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ROARS VS. RESULTS: A NATURAL EXPERIMENT ON SPECTATOR IMPACT IN ELITE EUROPEAN FOOTBALL LEAGUES

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Abstract

Introduction. The Covid-19 pandemic influenced the world in many ways, including sport. Many competitions were held without spectators, creating a natural experiment for the evaluation of home advantage. The present study thus evaluates the impact of crowd presence on home advantage in high level football competitions, specifically outcomes of all games in four highest ranked European leagues (England – Premier League, Spain – La Liga, Italy – Serie A, Germany – Bundesliga) from the start of the 2018/2019 season until the FIFA World Cup in 2022. **Material and Methods.** The traditional method of Pollard was used to evaluate home advantage in divisions of leagues and on three time intervals relative to the Covid-19 pandemic – before, during and after. Test for one proportion was done to check if the result of home advantage was significant, while tests for two proportions were used to compare home advantage between the time intervals. **Results.** In three of the four leagues (English, Spanish, German), home teams had significantly lower coefficient of home advantage results in games without spectators compared to games with spectators, but in the four leagues combined, home advantage was significant in games without spectators. **Conclusions.** The results indicate that crowd support is a significant contributor to home advantage in the best European football leagues, although the presence of spectators per se is not the only factor which influences home advantage, suggesting a need to consider other factors that may be of relevance.

Keywords: team sports, fans, soccer, ghost matches, Covid-19

Introduction

Prior to the Covid-19 pandemic, professional football (soccer) games were rarely played without spectators. As such, it was difficult to systematically address or quantify the effects of crowd presence or absence on game outcomes. Most professional football leagues stopped public matches when the Covid-19 pandemic lockdown began in Europe in 2020, and played matches without fans for the latter part of the 2019/2020 season. In the subsequent 2020/2021 season, most games were also played without spectators, thus providing more than a full season of games without spectators, resulting in a “natural experiment” to evaluate the effects of presence or absence of spectators.

Home advantage in team sports is defined as “the consistent finding that home teams in sports competitions win over 50% of the games played under a balanced home and away schedule” [1]. It is an important factor that influences outcomes of competitions in many sports, and research on the topic has been reasonably extensive since the 1970s [1, 2, 3, 4].

Overall, data suggest that home advantage usually has a larger impact in football than in other team sports [4, 5, 6]. The influence of home advantage in football has been noted at least since the start of organized leagues in 1888 [4], and has been noted throughout the world in different time intervals, although trends varied with country, season and level of competition [7, 8, 9, 10]. Although home advantage in football has been re-

lated to crowd support, travel effects and referee bias [1, 4, 7, 11], crowd support is viewed as one of the most influential factors of home advantage and has been examined in the context of crowd size and level of competition [12, 13, 14]. Although relationships between crowd effects and other factors associated with home advantage have been noted, it is generally believed that crowd support is the primary factor that influences home advantage.

Confirmation of the general hypothesis that crowd support impacts home advantage can be theoretically evaluated by comparing home team results based on matches played with and without fans. It is nearly impossible, however, for organizational reasons to do so as crowd presence is an integral part of football matches, especially at the highest level of competition. The natural experiment created by the Covid-19 pandemic provided an exception, and permitted an evaluation of assumptions related to home advantage.

The Covid-19 pandemic changed day to day activity patterns [15] which influenced people's physical and mental health [16]. In sport, the Covid-19 interval influenced not only competitions, but also player training for participation. Player training became home-based, especially at the beginning of the pandemic which was associated with the most restrictions [17]. Difficulties associated with training during Covid-19 isolation have been noted in several studies addressing changes in physical activity associated with modified training methods [10, 17, 18] and also in the impact of Covid-19 per se on the physical

condition of athletes of various sports [19]. The preceding does not cover the complexity of issues as fans or spectators are an essential component in addition to players and coaches. Major league sport without spectators was thus a new situation that impacted the environment of sports emotionally, professionally and socially [20].

In the context of the preceding, the present study considered the relationship between the sports environment and the presence or absence of fans. The effect of crowd support on home advantage was thus considered in the context of three intervals related to the Covid-19 pandemic: (1) games with fans before the pandemic, (2) games without fans during the pandemic, and (3) games with fans after most Covid-19-related restrictions were removed. The present study thus used a natural experiment to investigate the impact of crowd presence on home advantage among the top-ranked European football (soccer) leagues in the three intervals related to pandemic status.

Material and Methods

Research Design

The present study is a historical cohort analysis of home advantage based on a natural experiment that permitted comparisons of outcomes of football matches that were played with and without spectators. The study was conducted in accordance with the Declaration of Helsinki and the research ethics of Poznań University of Physical Education. The Human Ethics Research Committee of Karol Marcinkowski Medical University in Poznań has determined that this study does not constitute human subjects research because it used a publicly available database that includes only de-identified data and does not require consent as in the case of clinical trials or other studies involving humans. The research was carried out at the Poznań University of Physical Education in compliance with all principles of methodology and research ethics. The Covid-19 pandemic permitted analysis of the outcomes of football matches played during three intervals: (1) before the Covid-19 lockdown for spectators; (2) during the Covid-19 lockdown without spectators; and (3) after the Covid-19 lockdown when spectators returned to stadiums.

Research material Leagues

The four best football European leagues according to UEFA ranking from the 2021/2022 season [21] were the English, Spanish, Italian and German leagues based on results in European competitions. The leagues can be considered the highest level of competition in European football because they have the highest number of teams playing in UEFA Champions League; only teams from these four leagues have won UEFA Champions League since the 2004/2005 season; and they have been among the four best European leagues in ranking since 2008/2009 season.

The English, Spanish and Italian leagues each have 20 teams and the German league has 18 teams competing for the championship in the respective countries. Each of the leagues has a double-round-robin format in which all teams play against every other team twice – once at home and once on the road. The overall number of games played in a single season was 306 in the German league and 380 in the other three leagues, resulting in a total of 1446 games in the four leagues combined. Details of the number of games taken into account in this analysis are presented below.

Seasons

The present analysis is based on 6,355 games with and without crowd presence from the start of 2018/2019 season (August 2018) until the start of FIFA World Cup in November 2022 in the four European leagues. Initially, matches which were “walkovers” were excluded as they disrupted home advantage by having automatic 3-0 results no matter what happened in the game. There was only one such game – between Hellas Verona and Roma in the Italian league played without crowd presence in the 2020/2021 season. Without this game, the 6,354 matches played in the four best European leagues from the start of 2018/19 season until the FIFA World Cup in 2022 [22] were analyzed (Fig. 1).

It is important to note that prior to the Covid-19 pandemic, almost all games at the highest level were played with crowd presence with several exceptions due to penalties or unusual coincidences. Of note, in the three seasons preceding the Covid-19 pandemic (2016/2017, 2017/2018 and 2018/2019), only 2 games (less than 0.1%) were played without crowd presence in four best European leagues.

Lockdown in Europe caused by the Covid-19 pandemic began in March 2020 and stopped the 2019/2020 season. Subsequently, the last part of the 2019/2020 season (408 games overall, 28% of the season) and 92% of games in the 2020/2021 season in the four leagues (1327 of 1445) were played without spectators (i.e., with crowd absence). Spectators attended games in the 2021/2022 season and crowd support reached 99% of games (1429 of 1446). Accordingly, the data were partitioned into three time intervals:

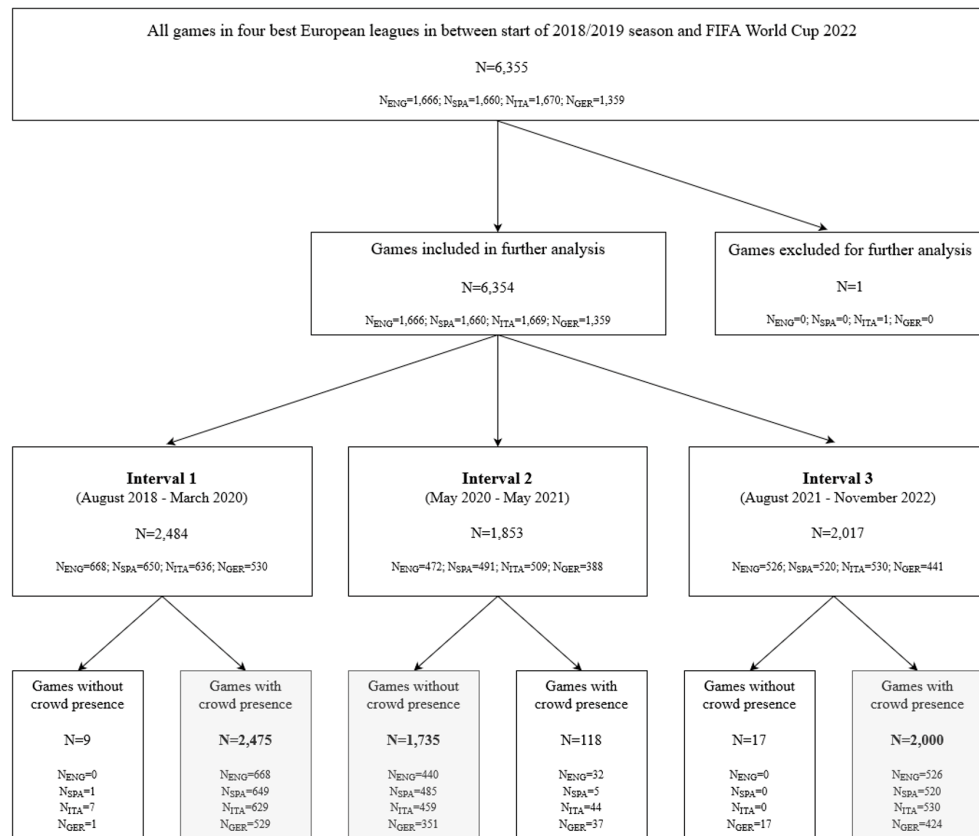
Interval 1 (August 2018 to March 2020) included all games from the 2018/2019 season and 72% of games from the 2019/2020 season (games before the start of the first lockdown caused by the Covid-19 pandemic);

Interval 2 (May 2020 to May 2021) included all games during the Covid-19 pandemic with most restrictions, i.e., the latter part (28% of games) of the 2019/2020 season after the initial lockdown through all games of the 2020/2021 season;

Interval 3 (August 2021 to November 2022) included games after most of the Covid-19-related restrictions were lifted until the World Cup, i.e., all games of the 2021/2022 season and all games in the 2022/2023 season prior to the FIFA World Cup in 2022 (39% of games in the season) (Fig. 1).

Because the objective of the study was to compare home advantage in games with and without crowd presence, only games played with fans in Interval 1 and in Interval 3 and only games played without fans in Interval 2 were included. Nine games (0.4%) were played without spectators in Interval 1; 118 games (6.4%) were played with crowd presence in Interval 2; and 17 games (0.8%) were played with crowd absence in Interval 3 (Fig. 1). These games were excluded so that for the present analysis, Interval 1 includes only games that were played with crowd presence; Interval 2 includes only games that were played with crowd absence; and Interval 3 includes only games that were played with crowd presence (areas marked in grey in Fig. 1).

The number of games played in all three intervals was higher than in one full season (1,446 games), but was also lower than the number of games played in two full seasons (2,892 games). The number of games in Interval 3 was the maximum possible at the time of the analysis and preparation of the report. The impact of the unusual date of the World Cup was also taken into consideration as it occurred during a one month mid-season break for players who did not participate in the World Cup. The latter may have influenced the condition of the players, which, in turn, may have impacted results in relation to earlier



Note: N – number of games played in the combined sample of four best European leagues, NENG – number of games played in English league, NSPA – number of games played in Spanish league, NITA – number of games played in Italian league, NGER – number of games played in German league.

Figure 1. Diagrammatic illustration of the analyzed research material regarding the total number of games in the four leagues and in each specific league separately divided by intervals related to the Covid-19 pandemic and crowd presence.

observations. More games could have been taken into account in Interval 1, but this was not done given the potential impact of sample size on the statistical tests used in the analysis, specifically of comparison of home advantage coefficients by tests for one or two proportions which rely on the number of games. A larger number of games may have given misleading results and significance of differences. It was also done in order not to disrupt the equality of frequencies (percentages) of the three intervals which were examined separately in each of the four leagues and for the four leagues combined. No significant differences ($p > 0.05$) in frequencies were indicated. Detailed procedures of test selection are described in the Statistical methods (below).

Data

Data were collected from the open-access page FB REF [23] which provided the results of all games as well as numbers of spectators in the respective matches. Data were validated with corresponding information posted on two other websites: World Football Net [24] and Flashscore [25]. In case of conflicting results during the validation process, the video footage of the match was viewed and the presence or absence of spectators was verified.

Methods

Home advantage coefficient

In sports for which results are either wins or losses (e.g. basketball), home advantage is evaluated in percentages by dividing the sum of the number of games won by home teams by all games played. In this case, 50% is the threshold value; proportions higher than 50% indicate home teams won more games,

while those lower than 50% indicate that visiting teams (not playing at home) won more games.

The situation in football is more complex as three results are possible for home teams: win, draw or loss. At least four coefficients that measure home advantage have been used [26], but the most frequently used coefficient in football is the traditional method of Pollard [4] that has been used in several studies [4, 8, 9, 27]. The home advantage coefficient (HA) with Pollard's traditional method is described by following formula:

where:

$$HA (\%) = \frac{H_p}{H_p + A_p} \cdot 100\%,$$

H_p denotes the number of points won by home teams, A_p denotes the number of points won by away teams.

The method uses home advantage as the percentage of points won by home teams in all games (won by both home and away teams). Thus, interpretation of this coefficient is also the same as in sports with only two possible outcomes of matches – win or lose.

The following equation was subsequently developed:

where:

$$HA (\%) = \frac{3 \cdot W + 1 \cdot D + 0 \cdot L}{(3 \cdot W + 1 \cdot D + 0 \cdot L) + (0 \cdot W + 1 \cdot D + 3 \cdot L)} \cdot 100\% = \frac{3 \cdot W + 1 \cdot D}{3 \cdot W + 2 \cdot D + 3 \cdot L} \cdot 100\%$$

W denotes the number of home team **wins**,
D denotes the number of home team **draws**,
L denotes the number of home team **losses**.

This equation is the most practical for football as the distribution of points is 3 for a win, 1 for a draw and 0 for a loss; an equation in this form was thus used to calculate home advantage in the present study.

Statistical methods

The data are presented for three intervals as the number of games played overall and also on the basis of results for the home teams (win, draw or loss). The results are shown separately for the four leagues by country and for the four leagues combined. In all instances, home advantage was calculated by the traditional method of Pollard (HA). Because the unit of HA is a percentage, comparisons between results of the coefficient are presented as percentage points (p.p.).

Pearson Chi-square tests for equality of frequencies were used to test whether the number of games played in the three intervals did not differ from each other. First, in order to verify the hypothesis that home advantage exists (i.e., is statistically significantly higher than no home advantage), a one-sided test for one proportion [28] was used for HAs in every interval of each league. The test compares the value of given HA and the number of games played with 50% (no home advantage). The result of the test is the u statistic from which a p value (level of significance) was obtained.

Next, in order to verify whether spectator presence is associated with an increase in home advantage (consistent with the literature), a one-sided test for two proportions [28] was used. The test compares HA values in interval 2 with HA values in intervals 1 and 3 ($H_1: HA_{interval1} > HA_{interval2}$, $HA_{interval3} > HA_{interval2}$) with the respective number of games played in each league and in all four leagues combined. Furthermore, a two-sided test for two proportions was used to evaluate differences between interval 1 and interval 3 ($H_1: HA_{interval1} \neq HA_{interval3}$). The result of the test for two proportions is the u statistic which provides the p value for significance.

Results of the tests were calculated with TIBCO Software Inc. (2017, Statistica data analysis software system; version 13; available at <http://statistica.io>). The significance level was set at $p < 0.05$.

Results

Results of HA for the four leagues included in the current analysis are presented in Table 1 and Figure 2. Analyses for individual leagues in the order of UEFA rankings [21] are initially described and then followed by the results of the analysis of four European leagues together.

English league (Premier League)

Results indicate that HA in interval 1 was significantly higher (by 7.66 p.p.) than no home advantage ($p < 0.0001$). Similarly, HA in interval 3 was significantly higher (by 6.80 p.p.) than no home advantage ($p = 0.0009$). However, HA in interval 2 was lower by 0.12 p.p. than no home advantage ($p = 0.5199$). HA in interval 1 was also significantly higher (by 7.78 p.p.) than in interval 2 ($p = 0.0055$), and HA in interval 3 was also significantly higher (by 6.92 p.p.) than in interval 2 ($p = 0.0159$). On the other hand, the difference between HAs in intervals 1 and 3 was not significant ($p = 0.7655$). (Tab. 1, Fig. 2).

Spanish league (La Liga)

HAs in all three intervals in the Spanish league were significantly higher (11.07 p.p., 6.04 p.p., and 8.05 p.p. in intervals 1, 2 and 3, respectively) than no home advantage ($p < 0.0001$, $p = 0.0039$ and $p = 0.0001$, respectively). HA in interval 1 was also significantly higher (5.03 p.p.) than HA in interval 2 ($p = 0.0443$). Although HA in interval 3 was higher by 2.01 p.p. than

Table 1. Results in the four best European leagues and the four leagues combined by Covid-19 pandemic intervals – before (1), during (2), after (3) the pandemic: number of games, home team results and home advantage coefficient (HA).

League	Interval	Games (N)	Home Team Results			HA (%)
			Win (N)	Draw (N)	Loss (N)	
English	1	668	310	143	215	57.66 ^{a,b}
	2	440	170	98	171	49.88
	3	526	235	122	169	56.80 ^{a,b}
Spanish	1	649	297	185	167	61.07 ^{a,b}
	2	485	200	138	147	56.04 ^a
	3	520	226	144	150	58.05 ^a
Italian	1	629	266	164	199	55.83 ^a
	2	459	190	114	154	54.29 ^a
	3	530	215	134	181	53.50
German	1	529	234	122	173	56.25 ^a
	2	351	140	89	122	52.80
	3	424	198	99	127	59.08 ^{a,b}
All four leagues	1	2,475	1,107	614	754	57.77 ^{a,b}
	2	1,735	700	439	594	53.34 ^a
	3	2,000	874	499	627	56.74 ^{a,b}

Note: a – HA significantly higher than 50% (test for one proportion); b – HA significantly higher than HA in interval 2 in the same leagues and the four leagues combined (test for two proportions).

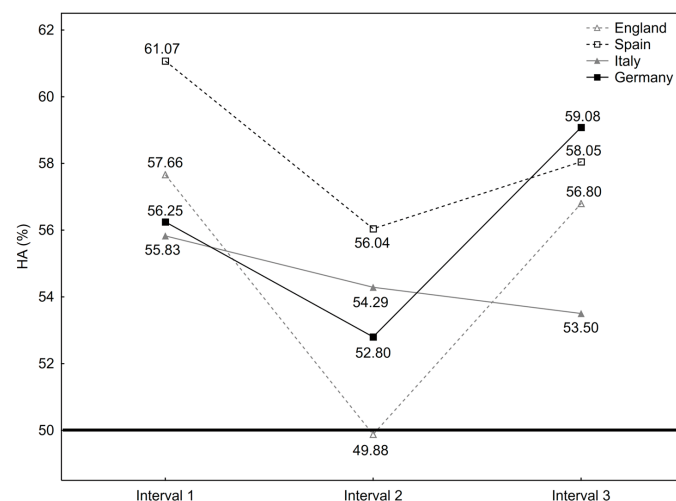


Figure 2. Results for the home advantage coefficient (HA) in the four best European leagues in the three intervals related to the Covid-19 pandemic.

HA in interval 2, the difference was not significant ($p = 0.2600$). The difference between HA in intervals 1 and 3 also did not differ significantly ($p = 0.2955$). (Tab. 1, Fig. 2)

Italian league (Serie A)

In the Italian league, HAs in intervals 1 and 2 were significantly higher by 5.83 p.p. and by 4.29 p.p., respectively, than no home advantage ($p = 0.0018$ and $p = 0.0329$), whereas HA in interval 3 was higher by 3.50 p.p. than no home advantage, but the difference was not significant ($p = 0.0537$). Although HA in interval 1 was higher by 1.54 p.p. than in interval 2, the difference was not significant ($p = 0.1000$).

rence was not significant ($p = 0.3070$). However, HA in interval 3 was lower than HA in interval 2 by 0.79 p.p. ($p = 0.5981$). No significant difference was also noted between HAs in intervals 1 and 3 ($p = 0.4272$). (Tab. 1, Fig. 2)

German league (Bundesliga)

Observations in the German league indicated that HAs in intervals 1 and 3 were significantly higher than no home advantage by, respectively, 6.25 p.p. ($p = 0.0020$) and 9.08 p.p. ($p = 0.0001$). Although HA in interval 2 was higher by 2.80 p.p. than no home advantage, the difference was not significant ($p = 0.1469$). HA in interval 1 was higher by 3.45 p.p. than HA in interval 2, but the difference was not significant ($p = 0.1569$), while HA in interval 3 was higher by 6.28 p.p. than HA in interval 2, and the difference was significant ($p = 0.0397$). In contrast, the difference between HAs in intervals 1 and 3 was not significant ($p = 0.3798$). (Tab. 1, Fig. 2)

All Four Leagues Combined

In all four leagues combined, HAs in all three intervals were significantly higher (by 7.77 p.p. in interval 1, by 3.34 p.p. in interval 2 and by 6.74 p.p. in interval 3) than no home advantage ($p < 0.0001$, $p = 0.0027$ and $p < 0.0001$, respectively). Moreover, HA in interval 1 was significantly higher by 4.43 p.p. than in interval 2 ($p = 0.0022$), and HA in interval 3 was significantly higher by 3.40 p.p. than in interval 2 ($p = 0.0186$). The difference between HAs in intervals 1 and 3 was not significant ($p = 0.4886$) (Tab. 1, Fig. 2).

Discussion

Results of the respective analyses showed differences in HA during the three intervals associated with the COVID-19 pandemic in the four best European leagues. The impact of crowd support on HA, however, differed among leagues. On the other hand, results of the analyses in all four leagues combined indicated significant differences in HA between games with and without crowd presence. Similar analyses of the impact of crowd support on HA were conducted by others [27, 29, 30], but the studies were not able to compare seasons with no spectators relative to the return of crowd support.

In the study by Sors et al. [30], HA was examined in all games of first and second division teams of the five best European leagues in every season from 2014/2015 to 2020/2021. HAs in the ten leagues combined (two divisions in five countries) were 59.36% in five complete seasons without attendance restrictions and 54.95% in the full 2020/2021 season when most games were played without crowd presence. The results were generally consistent with the present analysis.

In the study of Jaguszewski [27], the four best European leagues were examined in games with and without crowd presence between the 2015/2016 and 2019/2020 seasons, while in the study of Almeida and Leite [29], only games from the 2019/2020 season in the four best European leagues (English, Spanish, Italian, German) and in the Portuguese league (6th best European league at the end of 2021/2022 season [21]) were considered. Results indicated that in the German league, HA totally disappeared in games without fans, whereas in the other leagues (English, Spanish, Italian, Portuguese), home advantage changes associated with crowd absence were small and not significant.

In the preceding analyses [27, 29], only games from the 2019/2020 season after the Covid-19 pandemic were taken into consideration as games without spectators, and as such sample size was small. Observations thus differed from those in the present analysis as most games in the 2020/2021 season were play-

ed with crowd absence. To address the differences between the present results and previously published observations, results of interval 2 were divided into two parts: games without fans from the last part of 2019/2020 season (which were taken into account in the earlier analyses), and games without fans from the 2020/2021 season (Tab. 2).

Table 2. Results in the four best European leagues and the four leagues combined during interval 2 – games without crowd presence by seasons: number of games, home team results and home advantage coefficient (HA).

League	Season	Games (N)	Home Team Results			HA (%)
			Win (N)	Draw (N)	Loss (N)	
English	2019/2020	92	43	20	29	58.20
	2020/2021	348	127	78	142	47.66
Spanish	2019/2020	110	45	30	35	55.00
	2020/2021	375	155	108	112	56.34 ^a
Italian	2019/2020	124	55	27	42	55.65
	2020/2021	335	135	87	112	53.77
German	2019/2020	82	26	19	37	42.73
	2020/2021	269	114	70	85	55.90 ^a
All four leagues	2019/2020	408	169	96	143	53.46
	2020/2021	1327	531	343	451	53.30 ^a

Note: a – HA significantly higher than 50% (test for one proportion).

Due to the relatively small number of games played without crowd presence in the 2019/2020 season, in each of the four leagues (and also in all four combined), HA was not significantly higher than no home advantage. In each of four leagues considered, there were more games played without fans in the 2020/2021 season than in the previous season. In the 2020/2021 season, HAs in the English and Italian leagues were not significantly higher ($p > 0.05$) than no home advantage, whereas HAs in the Spanish league ($p = 0.0070$) and German league ($p = 0.0265$) and in all four leagues combined ($p = 0.0081$) were significantly higher than no home advantage. It was also noticed that HA in two seasons included in interval 2 did not differ by more than 2 p.p. in the Spanish and Italian leagues (and also in the four leagues combined). In contrast, differences over 10 p.p. between HAs in the two seasons were noted in the English and German leagues (Tab. 2).

In the English league, HA in 92 games without crowd presence from the 2019/2020 season was higher by 8.20 p.p. than no home advantage, whereas HA in 348 games without crowd presence from 2020/2021 season was lower than no home advantage (Tab. 2). This is likely the reason why the earlier studies in the English league [30] noted no differences between games with and without crowd presence, whereas in the present study the impact of crowd support was significant. Finding an explanation for this unusual situation, however, is ambiguous. One of the possible reasons may have been the change in the number of substitutions as rule changes were considered one of the factors influencing home advantage [1, 11]. The English league was the only league of the four best European leagues which reduced the number of substitutions from five to three at the start of the 2020/2021 season. Nevertheless, studies addressing this possible reason are apparently lacking, and the issue merits attention in future studies.

In contrast, analysis of results in the German league (Tab. 2) showed a trend opposite to that observed in the English league. In 82 games played with crowd absence in the 2019/2020 season, HA was lower by more than 7 p.p. than HA, while in games without fans in the 2020/2021 season, HA was significantly higher by 5.90 p.p. ($p = 0.0265$) than no home advantage. One possible explanation for this seemingly unexpected result is that the German league was the first to resume matches after the lockdown among the four leagues analyzed in this study – on May 16th, compared to June 11th (Spanish), June 17th (English), and June 20th (Italian). The German league thus had less time than the other three leagues to prepare for the return to play after the initial lockdown, which may have impacted home advantage.

Covid-19 resulted in a break of over 2 months in games among players in the four best European leagues. This unexpected situation may have affected player training and preparation so that also their performances were not as optimal as expected during the regular, uninterrupted season [10, 17, 18]. In addition, player morbidities and the regular testing for Covid-19 may also have contributed to the uncertainty [19], and in turn affected familiarity among players, which is a factor in home advantage [1, 7]. Rule changes may also have contributed to the home advantage factor [1, 11], as “cooling breaks” were introduced and the number of substitutions was increased from three to five after the first lockdown.

Given the aforementioned factors (familiarity and rule changes) that may have influenced home advantage, the interval of the Covid-19 pandemic time was not really ideal to evaluate the effect of crowd absence per se on home advantage. Nevertheless, spectators are an integral part of sports events, and even under normal conditions, sports competitions do not take place without them, especially at the highest levels of competition. Furthermore, factors associated with the Covid-19 pandemic were beyond our control, so that conditions to test the specific theoretical hypothesis for the study were not ideal.

Limitations and Directions for Future Studies

The limitation of this study is the fact that there was no full season with all games played with crowd absence (i.e., double-round-robin system) in the four leagues considered. As such, the home/away schedule was not completely balanced. Moreover, more data could have been used to evaluate long term trends of home advantage and the impact of crowd support. However, this was not possible. Nevertheless, the number of games without crowd presence taken into consideration in the present study represented the total number of games without spectators at the highest level of football competition.

The impact of crowd support on home advantage is a topic that merits further study in other leagues and at lower levels of competition. Furthermore, there is a need to consider the potential impact of specific factors which may influence the impact of crowd support on home advantage, total number of shots per se and shots on goal, yellow and red cards, etc. They should be evaluated in the context of the three intervals considered in this study.

Conclusions

Restrictions related to the Covid-19 pandemic provided an opportunity to evaluate the impact of crowd absence as a factor which influences home advantage in football matches at the highest level of competition. The results varied among teams in the four best European football leagues. Of interest, home

teams had significantly weaker results in games without spectator presence compared to games with spectator presence. The hypothesis that crowd support is a significant factor of home advantage was thus confirmed, at least among the best European football leagues. Nevertheless, home advantage was a significant factor even without spectators, suggesting that crowd presence, though important, is one of several factors that may influence home advantage in the best European football leagues. Other factors, independent of crowd presence, merit further study.

Practical Implications

- Home advantage in the four best European football leagues did not differ significantly in games with fans before and after the Covid-19 pandemic.
- Home advantage in the best European leagues was significantly higher in games with than in games without spectators.
- Nevertheless, home advantage in games with crowd absence during the Covid-19 pandemic was still significant.
- Crowd support is a significant factor influencing home advantage in the best European football leagues.
- The details of how crowd support impacts home advantage needs further study because it is not the only factor influencing home advantage in football, highlighting the need to consider other factors that may be of relevance.

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