the field. Since then, several reviews and meta-analyses have contributed to the literature (e.g. Jamieson, 2010; Pollard, 2006, 2008). A considerably small number of articles were published prior to 1995, with the following distribution: two in 1994, three in 1993, four in 1992, one in 1991, one in 1990, one in 1987, one in 1986, one in 1985, one in 1983, and one in 1977.
Note: Records for the year 2022 are up until October, when this review was conducted.

Figure 1. Distribution of home advantage publications by year.

The 426 articles were published in 129 different journals. The top five most active journals in HA research include the Journal of Sports Sciences (43 published articles; IF=3.943), International Journal of Performance Analysis in Sport (40; IF=2.488), Journal of Sports Economics (25; IF=1.848), Perceptual and Motor Skills (25; IF=2.212), and Psychology of Sport and Exercise (15; IF=5.118), having published 34.7% of the total number of articles in the current analysis. Among the authors, the five most productive authors include Gómez (28 articles), Pollard (25), Nevill (15), Lago-Peñas (12), and Sampaio (11). In terms of citation impact, the five most cited papers throughout the analysed period include Courneya and Carron (1992), Nevill et al. (2002), Nevill and Holder (1999), Lago-Peñas and Martín (2007), and Pollard (1986). These papers have received an average number of annual citations of 10.16, 13.95, 9.5, 14, and 5.84, respectively. The research areas in the HA field include sport sciences, social sciences, psychology, and business economics – which indicate a multidisciplinary approach to the study of the HA phenomena.

Evidence for HA in competitive sports

The vast majority of team sports follow a league format where teams meet twice, both at home and away. Unlike team sports, most events in individual sports are organized as tournaments, at fixed locations. This setup creates difficulties in comparing the performance of an athlete at home with performance under similar conditions away. Typically, home players belong to the country hosting the tournament, while the rest are considered away players. However, complexities arise when athletes change nationalities, further complicating the assessment. As a consequence, estimates of HA in individual sports are more involved and by far less researched compared to team sports.

The HA has been examined in various outdoor and indoor team sports, including American football, soccer, baseball, basketball, handball, volleyball, futsal, hockey, rugby, cricket, and water polo (e.g. Carron et al., 2005; Nevill & Holder, 1999; for sport-specific HA studies, see Gómez-Ruano et al., 2021), as well as the Summer and Winter Olympic sports (Balmer et al., 2001, 2003). While HA has consistently been found to impact points and goals (e.g. Ribeiro et al., 2016; Sors et al., 2021), it has also been observed in other performance-related variables, including ball possession, passes, tackles, distance covered, shooting attempts, and corner kicks (e.g. Lago-Peñas & Martin, 2007; Lago-Peñas et al., 2017). A recent study that

²IF: 2021-2022 Journal Citation Reports (JCR) Impact Factor.
compared the magnitude of the HA in a range of sports, for both genders and across countries, found evidence of this effect in all sports examined, yet with a greater effect observed in men's leagues than in women's (Pollard et al., 2017). Evidence from other studies suggest that HA tends to play a much smaller role in individual sports, such as golf, tennis, and boxing (Jones, 2013) and in one-on-one situations in team sports (e.g. ice-hockey shootouts) – with the exception of subjectively rated sports (e.g. diving, gymnastics, and figure skating; Balmer et al., 2003).

A meta-analysis by Jamieson (2010) examined the impact of several moderator variables on HA in 10 different sports. The analysis revealed a significant HA effect in all sports, however the magnitude of the effect varied depending on era (with greater HA observed before 1950), season length (with sports featuring over 100 games per season exhibiting a lower HA), game type (with high-pressure championships and playoff games showing a stronger HA effect), and the sport itself (with soccer demonstrating higher HA values and baseball showing lower HA values). Similar patterns were observed in an analysis of data from nine different professional team sports in Spain, further supporting the aforementioned findings (Gómez et al, 2011). However, rugby displayed the highest HA (67%), possibly due to the aggressive and intense nature of the sport.

In general, research shows that the home team or competitor wins about 60% of their contests, regardless of the level of competition (i.e. amateur, professional, or elite). For specific sports, home winning percentages were found to be about 55% for American Major League Baseball, 55-60% for ice hockey and American football, 60-65% for basketball and handball, and 60-70% for soccer (Carron et al., 2005; Pollard & Pollard, 2005). These figured indicate substantial differences in the odds.

The literature mostly examines the HA at the club level. Yet several studies have identified a highly significant and robust HA effect at the international level, such as World Cup matches and the Olympic games, with hosting nations achieving a higher number of wins or medals (Franchini & Takito, 2016). Variations in HA across different nations have been attributed to cultural and social characteristics (Gelade, 2015). For example, a particularly high HA has been identified within the Balkans, Andean nations of South America (such as Bolivia and Ecuador), and certain African countries (notably Nigeria, with an HA of almost 87%). This was also seen in games played by soccer teams from Corsica and Sicily – two ethnically distinct and isolated locations within their respective countries (Pollard, 2006; Pollard et al., 2017). Moreover, HA was significantly higher for teams playing in cities with a large ethnically distinct population and/or in geographically distinct parts of the country – in countries such as Bulgaria, Albania, Bosnia, Serbia, Turkey, and Greece (Armatas & Pollard, 2014). Differences in HA were also found in the Brazilian soccer league for teams playing in more isolated regions of the country. Finally, HA has also been associated with the city level, with a greater effect observed for teams playing in non-capital cities.

One possible explanation suggests that HA tends to be more prominent in countries characterized by high levels of collectivism and in-group favouritism. It is also higher in countries where the officials' integrity, such as the referees' normative values, and their adherence to rules and laws, including attitudes toward violence or corruption, are relatively low (Gelade, 2015; Sánchez & García-de-Alcaraz, 2021). Such explanation is consistent with the concept of HA as a social phenomenon, influenced by both the impact of the crowd on match officials and the sense of territoriality among players inhabiting these regions. It is plausible that such territoriality could be particularly pronounced in areas experiencing armed conflicts.
Causes of HA

Even after decades of research, the exact causes of HA are still debated. The literature points to six main factors, which can act independently or interact with one another: (1) crowd effects (e.g. Salminen, 1993); (2) the adverse effects of travel, including fatigue, changes in time zones or climate (e.g. Pace & Carron, 1992); (3) territoriality, i.e. a feeling of ownership, and the territorial protective response to the invasion of rivals – as part of the social bonding when competing at home (Neave & Wolfson, 2003); (4) familiarity with the local facility, such as the stadium architecture (Pollard, 2002) or playing surfaces (van Ours, 2019); (5) rules of the sport that directly or indirectly favour the home team or athlete (relevant in a limited number of sports; e.g. the advantage of batting last in baseball; Courneya & Carron, 1990); and (6) referee bias, including disciplinary sanctions used and points decisions (e.g. Balmer et al., 2005; Dohmen & Sauermann, 2016). HA can also be the result of different tactics and playing styles, such as teams who display more effective offensive actions (rather than defensive ones), quicker attacks, and more collective tactical behaviour among the home players (Staufenbiel et al., 2015).

The HA is commonly explained through three main frameworks, each outlining factors that impact the psychological, behavioural, and physiological states of the athletes, coaches, and officials (Carron et al., 2005; Courneya & Carron, 1992; Dosseville et al., 2016; Pollard, 2008; for a review see Allen & Jones, 2014). These changes, in turn, impact performance outcomes. Courneya and Carron (1992) were the first to introduce a conceptual HA model, drawing upon theories from several fields, including biology (e.g. territoriality of local players with increased testosterone levels), psychology (e.g. the impact of arousal and anxiety on both local and visiting players), cognition (e.g. increased assertiveness among local players), and sociology (e.g. social support for local players’ behaviour). A later revision of this model removed the term officials, as they were deemed to lack a home or away status (Carron et al., 2005).

The possible sources of HA differ across competitions and teams. Specifically, travel factors are not so relevant in most individual sports due to tournaments being held in fixed locations. In addition, familiarity with local conditions may be helpful in some specific cases than in other cases, such as a tennis player’s familiarity with a particular playing surface. Rule-related advantages may also apply selectively, for example, seeding an athlete in the schedule. As for crowd noise or crowd support for athletes, although it may influence referees in many individual sports, as it happens in team sports, this is not the case in all sports. For example, golf audiences usually stand along the fairways of the holes, and typically applaud good strokes by both the home and visiting competitors. In addition, golf players are trusted to act fairly according to the rules, with the referees mainly having a consulting role in case of disagreement over a rules issue between players. One additional source of HA relevant to just individual sports is that, in some cases, home athletes may have better access to participation in tournaments than away athletes, on the basis of wild cards given to them by the tournament organization (Koning, 2011). These athletes from the home country have the opportunity to enter the competition although being not qualified to participate in the usual way.

As for team sports, since most sports use a league format in their competitions, travel effects (e.g. travel fatigue, sleep loss, or jet lag) are negligible when match site is a short distance away and within the same time zone (Courneya, & Carron, 1991). Some studies examining the effect of traveling across time zones did identify significant fluctuation in HA (e.g. Jehue et al., 1993). Overall, travel factors are not thought to be a major cause of the HA. In several sports, rule advantages and familiarity have been shown to be insignificant factors (Nevill & Holder, 1999), however not when teams have had to relocate to a new stadium (Pollard, 2002). In contrast, the evidence from studies investigating crowd factors appeared to provide the most dominant causes of HA. Two possible mechanisms were proposed to explain these observations. We will discuss the crowd effects, and the related referee bias, in more detail later.
Research on several team sports (e.g. Gómez et al., 2016; Yi et al., 2020) shows that match location (home/away) interacts with several other situational variables, such as the type of competition (e.g. regular season vs. knockout stage, playoffs, first leg vs. second leg), match status (i.e. the score-line: win/lose/draw, margins in the score), match period (e.g. first half vs. second half, set number), and quality of opposition (e.g. weak team vs. strong team). Other contextually influencing factors include match day, daytime, points earned in last matches, and the time elapsed since last match (Fischer & Haucap, 2021). Although these factors do not solely constitute the HA, they may add to its degree. Thus, investigating the complex interplay of causes of HA requires either a multivariate approach or careful control for possible confounding variables that are not among the main likely causes of the phenomenon, such as game importance or number of prior games played (Pollard, 2008).

![Model of Home Advantage and Referee Bias](image)

Note: The model represents a modified version of Courneya and Carron’s (1992) model, taking into account both the direct and indirect effects of the crowd on the home advantage and sports officials.

Dosseville et al. (2016) recently proposed a new HA framework that directly integrates the impact of sports officials, not solely through the influence of the crowd, but through four additional dimensions. These include game situation, which relates to factors that influence current decision making (e.g. the sport official’s emotional state; Laborde et al., 2013); expectations that sports officials may develop towards teams (e.g. rank or reputation), crowd reaction (e.g. excited derbies or high match stakes), and the stadium (e.g. artificial playing field or the structural design of the stadium); individual factors, including individual differences in the official’s personality, coping strategies, and emotional intelligence (Poolton et al., 2011), as well as differences in communications, social interactions, and player management (Avugos et al., 2021) – all of which could influence decision making processes and may have practical consequences; and external pressures that stem from ethical, cultural, and economic factors that should be considered when addressing the HA (e.g. a cultural closeness between the referee and the athlete or team, with regard to region or language; Torgler, 2004).

At the methodological level, the magnitude of HA in team sports has been quantified and compared in different sports, between teams or leagues, and over different time periods – at domestic or international level competitions. Studies commonly used simple outcome measures such as home winning percentage (calculated as the number of homes wins out of the number of total wins both at home and away), or in some sports the team’s score difference (e.g. Courneya & Carron, 1992; Pollard & Pollard, 2005), known as the
Pollard method. For winning percentage, specific adjustments are needed for certain team sports, where games may end without a winner (e.g. soccer), and calculations may be based on the proportion of points won at home (Pollard, 1986).

Basic methods for quantifying HA (e.g. paired comparisons; Goumas, 2014) have been criticized for not addressing differences between the competing teams in a league or the situational variables that might affect the magnitude of the advantage, such as crowd size, venue size, and travel distance. Specifically, it is more likely for better quality teams to win games both at home and away, regardless of any home bias, as was found, for example, in the analysis of data from the English soccer league (Allen & Jones, 2014). To identify the true effect of HA, some studies have used different regression models that take into consideration various predictor variables (e.g. Armatas & Pollard, 2014).

In individual sports, estimates of HA are usually obtained through the analysis of either the relative performance (the probability that athlete A wins against athlete B; boxing: Balmer et al., 2005; tennis: Koning, 2011; judo: Krummer, 2017), absolute performance (e.g. finish time; skeleton: Chun & Park, 2021; biathlon: Harb-Wu & Krummer, 2019; speed skating: Koning, 2005), or medals won at the country level (e.g. combat sports; Franchini & Takito, 2016).

**HA and referee bias: The crowd effect**

As stated earlier, crowd factors appear to provide the most dominant causes of HA. However, there has been conflicting evidence as to how important crowd support is in contributing to HA. The crowd effect has been investigated in relation to noise (e.g. calm vs. pressing), size (attendance), density (percentage of ground capacity), and composition of the crowd (i.e. the balance between home and away supporters). For example, increased crowd noise due to the stadium architecture was found to be associated with greater HA effect in baseball and American football (Romanowich, 2012; Zeller & Jurkovac, 1989). Early studies investigated the impact of both crowd size and crowd density, yet only found evidence for either the impact of size (e.g. Pollard, 1986) or crowd density (e.g. Agnew & Carron, 1994), or that no such impact existed at all. However, according to a more recent study by Goumas (2014), it is crowd density that determines the HA and referee bias.

Boyko et al. (2007) found that crowd size (but not crowd density) and referee affected goal differential in the English Premier League, by affecting both home scoring and away scoring. It was also shown that larger crowds reduced the number of yellow and red cards given to the home team, and that crowd density negatively correlated with the number of away penalties. Conflicting evidence also exists regarding the impact of crowd composition on the results. The composition of the crowd is assumed to be influenced by the distance travelled by the visiting team, whereby the closer the home and away stadiums, the more likely the supporters of the away team are to travel to see their team play (Fontenla & Izón, 2018; Garicano et al., 2005).

Laboratory studies (e.g. Balmer et al., 2007; Nevill et al. 2002), as well as archival data (e.g. Balmer et al., 2001), were used to advance this line of research. It has even become possible to study the crowd effect in real-world settings, when teams have had to play home matches in empty stadiums – prior to the COVID crisis. For example, in the 2006-2007 season, tight safety regulations forced some teams in the Italian soccer league to play without spectators. Data on fouls, yellow cards, and red cards collected from 21 games played without spectators (out of 842 games that season) revealed a large and significant HA effect, whereby home teams were favoured in games with spectators compared to games without spectators, and whereby visiting teams were punished 20%-70% more harshly when crowds were present in the stadium (Pettersson-Lidbom
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& Priks, 2010). However, player's performance (e.g. number of shots on target or number of tackles) does not seem to be affected by the presence or lack of spectators during games, for both home and away teams.

Further analysis of the same Italian league series of games showed that home crowd support is not a necessary precondition for HA, as the home team still had an advantage in games where no audience was present. Furthermore, in some same-stadium derbies (games played between 2 teams that share a stadium; e.g. AC Milan vs. Internazionale in soccer), the home team always has more crowd support (mainly thanks to season ticket holders; van de Ven, 2011), but in these games no HA existed. Sharing the same stadium by both teams from the same city cancels out the effect of travel fatigue and familiarity with the stadium. Yet when the study was replicated using twice the number of same-stadium derbies (128 observations), HA was seen, thereby suggesting that crowd noise does have an effect (Ponzo & Scoppa, 2018). Together, the current data show that crowd support contributes to the HA, but HA may still occur where no crowd is present. The phenomena might thus be much broader than assumed so far.

The global COVID-19 pandemic provided a semi-natural experiment to comprehensively test the effect of crowds on both referees and players. This has been possible due to a series of lockdowns and social distancing limitations that forced professional leagues around the world to play in empty stadiums (also known as “ghost games”). A literature review published by Leitner et al. (2022), when the pandemic was still raging, examined 20 peer-reviewed articles (out of 26) that were published up until April 2021 on soccer games without crowds. These studies vary in scope – ranging from an analysis of matches played in individual league or between leagues within the same country (e.g. Endrich & Gesche, 2020), to a number of leagues across countries (e.g. Benz & Lopez, 2021; Bryson et al., 2021). Almost all studies focused on European Leagues.

We extended Leitner et al.’s analysis to include an updated search, which yielded 61 peer-reviewed articles (5 in 2020; 28 in 2021; and 28 in 2022). The rich dataset contains studies in various team sports, including soccer (44), basketball (10), baseball (4), American football (2), rugby (3), and hockey (4), and involves teams with a range of abilities (see Table 1). The top four countries in the UEFA ranking (England, Germany, Italy, and Spain) stand out in the data, however data were also collected from North American leagues, Brazil, and Australia. The studies compared the HA, performance, and disciplinary aspects with or without crowds, and in few cases with partial attendance (games played with socially distanced fans under COVID-19 protocols; e.g. Ehrlich & Potter, 2023).

We found that most analysis has focused on the differences in wins, points, and goals scored for the home and away teams pre- and post-pandemic. However, other within-game performance indicators were also examined (e.g. Almeida & Leite, 2021; Bustamante-Sánchez et al., 2022; Link & Anzer, 2022), including team activity (e.g. running distance, number of sprints) and team performances (e.g. number of goal shots, corner kicks). About half of the studies on games played in empty stadiums (n=33) involve the analysis of referee’s decisions regarding the number of warnings issued (e.g. fouls, penalties, yellow cards), send-offs (red cards), and extra time decisions. This proportion of referee-bias research is also observed in our overall dataset. Among the possible covariates examined by about third of the studies are players' experience, referee age and experience, team quality/strength, travel distance, days of rest before the match, altitude, daily weather, and stadium running track.

While the general trend seen in the data indicates slightly reduced HA during ghost games (yet with large differences between countries and competitions), more pronounced differences were seen in referee-related variables. For example, an analysis of 841 matches played by different national soccer leagues behind closed
doors showed a slight decrease in the percentage of points and number of home victories, yet not for ball possession and corner kicks – and the absence of referee bias in terms of fouls, disciplinary cards, penalties, and recovery time given at the end of normal time (Sors et al., 2021). It seems that a certain degree of HA still exists even without spectators, due to the influence of other factors such as travel fatigue, familiarity with the pitch, and pre-match routines.

Table 1. Peer-reviewed studies on HA during the COVID-19 pandemic, by date.

<table>
<thead>
<tr>
<th>No.</th>
<th>Year</th>
<th>Month</th>
<th>Author(s)</th>
<th>Sport</th>
<th>Data source/ Leagues/ Competition</th>
<th>Analysed factors (&amp; possible covariates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2020</td>
<td>Oct</td>
<td>Sánchez &amp; Lavin</td>
<td>Soccer</td>
<td>Austria, England, Germany, Italy, Spain</td>
<td>Win ratio; Points; Goals; Budget; Stadium; Number of foreigners; Players' experience; Table position; Average attendance; Cards</td>
</tr>
<tr>
<td>2</td>
<td>2020</td>
<td>Nov</td>
<td>Tilp &amp; Thaller</td>
<td>Soccer</td>
<td>Germany</td>
<td>Win ratio; Points; Goals; Table position; Fouls; Cards; Penalty kicks</td>
</tr>
<tr>
<td>3</td>
<td>2020</td>
<td>Nov</td>
<td>Sors et al.</td>
<td>Soccer</td>
<td>England, Germany, Italy, Spain</td>
<td>Win ratio; Points (Team strength); Goals; Ball possession; Shots; Shots on target; Corner kicks; Fouls; Cards; Penalty kicks; Extra time</td>
</tr>
<tr>
<td>4</td>
<td>2020</td>
<td>Dec</td>
<td>McHill &amp; Chinoy</td>
<td>Basketball</td>
<td>NBA</td>
<td>Win ratio; Points; Shooting accuracy; Turnovers; Rebounds; Travel distance</td>
</tr>
<tr>
<td>5</td>
<td>2020</td>
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The literature is rich in studies indicating that referees tend to favour the home team – consciously or unconsciously – in their decision making, and that this favouritism is assumed to be caused by social pressure (e.g. Buraimo et al., 2010, 2012; Dohmen, 2008; Page & Page, 2010). Clear indications of biased calls made by the referee can be found with regard to fouls (e.g. Balmer et al., 2007; Nevill et al., 2002; Sapp et al., 2018), yellow cards (e.g. Balmer et al., 2007; Goumas, 2014; Unkelbach & Memmert, 2010), red cards (e.g. Dawson et al., 2007; Pettersson-Lidbom & Priks, 2010), penalties (e.g. Armatas & Pollard, 2014), and extra injury time at the end of a match (e.g. Garicano et al., 2005; Scoppa, 2008; Sutter & Kocher, 2004). Data from the German Bundesliga also shows that referee bias greatly increases when there is no running track that separates between the supporters and the pitch (Buraimo et al. 2010).
The underlying mechanism of the crowd's impact on the referees' judgment calls remains unclear. One possibility is that referees either use crowd noise (volume and intensity) as a decision heuristic (e.g. how severe a foul is), or as useful additional information for guiding their decision making. One common, normative type of conformity effects suggests that sports officials strive to satisfy the crowd in the stadium, thereby demonstrating agreement with the opinion of the more dominant crowd (Myers et al., 2014). It is also possible that referees might feel intimidated by the crowd in a way that influences their ability to conduct a fair match. For example, Anders and Rotthoff (2014) found that part of the home-field bias arises from the prospect of fan violence. However, typical crowd behaviours at sporting events, as well as the extent to which referees are willing to please the home crowd, are apparently subject to cultural differences and therefore may vary between countries (Gelade, 2015).

It also remains to be determined whether crowd noise affects referees differently, with some referees being more prone to crowd influence than others (Page & Page, 2010). Nevill et al. (2002), for example, found in their experiments that highly experienced referees were as biased towards the home team as less experienced ones – suggesting that expert referees may not be more capable of applying improved strategies for coping with stressors, such as crowd support, when making decisions. However, other studies have reached different conclusions. For example, an analysis of real-match data showed that the more experienced and skilled soccer referees were less susceptible to home team effects in terms of issuing yellow cards to the visiting team (Goumas, 2013). Moreover, referees who showed a tendency to over-involve consciousness in decision making made less decisions in favour of the home team compared to those who were categorized as high “decision ruminators” (Poolton et al., 2011). These individual differences must be taken into consideration when striving to decrease home bias and improve referee practices.

Laboratory experiments have manipulated crowd noise through the use of video-recorded tackles with and without crowd noise. Balmer et al. (2007) and Nevill et al. (1999, 2002), for example, found that refereeing in the presence of crowd noise resulted in a significant imbalance of decisions in favour of the home team, as well as fewer fouls against the home players, compared to the “no noise” condition. Unkelbach and Memmert (2010) improved on previously designed laboratory set-ups by using a larger sample of videos, with high and low volumes of crowd reactions to fouls at different stadiums. The study demonstrated the impact of crowd noise on referees' yellow card decisions, whereby more yellow cards were given to the visiting team when crowd noise was present, compared to the fewer penalties given to the home team.

While experimental designs enable the exclusion of certain confounding effects that could threaten the internal validity of the study, the referees who participated in these experiments were not making decisions in front of a live crowd who cared about their decisions, as in real live stadiums. To enhance external validity, Myers and Balmer (2012) conducted a unique controlled experiment using a live tournament setting, at venues of various sizes, with various crowd sizes and crowd densities, and qualified judges with varying experience. The study used a combat sport with varying levels of competition. In the ‘no noise’ condition, judges had noise-cancelling headphones. The results showed a significant difference in points in favour of the home fighter for the live “crowd noise” condition, across all settings.

One possible explanation for inconsistent decisions made by referees, in crowd noise compared to quiet conditions, could stem from the referees' increased stress during the game. Using a single measure of bias, Balmer et al. (2007) found that referees who exhibited greatest HA bias were more likely to have higher levels of cognitive anxiety and exercise greater mental effort when performing the task. This implies that to avoid negative consequences of anxiety, when making unpopular decisions against the home team (which are likely to produce vociferous crowd noise), referees tend to award fewer decisions against the home team.
Some studies suggested that supportive crowds may not necessarily result in superior home performances (e.g. Strauss, 2002) – and in some cases (e.g. when the stakes are extremely high) might even have a detrimental effect on performance (Wallace et al., 2005). As such, Balmer et al. (2007) attributed the imbalance that they found, in favour of home competitors, to the referees' biased decisions due to crowd noise – rather than to superior home performance.

**HA: The perspective of key stakeholders**

While the actual effects of the HA and referee bias have been widely investigated, especially in relation to the crowd, the beliefs and perceptions of fans, athletes, coaches, and officials have only attracted marginal research attention (Fothergill et al. 2014). The existing studies show that in general, fans, and even the media, believe that the crowd is the main cause of HA (Smith, 2005). For example, English soccer fans reported that they are able to affect the outcome of a match by motivating their team, distracting the opponents, and biasing the referees' decisions (Wolfson et al., 2005). Yet fans perceived officials to be more influenced by the teams' ranking than by the location of the game. Relatively stronger perceptions, about their ability to bias officials to favour the home team, were found among fans in the American Football League (Goldschmied & Hochuli, 2014). The officials themselves, on the other hand, perceived the fans' impact on their decisions to be negligible, but in their opinion other officials are slightly affected by the fans. However, both officials and fans believe that fans contribute to the HA through their ability to affect the athletes' performances (Goldschmied & Hochuli, 2014).

Similar perceptions were found in a survey of soccer players, fans, and referees in England, with the three groups attributing the HA mainly to crowd support and environmental familiarity (Anderson et al., 2012). As expected, referees in the study reported that they are robust to the crowd effect. Previously, athletes had reported travel-related factors as being one of the three most important variables that impact HA (Bray & Widmeyer, 2000). A more recent survey of a handball premier league, conducted with these target groups, including coaches, provided overall support for previous research, whereby the crowd is perceived as the most important factor that contributes to the HA phenomenon (Gershgorn et al., 2021). However, differences were found between groups. While fans over-ranked their contribution to the HA effect, officials under-ranked their contribution to this bias in comparison to the other groups. The players in the study ranked their own related factors (i.e. familiarity, travel, territory, and psychological attributes) as high in importance, yet coaches emphasized external factors, such as travel and officiating, that are beyond their control. The authors attributed these differences to self-serving bias, whereby each group strives to protect her ego, i.e., to achieve feelings of pride, or at the very least, to avoid feeling embarrassed.

Indeed, the question of how different groups perceive the HA and its causes is important and may affect the formation and rate of this phenomenon. Yet it is important to expand the existing literature on the topic of these stakeholders' view, about the causes of HA in general, and the crowd effect in particular, as the literature is lacking in this area.

**DISCUSSION**

The HA has been extensively studied, mainly in team sports, with officiating bias attracting research attention as one of its major causes. Our review shows that HA is elevated in sports that entail higher levels of physical contact (e.g. rugby, soccer, and basketball); when there are larger crowds; when competitions are held in smaller stadiums; and when the crowd is physically closer to the pitch. However, while crowd effects are present across many sports, it is difficult to determine whether the influence of the crowd on HA is primarily due to player performance (e.g. exhibiting greater dominance, confidence, or aggressive behaviours; Furley...
et al., 2018) or referee bias (e.g. favourable decisions toward the home team; Sutter & Kocher, 2004). Our review shows that the literature supports the referee bias to be the most important and dominant explanation in soccer. Yet, evidence from other sports suggests that either, or both, mechanisms are plausible. For most sports, the extent to which matches are influenced by either mechanism is difficult to assess.

As much as HA arises from referees favouring the home team, sport organizations are undoubtedly interested in reducing human error for reasons of fairness. Later in this review, we will discuss the ways sport organizations are taking to reduce referee bias. However, they might probably be less interested in reducing the HA that results from an elevated performance of players when competing at home, because games become more competitive and exciting. This makes the HA not necessarily an effect that should be minimized.

Considering player performance, several studies have demonstrated that male players experience higher testosterone levels when competing at home (e.g. McGuire et al., 1992; Neave & Wolfson, 2003), which can elicit a range of psychological and behavioural responses, such as higher motivation or aggressiveness (Carré et al., 2006). However, the impact of competing at home in front of a domestic audience, regardless of the type of sport, can vary among athletes. While it may boost confidence levels and outcome expectations for some athletes, leading to improved performance, it can also increase pressure to perform well for others, resulting in poor performance due to stress and over-cautiousness (Harb-Wu & Krum, 2019; Wallace et al., 2005), known as the “home disadvantage” effect (Baumeister & Steinhilber, 1984). The athlete’s experience might play a role as well (Sánchez & Lavín, 2020).

The possibility to study the effects of crowd noise in an ecological context emerged by the matches played behind closed doors due to the COVID-19 pandemic. The studies examined how the crowd size influenced the HA, performance, and disciplinary decisions in the match. The pandemic also prevented close contact between players and referees, which could have also affected fouls and punishments. Our review of the research on crowd attendance have shown mixed results, with the majority of studies showing a positive effect of crowd presence on HA (e.g. Arboix-Alliò, et al., 2022; Bryson et al., 2021; Correia-Oliveira & Andrade-Souza, 2021; Hill & Van Yperen, 2021; McCarrick, et al., 2021; Scoppa, 2021; Sors et al., 2021), while others found no changes in HA over the seasons analysed (e.g. Almeida & Leite, 2021; Benz & Lopez, 2021; Matos et al., 2021; Wunderlich et al., 2021).

With the outbreak of the epidemic, it has also become possible to examine the socio-cultural and environmental robustness of HA, based on data collected from leagues within and across countries. Our review shows that the decrease in HA during ghost games varied between the different studies and seems to depend on different factors, including playing levels (e.g. first vs. second divisions) and country (e.g. German Bundesliga vs. English Premier League). For example, variation in the dynamics of HA was found in German soccer teams, with the first Bundesliga showing a more drastic reduction in HA than teams in the second and third league (Fischer & Haucap, 2021). It was suggested that playing without crowds had a much greater effect on teams that normally play in front of larger crowds at their stadiums. Likewise, Ribeiro et al. (2022) identified in Brazilian elite soccer (Series A and B) a decrease in HA only for Serie A in the absence of crowd, while Serie B analyses indicated no changes in HA over the three seasons analysed. Interestingly, the reduction in the advantage of playing at home for Serie A was found not only in the 2020 season, when there was no crowd support in the stadiums, but also in the 2019 season, when fans were present in the stadiums – compared to the 2018 season. This indicates the existence of other modulating factors of the HA effect.
Variations in HA levels between countries and populations within regions can be explained by social and cultural differences, as suggested by Pollard (2006) and Pollard et al. (2017). Yet environmental conditions may also play a significant role in HA. For example, van Damme and Baert (2019) found that soccer teams with a high-altitude home stadium (i.e. low oxygen levels) were more likely to win against teams from sea-level stadiums. Given the abundance of literature on HA, future research should focus on additional potential factors that contribute to the HA, as with van Damme and Baert (2019), rather than continuing to simply validate its existence. Part of the “unresolved puzzle” is the interaction of causes, which poses a challenge to investigate, isolate, and quantify how each likely cause operates with the other to establish the HA, as outlined by Pollard (2008).

Theories related to the impact of social pressure and conformity offer possible explanations for the decreased HA in ghost games. For example, Sors et al. (2021) argued that crowd noise/presence has a direct effect on referee bias, due to its related social pressure, as well as a direct and indirect effect on HA – as illustrated in Figure 2. While the direct effect stems from the crowd's support for the home team and/or the booing of the visiting team (Greer, 1983), the indirect effect is due to the occurrence of referee bias. The stadium capacity, the distance to the field, and the atmosphere created by a roaring crowd contribute to both phenomena. Thus, strategies for reducing referee bias – by coping more effectively with social pressure conveyed by the crowd – are of the utmost importance. It is worth noting, however, that although crowd is a major source of HA and referee bias (Endrich & Gesche, 2020), the evidence indicates that crowds do not have to exist in order for HA to occur – as additional factors can contribute to such bias during matches.

From a sport psychologist perspective, the COVID-19 pandemic provided a unique global opportunity for researching the emotional behaviour of players and referees (Webb, 2021). However, existing studies on this topic are scarce, with one example being the work of Leitner and Richlan (2021a). Using a video-based analysis system of nonverbal behaviour during soccer matches, the authors found that there were about 20% less emotional situations in matches without spectators, and that referees were significantly less actively involved in these emotional situations. In addition, limited attention has also been paid to exploring how the absence of fans affects the subjective experiences of players and officials, and their consequent behaviour.

Beyond the specific circumstances created by the pandemic, psychological factors are believed to play a major role in determining HA in team sports (Neave & Wolfson, 2004). One such factor is the mental attitude of players, coaches, and referees about the likelihood of winning the game when playing at home. According to Pollard (2008), such state of mind acts as a self-fulfilling phenomenon that impacts behaviour and actions, and consequently the outcome of the game and the role played by HA. Moreover, there is consistent evidence suggesting that athletes and coaches psychological states are superior when playing at home, in terms of their personal confidence and confidence in their team, as well as their emotions and mood states (Carron & Paradis, 2014). The findings support the proposal by Courneya and Carron (1992) that psychological states are influenced by game location (Terry et al., 1998). In contrast, athletes feel intimidated when competing away from home in front of unfavourable crowd. These findings lead to the conclusion that players should be better prepared to cope with the perceived disadvantage of playing away from home and the related emotions that accompanied it.

As outlined throughout this review, referee biased-decisions are thought to contribute to HA. For example, referees in Boyko et al.’s (2007) study exhibited significantly different HA in penalties and yellow cards, which the authors considered of being two potentially game-changing factors. Likewise, Nevill and Holder (1999) argued that it only takes 2 or 3 crucial decisions to go against the away team or in favour of the home team to give the side playing at home the “edge” during the game. However, it would be interesting to assess, for
example, the exact impact of additional 1 or 2 yellow cards for the away team on the probability of victory for the home team. One such attempt was made by Anders and Rotthoff (2010). Using two regression models, the authors found in their data from the Bundesliga that yellow and red cards negatively impact the probability of winning games. As expected, when the home team receives a yellow card, it decreases their probability of winning by 13 to 15 percent (depending on the model used). One player receiving two yellow cards decreases the probability of the home team winning by 22 to 27 percent, and receiving a direct red card decreases the probability of victory by 44 to 48 percent. These results were significant at the one percent level.

More important to our discussion is the away team cards. It was found that when the away team receives a yellow card, it increases the probability that the home team wins by 5 to 6 percent, although these estimates are insignificantly different from zero. A yellow to red card for the away team increases the home team's chances of winning by 16 percent in one of the regression models ($p = 0.05$), and receiving a direct red card increases these chances by 20 to 25 percent ($p = 0.01$). A robustness test showed that although the model had a relatively low predictive power, the estimates gave an accurate measure of the effects of yellow and red cards in soccer matches. Clearly, it is a direction in which further research is needed.

Several other potential directions for future research emerged from our review. We found that most previous studies were focused on analysing the interaction between one specific variable and match location (e.g. type of competition, score-line, quality of opposition). Therefore, a topic that needs further exploration relates to the interacting effects of several situational variables with HA. This might be achieved thorough the development of new methods and models for the analysis of HA from a multivariate perspective.

Our review also shows that the analysis of individual and dual sports, as well as female competitors is sparse. Specific to women's sports, the HA effect has been demonstrated and studied mostly in basketball, volleyball, and soccer, with a consistently smaller effect for women than it is for men (Pollard & Gómez, 2014). These differences in the HA effect between women and men can be explained by physiological factors (e.g. hormonal effect; Bateup et al., 2002) or lesser crowd support in female competitions. However, the analysis of the exact causes and the way in which the different factors operate still remains a challenge for the future.

Not only is the research on women's sports limited, but so is the research on amateur and non- and semi-professional leagues, including collegiate and youth sports. At these lower levels of play, players' experience/expertise and playing conditions (e.g. training facilities or hours of practice) are generally poorer than those at the higher levels. The results from the different studies are inconsistent. Although the same factors of HA likely affect all different competitive levels (i.e. familiarity, travel effects, crowd support, referee bias, etc.), these factors may affect players and teams' performances in different ways and intensities. Hence, it is important to study the magnitude of HA at different competitive levels, and the possible causes of HA at different levels of play.

Finally, we found that little work has been done to examine individual differences in referees' respond to factors such as crowd noise (e.g. the referee emotional state, coping strategies, and social interaction abilities) when examining the HA, as outlined, for example, by Dosseville et al. (2016) and Boyko et al. (2007). If the subjective decisions of referees vary between individuals (after controlling for other factors, such as team abilities), we would expect the home bias to systematically differ between referees. Taking such individual differences into consideration would allow better predicting and coping with the home bias.
While this review is informative and involves an extensive search of the literature, there are limitations that have to be considered. First of all, relevant evidence may have been omitted from this review if they were not identified through the applied search methods. Moreover, as with almost any review, there might be an element of selection bias. However, these concerns may be alleviated somewhat because the sample of studies included in this narrative review is quite large and may adequately represent the overall picture. A possible bias of single studies may also occur, due to the measures used by researchers for capturing the HA and referee bias, while overlooking other possible independent variables that should be controlled (e.g. team strength, travel distance, and venue size). In some cases, this could distort valid comparisons between teams, leagues, or sports. Finally, attention should also be paid to differences that may be seen in the interpreting of results in the different studies, as not all researchers and studies apply the same scaling methods (see the recommendations by Jones, 2018).

**Reducing the HA effect and referee bias**

Over time, positive changes have been seen in HA in a range of professional leagues (e.g. English and Scottish soccer; Nevill et al., 2013), corresponding with significant improvements in referee training. However, the smallest decrease has been observed in higher divisions with larger crowds, such as ice hockey, basketball, and soccer (Webb et al., 2018). An interesting attempt to compensate for the home team advantage has been made by several leagues, such as the UK Motorcycle Speedway League, by awarding an extra point for an away win (three points instead of two). This change to the scoring system led to an approximate 30% reduction in the HA effect for this particular sport. Unfortunately, no other research evidence was found in the articles reviewed in this paper.

In the interest of fairness, sports organizations have taken several steps to reduce judgment errors made by the officials. For example, the Union of European Football Associations (UEFA) experimented with two additional assistant referees during Champions League and Europa League matches in the 2008/2009-2011/2012 seasons – resulting in decreased home or “big” team favouritism, and an increase in yellow cards issued for both home and away teams (Albanese et al., 2020). In addition, referees in a number of sports are now allowed to correct erroneous decisions through a third-party assistant, often someone who has access to technological monitoring.

Today, monitoring devices are increasingly used in sports for reducing human error, such as the Video Assistant Referee (VAR) in soccer, video replay in basketball and field hockey, computer guided cameras in tennis and cricket (the Hawk-Eye), and the Television Match Official (TMO) in rugby. While VAR has changed the dynamics of soccer games in several leagues (e.g. Lago-Peñas et al., 2019), yet technology have not necessarily improved balance in decision making when considering the HA bias (Dawson et al., 2020; Han et al., 2020). For certain sporting events, such as the semi-finals and finals in the English men's soccer league, improved control of HA and referee bias is obtained by holding games at neutral sites (e.g. the Wembley Stadium). Yet evidence is lacking regarding reduced favouritism and bias at different levels of competition (e.g. playoffs).

The training of professional referees has also greatly improved over time, extending beyond traditional physical training programs (Weston, 2015). The introduction of new technologies, such as the Prozone and Opta systems for performance analysis, is a huge step forward for referee training. Nowadays, structured training sessions in decision making are also more common (Webb et al., 2018), with referees analysing each of their decisions through video recordings of their actual matches. The shared mental model video-based training approach, for example, was found to have a positive impact on decisions made by Rugby Union referees (Mascarenhas et al., 2005).
While referees need physical fitness training for coping with fatigue and keeping up with the game (Castagna et al., 2007), they also require adequate psychological preparation (Lane et al., 2006). In some sports clubs, referees work closely with designated referee coaches and mentors, to provide them with additional support and training. Studies show that training can help referees become increasingly aware of external crowd pressure, while learning how to apply effective strategies for filtering out such pressure. For example, referees must learn to cope with stress that is associated with their making unpopular decisions, while practicing how to demonstrate greater confidence in their decision making (Di Corrado et al., 2011).

Higher levels of professionalism following improved referee training are clearly noticeable. For example, evidence of more balanced decisions made by referees was reported by Rickman and Witt (2008), with no indication of favouritism effects in close matches in relation to extra time due to injury. Similarly, no evidence of the HA effect due to crowd size and referee bias was found over several seasons of the English soccer Premiership (Johnston, 2008). As such, governing bodies should further improve the training of their officials as a means for reducing HA and referee bias. In addition, due to individual differences (Poolton et al., 2011), there is a need to identify those referees who may be prone to negative effects of external stimuli, such as crowd noise, and pro-actively provide them with training alternatives that can improve their performance (e.g. training in environments with live audience). Greater professionalization also includes the mental preparation of athletes as part of their training process to increase their mental resilience, thereby contributing to a further decline of HA. From a scientific perspective, more research is needed regarding the mechanisms through which crowd support contributes to physiological reactivity, attention, stress responses, and decision making by athletes and officials.

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