# Home Advantage during the Covid-19 pandemic: analyses of European soccer leagues.

Dane McCarrick*[1], Merim Bilalic[2], Nick Neave[2] and Sandy Wolfson[2]

[1*] School of Psychology, University of Leeds, Leeds, LS2 9JT, UK

[2] Department of Psychology, Northumbria University, Newcastle upon Tyne, UK, NE1 8ST.

* Corresponding author at: School of Psychology, University of Leeds, Leeds, LS2 9JT, UK; Email: D.J.McCarrick@leeds.ac.uk

Running Head: Home Advantage during Covid-19

This research received no specific funding from any of the affiliated authors.

Submitted: 10th August 2020

PRE-PRINT

## Introduction

The home advantage (HA) in sport has been widely recognised for many years. When setting their odds, bookmakers have traditionally placed an emphasis on where the competition will be taking place (Bookies.com, 2020), and media reports often comment on the difficulties of playing at venues other than one's own (Pollard, 2008). The classic paper by Schwartz and Barsky (1977) is frequently cited as the first empirical investigation of the extent of and reasons for the HA. They suggested that supportive crowds are social representatives of their players and exert an invigorating, motivational influence, encouraging the home side to perform well. Their extensive data collections of home and away results in American major league baseball, professional and college football, ice hockey and college basketball revealed a pronounced home advantage, though the extent for each sport varied. The authors ruled out venue familiarity as a major causal factor, though some later researchers demonstrated moderately reduced HA effects when a team changed its stadium (see Pollard 2012). Instead, social factors were deemed to be critical, due to the fans' proximity to the playing area and the more constant, loud, inspiring sounds from the crowd, where enthusiastic cheers and chants can inspire entertaining, attacking play and encourage home players to try harder. The paper stimulated a plethora of research examining the influence of the crowd on the HA.

For example, Zeller and Jurkovac (1989) demonstrated inflated HA in domed stadia and suggested this was due to the amplification of crowd noise and perceived proximity of the audience. In addition, Romanowich (2012) found the highest levels of HA in stadia with permanent or retractable domed roofs compared with open air stadia, although HA was found in all three types. The reverberation of sounds could affect the referees as much as the players, and it is thus important to note that some statistics seemingly showing influences of the crowd on the

PRE-PRINT

players may actually be due to the effects of the crowd on the referee. Indeed, recent work by McCarrick, Brewer, Lyons, Pollet & Neave (2020) has shown the dyadic interplay between referees and players may rely on external factors outside the remit of their control.

Dosseville, Edoh and Molinaro (2016) proposed a HA framework that prominently featured the referee. Their conceptualisation notes many studies indicating that referees tend to make more decisions in favour of the home team (see, for example, Nevill and Holder, 1999; Pollard, 1986; Boyko, Boyko and Boyko, 2007; Sutter and Kochera, 2004) and includes the assertion that officials are highly susceptible to social influence. This is because that their role is so challenging and difficult to implement successfully that they unknowingly rely on cues from the crowd when making their decisions. It is also possible that the referee's fear of the crowd's wrath will be influential in referee decision making. For example, they add more extra time at the end of the first half, and even more so in the second half, when the home team are behind by a goal; and more decisions against the away team are later found to be incorrect (Garicano, Palacios-Huerta, & Prendergast, 2005; Dohmen and Sauermann, 20016). This 'bias' is found in German, English and Italian soccer. The authors also note that while more experienced referees might be less susceptible to some of these influences, by time they reach expert levels, they have developed schemas that lead them to operate under certain expectations; these might include beliefs that home players will be more assertive and territorial (Neave & Wolfson, 2003) and thus hold an advantage.

In one of the few true experiments examining the referee's role in the HA, Nevill, Balmer and Williams (2002) asked qualified officials to indicate the legality of a series of 47 videoed incidents. Those participants randomly assigned to hear the accompanying crowd noise gave an increased number of decisions in favour of the home team compared to those who watched in

PRE-PRINT

65 silence. Indeed, home advantage decisions did not occur at all in the silent condition. The more
66 experienced referees felt less uncertain about their judgments. Since the referees made their
67 decisions without an actual 'real' crowd, this suggests that the effect may not be due to
68 intimidation or crowd pleasing, but instead that the audience provides information to the referees
69 that guides their judgments.

70 However, the evidence presented thus far is mostly based on methodologies that fail to
71 account for unmeasured confounds, such as attacking dominance of teams and positions within
72 relative merit tables, and this is problematic as it may influence the strength of the relationship
73 between crowd effects and HA. These methods also do not rule out the possibility that changes
74 in HA are attributable to changes in a team's performance, whereby the success of a team may
75 spur on supporters, rather than vice versa as hypothesised in HA theories. Equally, a third
76 variable, or 'spuriousness', may underpin the causal relationship between the presence of a
77 crowd and HA effects (see, Mauro, 1990), such as referee decision making or within-game
78 player behaviour. Given that referees punish players based on their on-field actions, measuring
79 fouls and yellow/red cards administered to players in crowd/no-crowd conditions reduces this
80 possibility.

81 Following its suspension due to the Covid-19 pandemic, the 2019-2020 European soccer
82 season resumed with approximately a quarter of games to be played 'behind closed doors.' This
83 provided a unique opportunity to observe a naturalistic manipulation wherein differences could
84 be analysed between games with and without the presence of an audience on player and referee
85 performance. This random (and unexpected) situation has manufactured a situation that allows
86 the analysis to take into account the influence of extraneous variables and the confounds outlined
87 above.

PRE-PRINT

Accordingly, we assessed all games from every European league that continued their respective seasons following Covid-19 suspensions on measures relating to HA both pre and post the suspension, in addition to its effects on referee decisions. In line with the aforementioned literature, we predict that; a) HA will be significantly reduced within the final quarter of games played without a crowd (i.e., home teams will win significantly fewer games, as measured via points accrued and goals scored), and b) referee decisions (in the form of fouls, yellow cards & red cards) will favour the home team during the games played with a crowd, such that the effects for each will be significantly reduced within games played without a crowd.

## Method

The present study was pre-registered via the Open Science Framework which can be viewed via the following DOI: DOI 10.17605/OSF.IO/4HU8R

### Data

All European leagues that finished the 2019/20 season without an audience were included in the analysis. Altogether, we analyzed 9,528 individual games from 15 different leagues spanning 11 different countries (England Premier League & Championship, Germany Bundesliga 1 &2, Spanish La Liga 1 & 2, Italian Serie A & B, Portugese Primeira Liga, Greek Super League, Turkish Super Lig, Austrian Bundesliga, Danish Superligaen, Russian Premier League and Swiss Super League). In total, 6,976 games (72.39%) were played with the presence of the audience (pre-COVID) and 2,552 (27.61%) in the post-COVID period without an audience. Data for each individual league can be seen in Table 1.

PRE-PRINT

The data on the individual games were obtained from the football data website (removed for review). The data includes the scores, goals for each team, shots, shots on target, corners, fouls, as well as yellow and red cards for each individual game. These data were supplemented with the 'XXX' database, which also included team ratings (Soccer Power Index, SPI) and the importance of the match for both teams, based on their respective league ranking. More information on the XXX database can be found at (removed for review) .

The data on team performance (points, goals, corners, shots, and shots on target) were available for all leagues in the databases we used, but the data for referee performance (fouls, yellow and red cards) were available for 11 out of 15 leagues (exceptions being Austria, Denmark, Turkey, Russia & Switzerland). We excluded any play-off games across leagues as these are subject to different playing conditions (i.e, over two legs; away goals; extra time) to maximize the internal validity of the results. Data extraction across both databases were first extracted before being independently checked in view of accuracy (Cohen's Kappa = 1).

**Table 1. Overview of the European leagues**

| | Pre-COVID (with crowd) | | | Post-COVID (no crowd) | | |
|---|---|---|---|---|---|---|
| League | Rounds | Games | Percent | Rounds | Games | Percent |
| England I | 28 | 576 | 75.79% | 10 | 184 | 24.21% |
| England II | 38 | 888 | 80.43% | 8 | 216 | 19.57% |
| Germany I | 24 | 446 | 72.88% | 10 | 166 | 27.12% |

PRE-PRINT

| | | | | | | |
|---|---|---|---|---|---|---|
| Germany II | 24 | 446 | 72.88% | 10 | 166 | 27.12% |
| Spain I | 28 | 540 | 71.05% | 10 | 220 | 28.95% |
| Spain II | 32 | 680 | 73.75% | 10 | 242 | 26.25% |
| Italy I | 26 | 512 | 67.37% | 12 | 248 | 32.63% |
| Italy II | 24 | 558 | 73.42% | 14 | 202 | 26.58% |
| Portugal | 24 | 432 | 70.59% | 10 | 180 | 29.41% |
| Greece | 26 | 364 | 75.83% | 10 | 116 | 24.17% |
| Turkey | 28 | 468 | 76.47% | 6 | 144 | 23.53% |
| Austria | 26 | 264 | 67.69% | 10 | 126 | 32.31% |
| Denmark | 24 | 334 | 70.01% | 12 | 150 | 30.09% |
| Russia | 22 | 352 | 73.33% | 8 | 128 | 26.67% |
| Switzerland | 12 | 116 | 64.44% | 6 | 64 | 35.56% |
| Total | 25.73 | 6976 | 72.39% | 9.73 | 2252 | 27.61% |

PRE-PRINT

*I refers to the 'top' league in that country, while II refers to the second league, e.g. in the UK I refers to the Premier League, and II refers to the Championship; 'Rounds' refers to N games played for each time in that respective league.*

## Analysis

We focused on two aspects of the data, one related to the outcome of the game, the other associated with the performance of the referees. The outcome of the game was associated with the points won, goals scored, as well as other indicators of dominance such as number of corners, shots, and shots on target. Referees' decisions were measured by the number of fouls given, as well as the number of official warnings (yellow and red cards).

**HA reflected in team performance (points, goals, and dominance).** The common way of quantifying the HA is to express the number of points (or goals) won at home as a percentage of the total number of points (goals) won, home and away (Pollard, 1986). This method has been previously validated (see Goumas, 2013) and works well with a full season of play where teams face each other at home and away. In the current context, where we wanted to compare the first three quarters of the season played with the crowd present with the last quarter played without a crowd, it is of crucial importance to account for the schedule difficulty. Some teams may have a much easier home schedule in the post-Covid period (playing without an audience) than in pre-Covid period (playing with an audience), which would bias the home advantage comparison between the two periods.

The possibility of adding confounding factors in our analysis is one of the reasons why we decided to use multilevel modelling (also known as mixed-effects, Wood, 2017) where the individual matches, played home and away, are nested within individual teams. Multilevel

PRE-PRINT

modelling is essentially a regression approach which not only uses individual teams as basic units with home and away games nested within them, but also allows for inclusion of additional factors, including possible confounds. In our particular case, we are interested in the factors Venue (home and away) and Covid period (pre and post), and most importantly, their interaction. If the HA is influenced by the audience presence, we would expect that teams win fewer points and score fewer goals at home compared to away games in the post-Covid period than in the pre-Covid period. In other words, our main interest is the interaction between Venue and Covid factors.

To control for possible differences in the pre- and post-Covid schedule and importance of the games, we used the strength of individual teams and the game importance for individual teams. FiveThirtyEight's team strength rating (SPI) includes teams' previous results, market values of players, and it is updated after each game based not only on the actual results and goals scored, but also on other indicators to account for randomness of a low scoring game such as soccer (e.g., adjusted goals, shot-based expected goals and non-shot expected goals). FiveThirtyEight's importance measures the impact of the match results on the team's outlook on the season. The importance is dependent on the team, as different teams play for the championship, qualification for international UEFA competitions, or not getting relegated. Similarly, the importance measure takes the situation in the individual league into account as the probabilities of achieving a team's goal are calculated depending on the outcome of the game. The difference between the probabilities is then expressed as a standardized variable. Both rating and importance measures range from 0 to 100 and are comparable not only within a single league, but also across the leagues. In our analysis we calculated the difference between both teams in rating and importance, standardized the difference (where mean is zero and standard

PRE-PRINT

deviation one, making the differences more interpretable), and included them as covariates in the multilevel models. We were particularly interested in their interactions with Venue and Covid period factors, as significant results would then indicate vastly differing schedules for pre- and post-Covid periods.

Although individual teams are the basic units in our analysis, they are also nested within country and division. We therefore included country and division as additional covariates of interest in our model. We do not expect, however, to find meaningful patterns between leagues and/or countries as the post-Covid period includes a small amount of data within a single league. That is also the reason why we use individual teams across the whole of Europe as single units for our multilevel level analysis and do not analyze the individual teams within a single country. Given the sparse nature of the post-Covid data, one can expect significant variation within a single country. However, the inclusion of all 15 leagues both produces considerably more data where the real underlying mechanisms are easier to detect and, given the homogeneous nature and operating conditions of the sample (i.e., elite athletes playing under the same football laws), it is doubtful that even if data were available few differences would either arise or be statistically detectible between leagues due to power issues (see, Cohen, 1992; Mooijaart, 2003).

The final analysis used all individual games, where each game was coded twice, once from the perspective of the home team, and once from the perspective of the away team. The variables included in the multilevel models were Venue (home and away), Covid period (pre and post), rating difference (standardized difference of SPI ratings), importance difference (standardized difference of importance ratings), country (one of the 11 countries), and division (1st or 2nd division). The same model was run separately for points and goals. Since the

PRE-PRINT

dependent variables are discrete occurrences which are rarely normally distributed, we used Poisson distribution for the modelling (for similar approaches, see Goumas, 2013).

The same multilevel models were run for the indicators of team dominance: corners, shots, and shots on target. These dependent variables were, however, normally distributed, and we consequently utilized the Gaussian distribution in our models. Given that all three predictors of dominance are highly related (correlations 0.50 - 0.90), we created a single 'Dominance' factor by conducting factor analysis on the three predictors. The latent factor of Dominance is thus a standardized single measure of attacking tendencies of the team, which can be used as an indicator for how much the team dominates the game. The factor analysis was conducted separately for each league, as the dominance indicators may vary greatly from league to league. Note that the Dominance latent factor based on the all available data was highly correlated with the Dominance latent factor that accounted for individual league - 0.98. Consequently, the pattern of results in our main analyses was independent of the way the Dominance factor was calculated.

**HA reflected in referees' performance (fouls, yellow and red cards).** We applied the same multilevel Poisson model to the dependent variables associated with the referee bias – number of fouls, number of yellow cards, and number of red cards. In addition to the already mentioned covariates (e.g., team strength, match importance, country, and division), we also accounted for attacking tendencies by adding the latent factor of Dominance (e.g. corners, shots, and shots on target). It is known that the more dominant a team is, the more it is going to get fouled and earn yellow and red cards for the opposing team (Goumas, 2014a).

## Results

### Team Performance (points and goals)

PRE-PRINT

Teams gained more points during home than away games, but the difference was less marked in the period without an audience (Figure 1A). Pre-Covid, teams won on average 0.39 points per game more at home than away, but this HA was almost halved in the period without the audience - the teams won only .22 points more at home than away.

A formal multilevel regression model confirmed that the Venue x Covid-Period was highly significant (see Table 2). The effect of an audience on HA was not driven by the difference in the schedule, or differing importance between home and away teams in the pre and post-Covid period. The stronger teams and the teams with more to play for won more points, but this was constant for home and away matches, as well as for the periods with and without an audience (see Table 2).

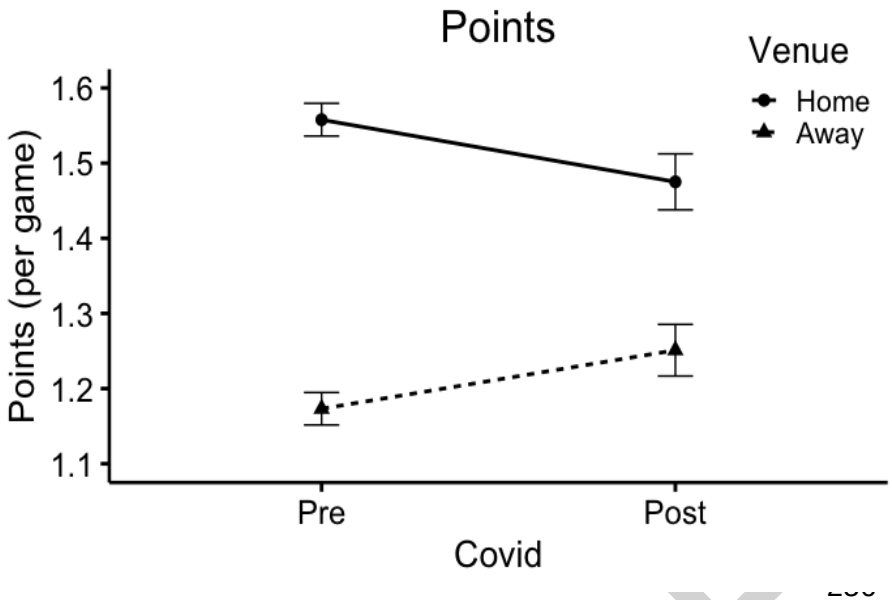
We found the same pattern of results when we looked at the goals instead of points (see Figure 1B). Home teams were scoring more goals than away teams in general, but this advantage was greatly reduced when the audience was absent. The home teams scored on average 0.29 goals more per game than away teams in normal circumstances when the audience was present. The same home teams scored only 0.15 goals more than the visitors when the audience was absent.

As with the goals, this interaction was highly significant in our formal regression model (Venue x Covid interaction, see Table 2). Both ratings and importance were positive predictors of the goals scored, but there were no significant interactions either with venue or Covid period (see Table 2). In other words, the effect of audience on HA was not influenced by differing schedules in the pre- and post-Covid periods.

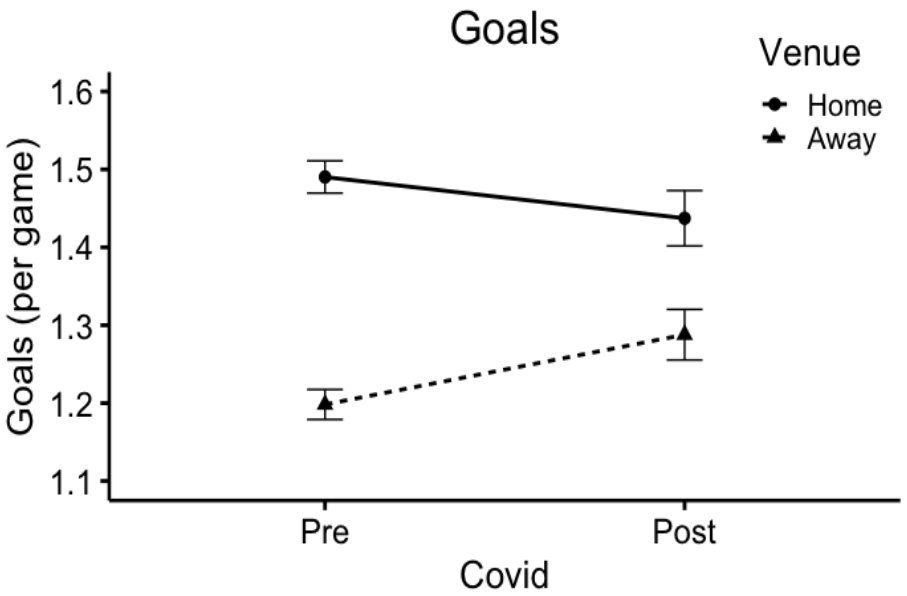
PRE-PRINT

**Figure 1. Home advantage. Points and goals across European soccer leagues in 2019/20 season with and without an audience.**

**A**




**B**




PREPRINT

**Table 2. Regression models for points gained, goals and dominance across European soccer leagues in 2019/20 season with and without an audience.**

| Predictors | Points | | | Goals | | | Dominance | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Incidence Rate Ratios* | *std. Error* | *p* | *Incidence Rate Ratios* | *std. Error* | *p* | *Estimates* | *std. Error* | *p* |
| (Intercept) | 1.51 | 0.01 | **<.001** | 1.43 | 0.02 | **<.001** | 0.28 | 0.02 | **<.001** |
| Venue [Away] | 0.74 | 0.02 | **<.001** | 0.81 | 0.02 | **<.001** | -0.52 | 0.02 | **<.001** |
| Covid period [Post] | 0.95 | 0.03 | **.036** | 0.97 | 0.03 | .234 | -0.27 | 0.03 | **<.001** |
| Rating difference | 1.30 | 0.01 | **<.001** | 1.24 | 0.01 | **<.001** | 0.41 | 0.02 | **<.001** |
| Importance difference | 1.05 | 0.01 | **<.001** | 1.03 | 0.01 | **.001** | 0.04 | 0.01 | **.001** |
| Venue [Away] * Covid period [Post] | 1.12 | 0.04 | **.004** | 1.10 | 0.04 | **.017** | 0.33 | 0.04 | **<.001** |
| Venue [Away] * Rating difference | 1.07 | 0.02 | **<.001** | | | | -0.06 | 0.02 | **.004** |
| Rating difference* Importance difference | 0.97 | 0.01 | **<.001** | | | | 0.02 | 0.01 | **.018** |
| **Random Effects** | | | | | | | | | |
| $\sigma^2$ | 0.56 | | | 0.57 | | | 0.77 | | |
| $\tau_{00}$ | 0.00 $_{Team}$ | | | 0.01 $_{Team}$ | | | 0.03 $_{Team}$ | | |
| ICC | 0.00 | | | 0.02 | | | 0.04 | | |
| N | 264 $_{Team}$ | | | 264 $_{Team}$ | | | 213 $_{Team}$ | | |
| Observations | 9528 | | | 9528 | | | 7995 | | |
| Marginal $R^2$ / Conditional $R^2$ | 0.182 / 0.183 | | | 0.096 / 0.118 | | | 0.198 / 0.227 | | |

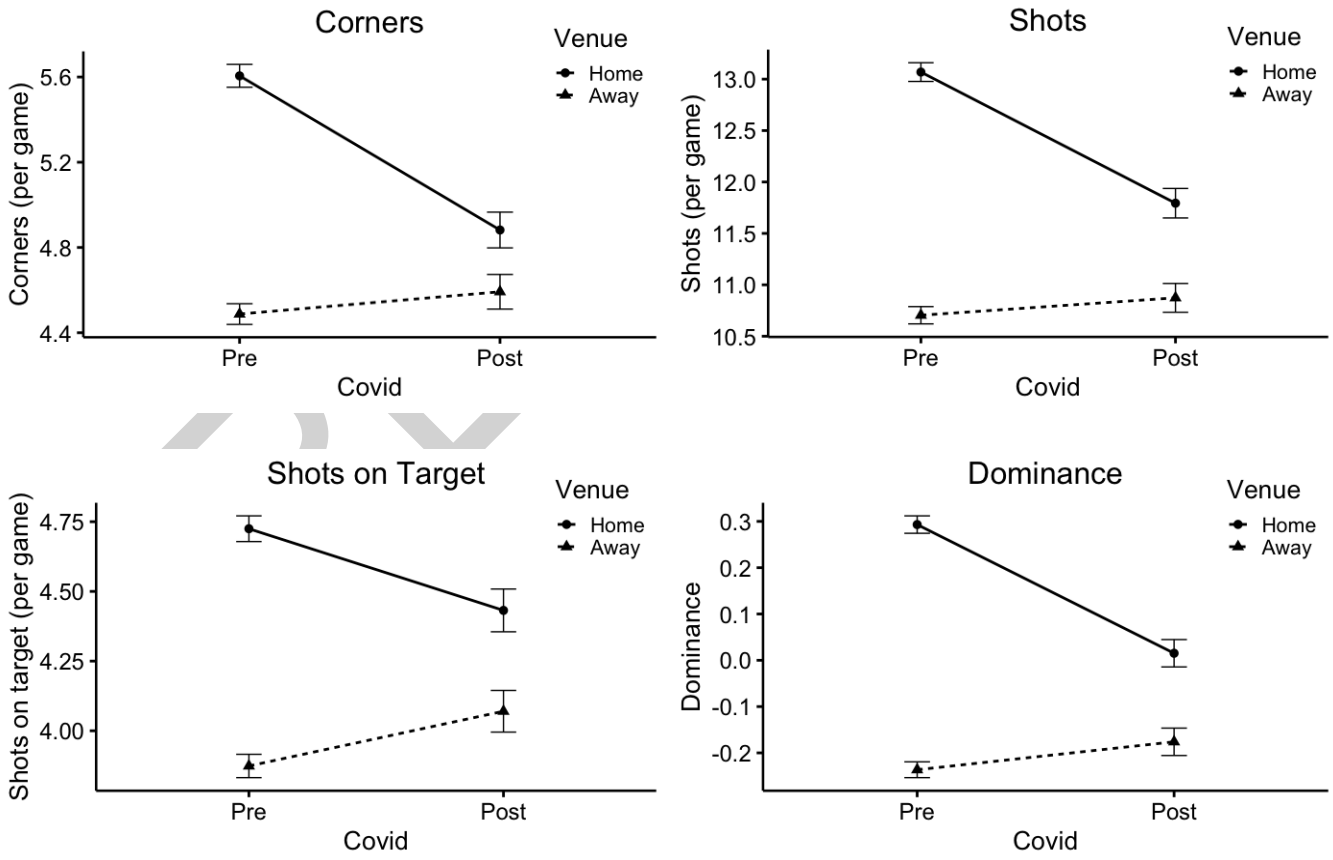
We also checked more detailed indicators of game dominance such as number of corners, shots, shots on target, as well as standardized latent factor of these three indicators, called Dominance. Figure 2 confirms the trend of the wavering dominance of the home teams playing without the support of their fans. When playing without an audience, the home teams won on average per game 0.7 fewer corners, had 1.3 fewer shot attempts, and 0.4 fewer of their shots were on target. Overall, home team dominance (as measured by a standardized latent factor of corners, shots, and shots on target) was 0.24 standard deviation smaller. The away teams, in contrast, were close to their performance in the pre-Covid period played in front of fans - only 0.10 more corners, 0.17 more shots, and 0.20 more shots on target. The overall dominance of away teams improved for only 0.05 standard deviation. The extent of the decrease in home team

PRE-PRINT

performance for some parameters is more than tenfold to the extent of the away team improvement.

The multilevel regression on these indicators confirmed the negative effect of the absence of audience on the home team performance (Venue x Covid interactions - see Table 2 for Dominance). More importantly, the difference in rating and importance, all important and significant factors on their own, were not related to audience - venue interaction (see Table 3). We can therefore be fairly certain that the diminishing performance of the home teams without their fans is not a consequence of the unbalanced schedules in the pre and post-Covid periods.

**Figure 2. Home advantage indicators. Corners, shots, and shots on target across European soccer leagues in 2019/20 with and without an audience.**




*Note.* Dominance is a (standardized) latent factor of the three HA indicators: corners, shots, and shots on target.

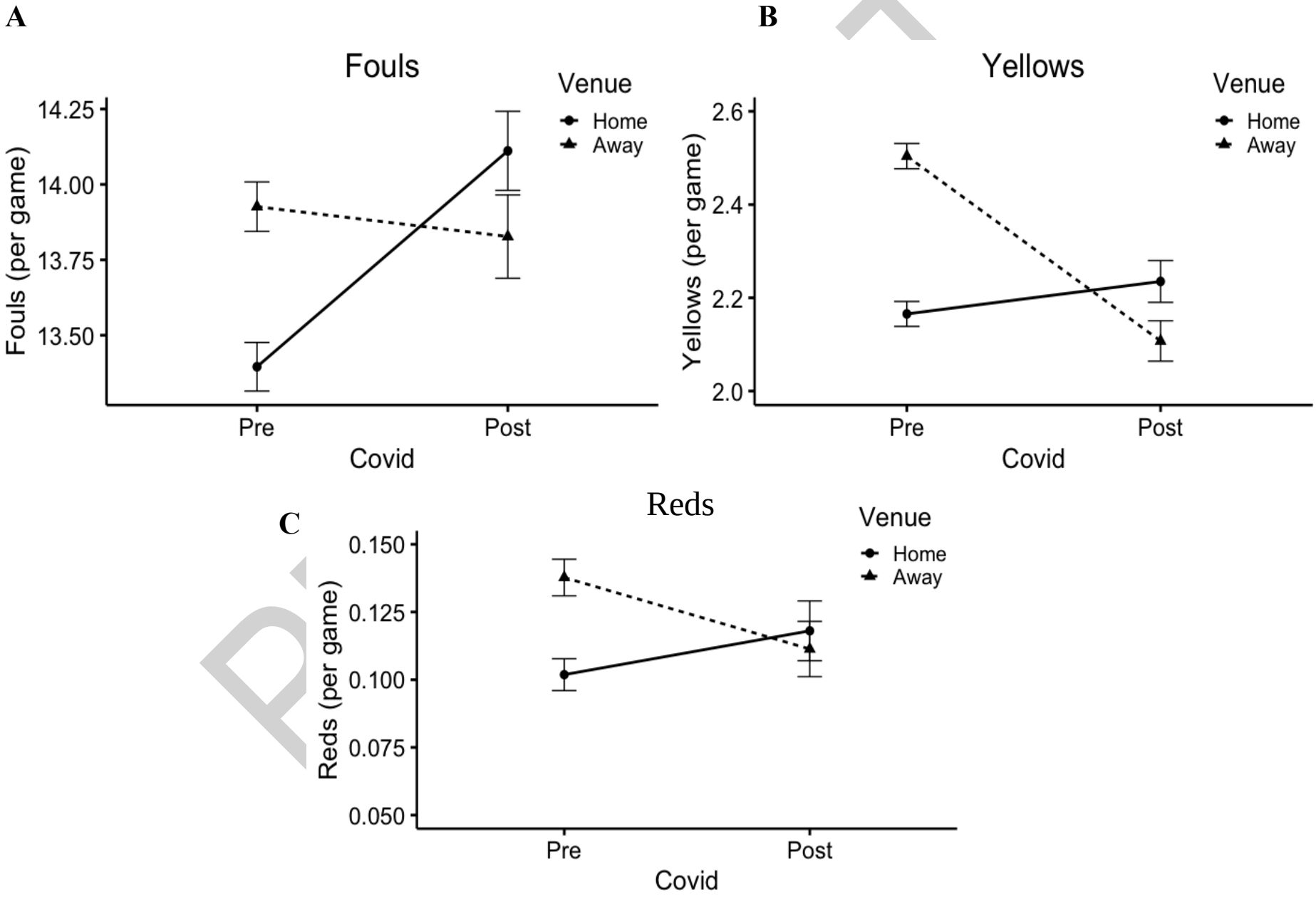
**Referees' Performance (fouls, yellow and red cards)**

Our data confirms previous findings that the audience influences referees' decisions. Figure 3 shows that overall the home team received fewer yellow/red cards and fouls, but this is more pronounced when an audience is present. In the post-Covid period without an audience, there were virtually no differences in the yellow and red cards between home and away teams while a small difference was present in the number of fouls.

A closer look at the data pattern shows that the referees identify more fouls against the home team when the audience is not present, while the number of fouls against the away side remained similar. However, the yellow cards data shows that these fouls were differently judged depending on the presence of the audience. The away team was penalized far less for fouls when the audience was absent whereas the home team, although fouling more, received similar amounts of warnings. The most drastic punishment, a red card, followed the same pattern, but the differences were less pronounced. The away team was indeed less often on the receiving end of a red card when the game was played without the audience, but the home teams were penalized more often without the support of their home fans.

PRE-PRINT

**Figure 3. Referees' decisions. Yellow and red cards, and fouls across European soccer leagues with and without an audience during 2019/2020.**



Multilevel regression analyses with fouls, yellow and red cards as dependent variables and venue (home-away) and audience (pre- and post-Covid) as predictors confirmed the descriptive results (see Table 3). The interactions between venue and audience were significant for fouls, as well as yellow and red cards. The differences in the rating and importance between the teams were not significantly related to the referees' decisions, and there were no interactions with Venue or Covid periods (see Table 3).

**Table 3. Regression models for referees' decisions. Yellow and red cards, and fouls across European soccer leagues in 2019/20 season.**

| | **Fouls** | | | **Yellow** | | | **Red** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Predictors** | *Estimates* | *std. Error* | *p* | *Incidence Rate Ratios* | *std. Error* | *p* | *Incidence Rate Ratios* | *std. Error* | *p* |
| (Intercept) | 13.61 | 0.17 | **<.001** | 2.16 | 0.02 | **<.001** | 0.10 | 0.06 | **<.001** |
| Venue [Away] | 0.35 | 0.10 | **.001** | 1.13 | 0.02 | **<.001** | 1.15 | 0.08 | .070 |
| Covid period [Post] | 0.48 | 0.14 | **.001** | 1.00 | 0.02 | .928 | 1.06 | 0.11 | .606 |
| Dominance | -0.34 | 0.05 | **<.001** | 0.95 | 0.01 | **<.001** | 0.73 | 0.04 | **<.001** |
| Rating difference | 0.23 | 0.08 | **.005** | 0.94 | 0.01 | **<.001** | 1.08 | 0.04 | .056 |
| Importance difference | -0.08 | 0.05 | .146 | | | | | | |
| Venue [Away] * Covid period [Post] | -0.70 | 0.20 | **<.001** | 0.83 | 0.03 | **<.001** | 0.77 | 0.15 | .086 |
| Rating difference * Importance difference | -0.16 | 0.04 | **<.001** | | | | | | |
| Venue [Away] * Rating difference | 0.30 | 0.09 | **.001** | 1.07 | 0.02 | **<.001** | | | |
| **Random Effects** | | | | | | | | | |
| $\sigma^2$ | 14.61 | | | 0.37 | | | 2.29 | | |
| $\tau_{00}$ | 4.70 $_{Team}$ | | | 0.04 $_{Team}$ | | | 0.11 $_{Team}$ | | |
| ICC | 0.24 | | | 0.10 | | | 0.05 | | |
| N | 212 $_{Team}$ | | | 212 $_{Team}$ | | | 212 $_{Team}$ | | |
| Observations | 7994 | | | 7994 | | | 7994 | | |
| Marginal $R^2$ / Conditional $R^2$ | 0.014 / 0.254 | | | 0.025 / 0.127 | | | 0.040 / 0.085 | | |

Note: observations were fewer due to data not being available for some countries/leagues.

PRE-PRINT

Given the above results, one could think that the presence of the fans biases referees' decisions against the visiting team. The above analyses do not, however, account for the attacking tendencies of teams. Passive teams, which are content to defend as indicated by low number of shots on goal and corners, tend to foul more and receive more warnings as they try to fend off a more dominant team. The referees' decisions could, therefore, simply be a consequence of teams' attacking tendencies. Given that the dominance of the home teams decreases considerably without the support of their fans (see Figure 2), it is of paramount importance to account for this factor before we conclude that the referees are influenced by the audience. Indeed, when we include the variable 'dominance' in the multilevel regression models, the referees' decisions were much less influenced by the audience presence and where the game was taking place. The interaction between Venue and Covid period was no longer significant for red cards, while the same interaction for yellow cards and fouls remained significant but was weakened (see Table 3). Together, these referee-specific analyses show referee bias is indeed an important factor in HA but its role is, at least to some extent, diluted when accounting for team dominance.

## Discussion

The 2020 Covid-19 pandemic provided a unique opportunity to explore some of the key factors which are thought to make a significant contribution to the HA in sport. In European soccer leagues, we examined how two factors - crowd influence on the teams and crowd influence on referee decision-making - changed as a result of teams playing the majority of their season with crowds present, and the remainder of the seasons with crowds absent. Previous research on the HA had demonstrated that the crowd can have a significant effect on team performance, arguably by spurring the home team on to better performance (e.g., through

PRE-PRINT

increased confidence and more attacking-type play) and depressing the performance of the away team (e.g. Agnew & Carron, 1994; Courneya & Carron, 1992; Goumas, 2014b; Nevill et al., 2005). Consequently, the home team on average will score more goals, show more attempts on goal, win more corners, giving them a greater chance at winning the game. In addition, research has shown that a key action of the crowd is to unconsciously bias the referee into making decisions favouring the home teams. Thus, referees will show more censure to away teams (issue more fouls, yellow, red cards and penalties) and allow more time at the latter stages of a match if the home team is behind (e.g. Boyko et al., 2007; Dohmen, 2008; Dosseville et al., 2016).

For team performance, our data clearly showed that when controlling for factors such as country, league, schedule and team quality, the effect of playing in virtually empty stadia had a significant negative impact on the typical home team performance. Thus, points per game, goals per game and team dominance (see Figures 1A, 1B, and 2) were all significantly reduced in the home teams compared to the away teams (who performed similarly in the presence or absence of a crowd). Our data thus support a wealth of previous literature showing that the presence of a crowd can have a strong effect on home team performance (e.g. Agnew & Carron, 1994; Courneya & Carron, 1992; Goumas, 2014b; Nevill et al., 2005).

The results for referee performance were more complex. Our initial data analysis showed that referees were indeed influenced by the absence of large crowds, penalising the away team less (awarding fewer yellow and red cards) when the home fans were absent. This is in accord with previous literature showing that the voluble presence of the home crowd can have a strong impact on referee decision-making and thus the home advantage (Dohmen, 2008; Dohmen & Sauermann, 2016; Nevill et al., 2002). However, our data revealed that team dominance was

PRE-PRINT

also important - i.e., whether a team was more 'attack' or 'defence' minded. The referees' decisions could, therefore, simply be a consequence of teams' attacking tendencies. After re-running our analysis controlling for team dominance we did indeed find that the number of red cards produced in relation to crowd presence or absence were no longer significant. However, whilst reducing the impact on referee-decision making for yellow cards and fouls, both remained statistically significant. Together, the more dominant home teams were when playing in empty stadia, the more they were punished by the referees – significantly more fouls were called against them and significantly more yellow cards were given for those fouls. This data shows clearly that referee decision-making can be influenced by the absence of the home crowd, their previous 'generosity' towards the home team being significantly reduced by the lack of a home crowd (Dohmen 2008; Nevill & Holder, 1999; Nevill et al., 2002).

Another potential factor to consider is that we were comparing games at the beginning and middle of the season with those at the end of the season, when key outcomes are much more likely to be relevant to the teams (e.g., promotion, relegation and final placings). Even so, our data provides little evidence to support this assumption often made by the games community. The effect of an audience on HA was indeed not driven by the difference in the schedule, or differing importance between home and away teams in both the pre and post-Covid period. We can therefore be fairly certain that the diminishing performance of the home teams without their fans is not a consequence of the unbalanced schedules in the pre and post-Covid periods.

We suggest that the unique circumstance provided by the Covid -19 pandemic has demonstrated that a key element of the HA (the crowd influencing players and referees) has been confirmed. Our findings show that home team performance is significantly negatively influenced by the lack of a home crowd, while the away team show a small improvement, both enough to

PRE-PRINT

annul the home advantage. The referees are also affected, showing less penalising sanctions towards the away teams. We acknowledge that there may be other variables which we were unable to control for which might have influenced these results, yet our data are so clear that we feel this is unlikely. It is possible that more data from different sports around the world may confirm our findings, or demonstrate the influence of other variables which we have not considered. For example, there may be interesting differences between and within countries that we did not explore due to the sparse nature of the post-Covid data and on the aforementioned statistical grounds. However, we are therefore currently exploring this possibility. That said, the results of the current study have cast new light on the HA phenomenon and are extremely interesting and valuable from both a theoretical and applied perspective, taking advantage of a rare world event that hopefully will not persist for long or happen again.

PRE-PRINT

## References

Agnew, G. A., & Carron, A. V. (1994). Crowd effects and the home advantage. *International Journal of Sport Psychology, 24*, 53–62.

Bookies.com. (2020, July 25). Retrieved August 2nd 2020 from https://bookies.com/news/nfl-releases-2020-schedule-home-field-advantage-shrink.

Boyko, R.H., Boyko, A.R., & Boyko, M.G. (2007). Referee bias contributes to home advantage in English Premiership football. *Journal of Sports Sciences, 25*, 11, 1185-1194.

Butler, J.L., & ,Baumeister, R.F. (1998) The trouble with friendly faces: skilled performance with a supportive audience. *Journal of Personality and Social Psychology, 75*, 1213-1230.

Cohen, J. (1992). Statistical power analysis. *Current directions in psychological science*, *1*(3), 98-101.

Courneya, K. S., & Carron, A. V. (1992). The home advantage in sport competitions: A literature review. *Journal of Sport and Exercise Psychology, 14*, 13–27.

Dohmen, T.J. (2008) The influence of social forces: evidence from the behaviour of football referees. *Economic Enquiry, 46*, 411-424.

Dohmen, T.J., and Sauermann, J. (2016) Referee bias. *Journal of Economic Surveys. 30*, 679–695

Dosseville, F., Edoh, K.P., & Molinaro, C. (2016) Sports officials in home advantage phenomenon: a new framework. *International Journal of Sport and Exercise Psychology, 14*, 250-254. DOI: 10.1080/1612197X.2015.1023422

Durkheim, É. (1974) [1953]. *Sociology and philosophy.* Translated by D. F. Pocock; with an introduction by J. G. Peristiany. Toronto: The Free Press. ISBN 978-0-02-908580-6. LCCN 74-19680.

PRE-PRINT

Fothergill, M., Wolfson, S., & Little, L. (2014) A qualitative analysis of perceptions of venue: do professional soccer players and managers concur with the conceptual home advantage framework? *International Journal of Sport and Exercise Psychology, 12*, 316-332.

Garicano, L., Palacios-Huerta, I. and Prendergast, C. (2005) Favoritism under social pressure. *Review of Economics and Statistics 87*, 208–216.

Gaviglio, C.M.. Crewther, B.T., Kilduff, L.P., Stokes, K.A., & Cook, C.J. (2014) Relationship between pregame concentrations of free testosterone and outcome in Rugby Union. *International Journal of Sports Physiology and Performance, 9*, 324 -331 http://dx.doi.org/10.1123/IJSPP.2013-0106

Goumas, C. (2013). Modelling home advantage in sport: A new approach. *International Journal of Performance Analysis in Sport, 13*, 428-439.

Goumas, C. (2014a). Home advantage and referee bias in European football. *European Journal of Sport Science*, *14* (sup1), S243-S249.

Goumas, C. (2014b) How does crowd support contribute to home advantage in soccer? *Journal of Sport Behavior, 37*, 236-250.

Mauro, R. (1990). Understanding LOVE (left out variables error): A method for estimating the effects of omitted variables. *Psychological Bulletin,* 108(2), 314.

McCarrick, D., Brewer, G., Lyons, M., Pollet, T. V., & Neave, N. (2020). Referee height influences decision making in British football leagues. *BMC Psychology*, *8*(1), 4.

Mooijaart, A. (2003). Estimating the statistical power in small samples by empirical distributions. *New Developments in Psychometrics* (pp. 149-156). Springer, Tokyo.

Neave, N., & Wolfson, S. (2003). Testosterone, territoriality, and the “home advantage”. *Physiology and Behavior, 78*, 269–275.

Nevill, A., & Holder, R. (1999). Home advantage in sport: An overview of studies on the advantage of playing at home. *Sports Medicine, 28*, 221-236.

PRE-PRINT

497 Nevill, A., and Webb, T. (2013) Improved training of football referees and the decline in home
498 advantage post-WW2. *Psychology of Sport and Exercise, 14*, 220-227.

499 Nevill, A., Balmer, N., & Williams, M. (2002) The influence of crowd noise and experience
500 upon refereeing decisions in football. *Psychology of Sport and Exercise, 3*, 261-272.
501 DOI: 10.1016/S1469-0292(01)00033-4

502 Nevill, A., Balmer, N., & Wolfson, S. (2005) The extent and causes of home advantage: some
503 recent insights. *Journal of Sport Sciences, 23*, 335-445.

504 Nevill, A.M., Newell, S., and Gale, S. (1996) Factors associated with home advantage in English
505 and Scottish soccer. *Journal of Sports Sciences, 14*, 181-186.

506 Pollard, R. (1986) Home advantage in soccer: a retrospective analysis. *Journal of Sport*
507 *Science, 4*, 237-248.

508 Pollard, R. (2008) Home advantage in football: a current review of an unsolved puzzle. *The*
509 *Open Sports Sciences Journal, 1*, 12-14.

510 Pollard, R., & Armatas, V. (2017) Factors affecting home advantage in football World Cup
511 qualification. *International Journal of Performance Analysis in Sport, 17*, 121-135.

512 Pollard, R., & Pollard, G. (2005). Home advantage in soccer: A review of its existence and
513 causes. *International Journal of Soccer and Science Journal*, 3, 25–33.

514 Ponzo, M. and Scoppa, V. (2016) Does the home advantage depend on crowd support?
515 Evidence from same-stadium derbies. *Journal of Sport Economics*, 562-582.

516 Romanowich, P. (2012) Home advantage in retractable-roof baseball stadia. Perceptual and
517 Motor Skills, 115, 559-566. DOI: 10.2466/06.20.23.PMS.115.5.559-566

518 Schlenker, B.R., Phillips, S.T., Boniecki, K.A., & Schlenker, D.R. (1995) Where is the home
519 choke? *Journal of Personality and Social Psychology, 8*, 649-652.

520 Schwartz, B. and Barsky, S.F. (1977). The home advantage. *Social Forces, 55*, 641-661.

Sutter, M., & Kochera, M. G. (2004). Favoritism of agents – the case of referees' home bias. *Journal of Economic Psychology, 25*, 461 – 469.

Wolfson, S., and Neave, N. (2007) Coping under pressure: cognitive strategies for maintaining confidence among soccer referees. *Journal of Sport Behavior*, 30 (2). pp. 232-247. ISSN 0162-7341

Wood, S.N. (2006). *Generalized additive models: An introduction with R*. Chapman & Hall/CRC, Boca Raton, FL, 2006.

Zeller, R., and Jurkovac, T. (1989) A dome stadium: does it help the home team in the National Football League? *Sport Place*, 3, 6-9.

PRE-PRINT