Original Article (short paper)

Second-leg home advantage in the *Copa Libertadores da América* (2005-2015)

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Abstract — Aims: To investigate the home advantage (HA) in the Copa Libertadores da América (CLA) from 2005 to 2015. **Methods:** A naive analysis was applied considering how many times a team that played the second leg at home qualified for the next round. To verify differences between home, away and draw results, the Chi-square (χ^2) and the Full Bayesian Significance Test were applied. For the binomial variables ("Home" or "Away"), the probability of second-leg knockout occurrence was calculated. **Results:** The probability of second-leg HA varied from 27.27% to 63.64% suggesting fluctuations of second-leg HA during competitive phases (round of 16, quarterfinals, semi-finals and final matches) and decision forms (full time, goals away rule or penalty-shoots). **Conclusion:** The results counteract the common belief that there is a large advantage to playing the second match of a two-leg tie at home during all competition phases. Penalty-shots seemed to affect positively the second-leg HA. Despite the causes of second leg HA in CLA need to be better investigated, soccer coaches could to use these results to think better strategies to win your knockout matches.

Keywords: soccer, knockout matches, South American football.

Introduction

Home advantage (HA) is a term coined to describe the consistent finding that home teams win over 50% of the games played under a balanced home and away schedule in sport competitions[1,2,3,4,5]. This is a well-documented concept in a wide range of team sports[5,6,7] and, in football (soccer), it has been verified since the inaugural season of the England League in 1888[5,8,9,10].

The HA occurrence has been justified by previous authors due to extrinsic and intrinsic factors. The extrinsic factors are game location[11], weather[12], crowd effects[13,14,15], travel length[3,13,15,16,17], and referee bias[14,15,17,18,19], whereas the intrinsic factors are first goal scored[20], team quality[11], coaches´ decisions[21], familiarity[22,23], technical factors[24], specific tactics[11,24], injury time[17], behaviour of the players[25], ball type[23], and territoriality[26].

Recently, examining 169,752 games of 157 national domestic football leagues throughout the world for six seasons between 2006 and 2012, Pollard and Gomez[27], found HA varying from 86.82% (Nigéria) to 48.20% (Papua New Guinea). Similar results were reported in Europe, where HA of football leagues varies from 78.95% (Bosnia) to 48.87% (Andorra), whereas in South America HA varies from 74.16% (Bolivia) to 52.10% (Uruguay)[9]. The HA of National Teams that played the 1998 World Cup (France) was also higher than 60% from 1987 to 1998[23]. HA beyond 60% has been also reported during the group stage of the UEFA Champions League (UCL) and Copa Libertadores da América (CLA)[28]. However, the findings cited above considered only the single-leg HA that ideally regard a balanced playing schedule in which each team plays each other team the same number of games at home and away. Therefore, there a lack of data about the second-leg HA concept which is relevant in all two-stage knockout competitions and occurs when, on average, teams are more likely to pass a two-matches knockout stage when playing the second-leg at home, i.e., even though both teams have an HA since they play one match at home, the advantage is greater for the team that plays the second match at home[29].

To the best of our knowledge, only four studies have investigated the second-leg HA. However, they were based on European tournaments and present conflicting conclusions because second-leg HA varied from 61.8% (with second-leg HA) to 47.8% (no second-leg HA)[20,29,30,31]. These differences may be explained due to the different mathematical models used to access second-leg HA. For example, Eugster, Gertheiss, Kaiser[30], using the naive analysis, found a probability of winning in favour of the team having the return match at home (56%). However, using refined statistical data analysis – which considered the team coefficient proposed by the UEFA – the authors suggested no evidence for the second-leg HA[30]. Lidor, Bar-Eli, Arnon, Bar-Eli[31], using multiple χ^2 analyses, also suggested that teams which play the second game at home have a substantially higher chance of advancing to the next round than teams playing the first game at home. On the other hand, using a regression model and discriminant analysis, García-Rubio, Gómez, Lago-Peñas, Ibáñez[20] found no effect on the success

of the team that played this match at home. Conflicting results were also found between García-Rubio, Gómez, Lago-Peñas, Ibáñez[20] and Allen and Jones[32], because whilst García-Rubio, Gómez, Lago-Peñas, Ibáñez[20] found no effect on the success of the team that played this match at home, Allen and Jones[32] reported greater HA in low-ability teams (teams with lower table league positions) than in high-ability teams. In spite of the model proposed by Eugster, Gertheiss, Kaiser[30] allow to comprehend better the HA phenomena, this model cannot be applied in South America because the South American Football Confederation (CONMEBOL) has not a teams´ ranking to be included in the model. Therefore, simplified analysis may help to comprehend the second-leg HA concept in South America which has been poorly explored in the literature.

The present study aimed to investigate the strength of the second-leg HA in the CLA, and to verify if the goals away rule and penalty shoot-outs affect the second-leg HA in the CLA. Our prior hypothesis was that second-leg HA occurs in the CLA, but would be reduced in advanced stages of the competition, because it was empirically expected that better teams would go forward in the competition and suffer lower than already eliminated teams from factors that affect HA (e.g. round of 16, quarterfinal, semi-final and final matches). Finally, a variation on second-leg HA according to the goals away rule or penalty shoot-outs was also expected.

Methods

The present study has a descriptive and qualitative design. It was conducted in accordance to the ethical principles and the ethical approval was obtained from the local ethical committee (Centro Universitário Anhanguera/nº 1281/15).

Data set

Data were taken from the websites: soccerway.com, www.bolanaarea.com, www.conmebol.com, and www.fifa.com. The visual revision and assessment were performed blinded by two experienced and independent observers. The procedures were in accordance with previous reports[29,30].

The database consists of CLA knockout matches played from 2005 to 2015, since before 2005 the goal away rule was not applied. To avoid bias of interpretations in the second-leg HA phenomena, only the knockout matches were analysed.

The second-leg HA was defined when the home team scored more goals than its opponent score and won the tie. Thus, the match was classified as "HOME". If the away team scored more goals than the home team, the result was "AWAY". When the two-legged match ended tied, the result was "DRAW". For draws, the away goal rule was considered. If, even considering the goals scored away the draw persisted, penalty shoot-outs were accounted. Thus, if the team who played the second match at home won during full-time, by goals away or by penalty shoot-outs, the result was classified as "HOME". If not, the result was considered as "AWAY". Despite FIFA ranking, quality of opponent, and several other factors that affect HA, they were not accounted in the present study due to the absence of precise information about these points by CONMEBOL that have not provide a ranking to qualify the teams. Therefore, the suggestion of Eugster, Gertheiss, Kaiser[30] that it is necessary to add the pre-strengths of the teams as covariate could not to be applied.

Statistical analysis

Firstly, a naive analysis was conducted counting the number of times that the qualified teams in each stage played the second leg at home. Thereafter, the Chi-square (χ^2) test was used and, under the hypothesis of no HA, the expected number of matches won, drawn or lost by the home team would be equal. The statistical analyses were performed using SPSS software (version 17.0; SPSS, Inc., Chicago, IL) adopting significant level of 5%. Secondly, to provide a reliable alternative that avoids these pitfalls, we also reported the Full Bayesian Significance Test (FBST) *E*-value. This test gives evidence in favour of the hypothesis – of uniformity, like the χ^2 test – given the observed data, and its results are not flawed if the sample size is small (for details see Pereira and Stern[33]). The FBST was performed using a simple program in R language (R Development Core Team, 2009 – http://www.ime.usp.br/~cpereira/programs/association.r).

Results

Overall, 326 ties were accounted. Figure 1 demonstrates the second HA results with the aggregate score. Table 1 (final row) displays χ^2-values, *P*-values and *E*-values of each stage, showing that the no HA hypothesis can be rejected in all stages, except for the quarterfinals.

Figure 2 displays the number of times the qualifying team (black) or visiting team (grey) were at home when the tie was decided by the goals away rule (Panel A) or by penalty shoot-outs (Panel B). Table 2 shows the results of the χ^2 test and the FBST testing the homogeneity hypothesis, i.e., the probabilities that the home qualifying or the visiting team qualifying were equal and therefore, one-half. The final column reports the posterior probability that p1 (probability that the home team qualifies) is larger than one. The prior distribution used for p1 was the uniform (beta (1,1)).

Figure 3 shows, for each stage, how the teams that played the second match at home qualified (Panel A), and the number of times the home teams (black) and visiting teams (grey) in the second-leg qualified. When the ties were decided after full-time dispute, the goals away rule and penalty shoot-outs were taking into account. Table 3 displays the χ^2 test *P*-value and the FBST *E*-value concerning the uniformity hypothesis, p1=p2, where p2 is the probability that the visiting team in the second-leg qualifies. Since p2=1-p1, the hypothesis of uniformity is equivalent to the test if p1=1/2. The fifth column brings the posterior probability that p1>1/2 and the final column reports the predictive probabilities, of each stage, that the next (out of the sample) tie will be won by the team playing at home in

the second-leg. Even though this probability is considerably larger than 0.5 for some stages, such as the quarterfinals and finals, overall the numbers demonstrate a slight advantage for teams playing at home in the second-leg (0.527).

Table 1. Chi-square and Full Bayesian Significance Tests (P- and E-value, respectively) for comparison between the occurrences of home, draw or away results in the aggregate result (second-leg home advantage concept).

		Chi-square	*P*-value	*E*-value
Aggregate Score	**Eight-final**	7.28	0.03	0.02
	Quarter-final	1.41	0.50	0.46
	Semi-final	2.82	0.24	0.23
	Final	4.55	0.10	0.08
	Total	10.36	0.01	0.00

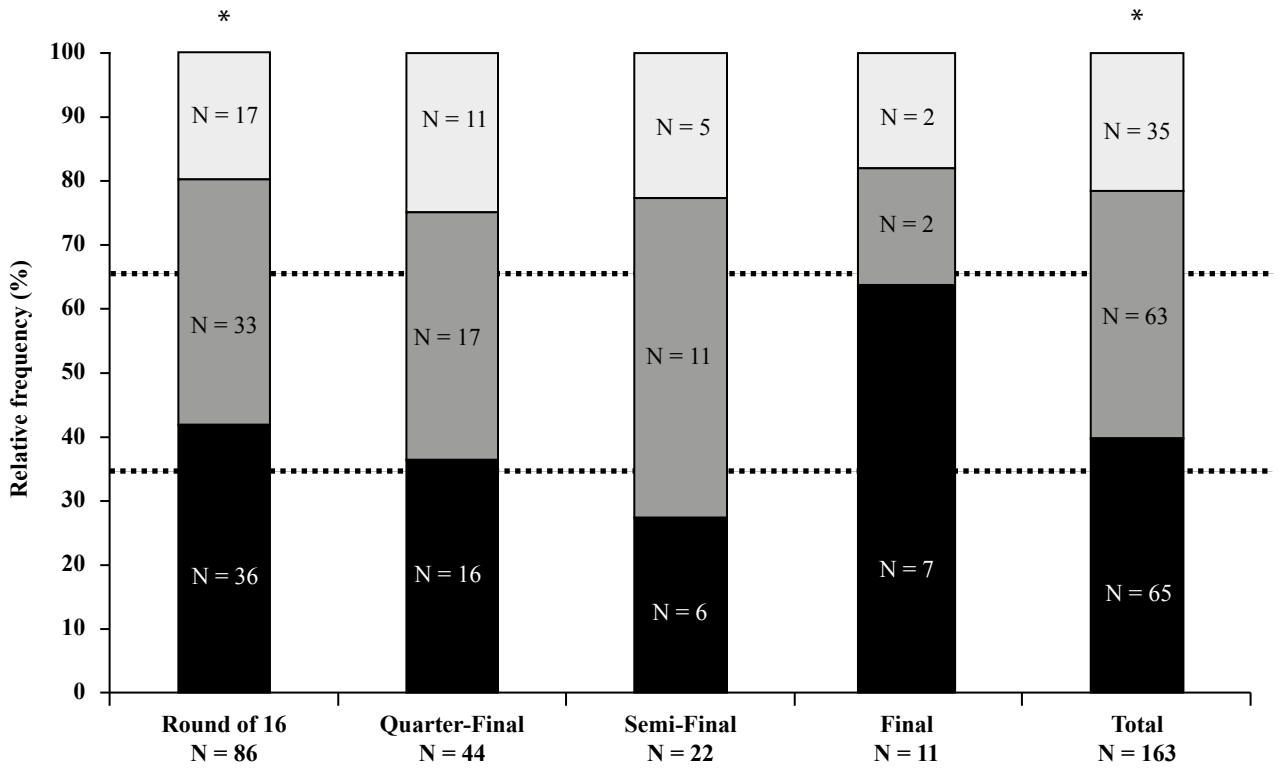

Figure 1. Home (black box), draw (dark grey box) and away (light grey box) results in the second-leg home advantage concept concerning the aggregate final result.

Table 2. Chi-square statistic (P-value), Full Bayesian Significance Tests (E-value), probability occurrence (p1<1/2) for the comparison between second-leg home advantage occurring due to the goals away rule or by penalty shoot-out decisions during each competitive phase.

Win form		**Chi-square**	***P*-value**	***E*-value**	***P* (p1>1/2)**
Goals away rule	**Eight-final**	0.14	0.70	0.68	0.36
	Quarter-final	1.80	0.18	0.13	0.89
	Semi-final	1.00	0.32	0.24	0.19
	Final	--	--	---	
	Total	0.00	1.00	1.00	0.50
Penalty shoots	**Eight-final**	0.00	1.00	1.00	0.50
	Quarter-final	6.00	0.01	0.01	1.00
	Semi-final	1.00	0.32	0.25	0.75
	Final	0.00	1.00	1.00	0.50
	Total	2.56	0.11	0.09	0.94

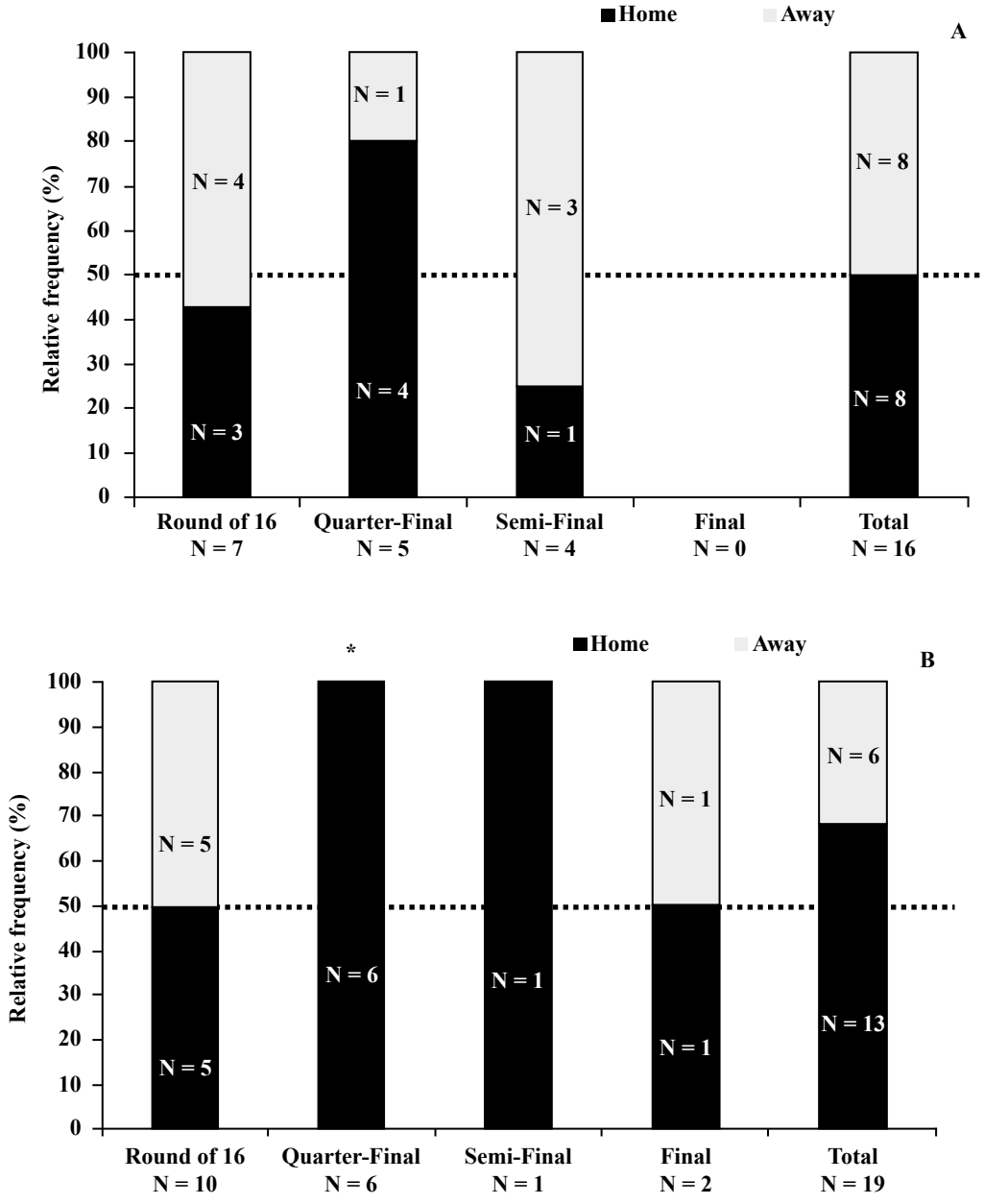

Figure 2. The relative distribution of second-leg home advantage defined by the goals away rule (Panel A) or by penalty shoot-out decisions (Panel B) during each competitive phase.

Table 3. Chi-square statistic (P-value), Full Bayesian Significance Tests (E-value), probability occurrence (p1<1/2) and predictive value for comparisons between second-leg home advantages occurring according to all win forms (full-time, goals away rule and penalty-shoots) during the round of 16, quarterfinal, semi-final and final, and all matches defined as binomial "HOME" or "AWAY" results according to all win forms (full-time, goals away, and penalties).

	Chi-square	*P*-value	*E*-value	*P* (p1>1/2)	Predictive
Eight-final	0.05	0.83	0.83	0.58	0.51
Quarter-final	1.45	0.23	0.22	0.88	0.59
Semi-final	1.64	0.21	0.18	0.11	0.37
Final	2.23	0.13	0.11	0.93	0.70
Total	0.50	0.48	0.48	0.76	0.53
Full-time	0.03	0.86	0.86	0.57	-
Goals away	0.00	1.00	1.00	0.50	-
Penalties	2.58	0.11	0.09	0.94	-
Total	0.50	0.48	0.47	0.76	-

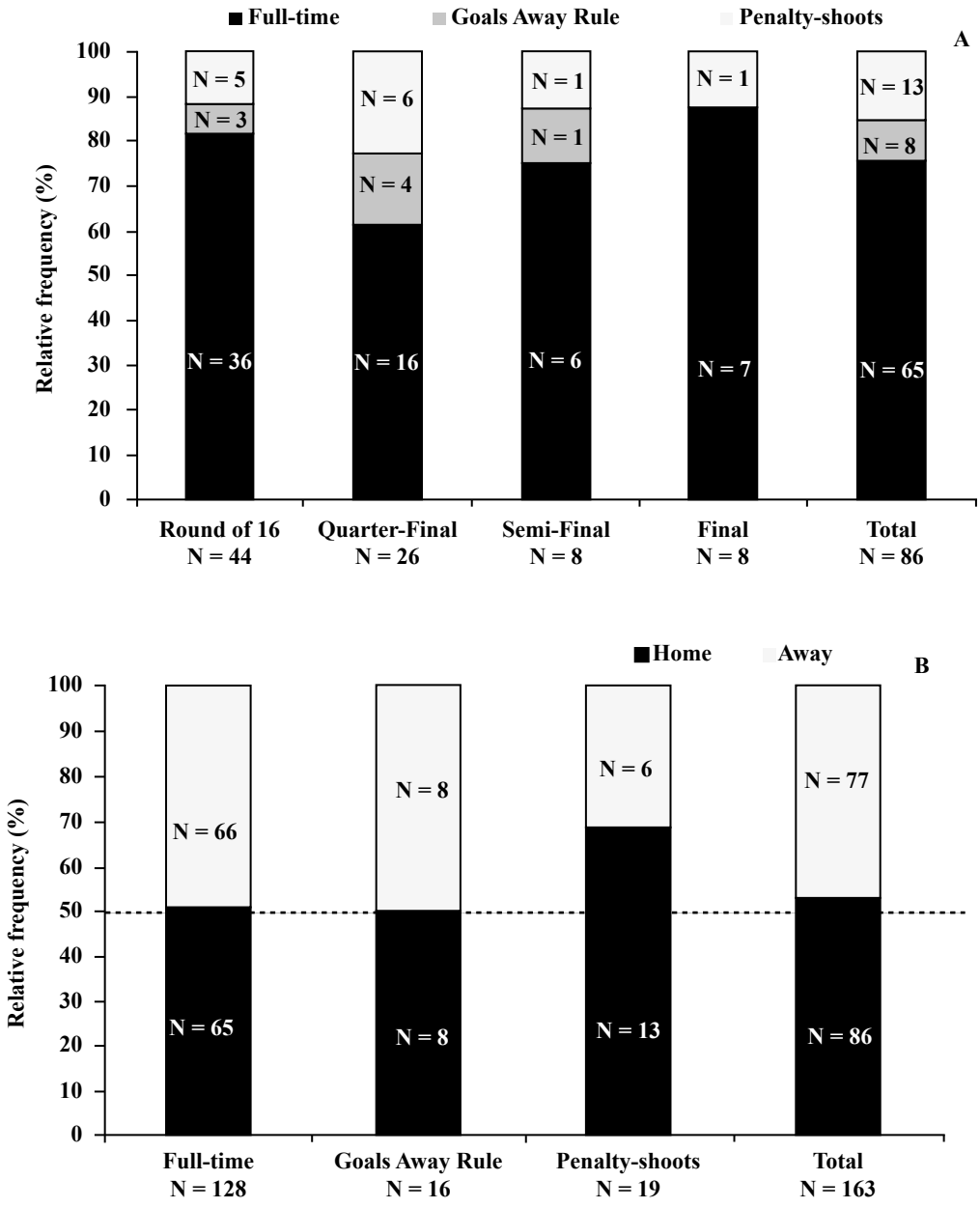

Figure 3. Second-leg home advantage occurring through all win forms (full-time, goals away rule and penalty shoot-outs) during the round of 16, quarterfinal, semi-final, final and total (Panel A), and the second-leg home advantage of all matches defined as binomial "HOME" or "AWAY" results according to full-time, goals away rule and penalty shoot-outs win forms (Panel B).

Discussion

The present study investigated the second leg HA concept of the most important football tournament in South America, the Copa Libertadores da América, from 2005 to 2015. The influence on the second-leg HA of the goals away rule and penalty shoot-outs was also investigated. Furthermore, the probability that teams that play the second match at home in a two-leg knockout match (second-leg HA) win the tie when disputing round of 16, quarterfinals, semi-finals and final phases was assessed by both naïve analysis (χ^2) and the full Bayesian significance test (FBST). The main findings were that: i) HA occurred in second-leg HA concept (52.76%) when direct wins, goals away rule and penalty shoot-outs were considered together; ii) second-leg HA varied in accordance to the competition phase with semi-finals showing the lowest second-leg HA (36.36%), and the final phase the highest second-leg HA (72.73%); iii) the penalty-shots seemed to affect positively the second-leg HA.

The second-leg HA found in the present study was in accordance to other authors who investigated the second-leg HA in European tournaments. Page and Page[29], for example, investigated the second-leg HA effect in European Football Cup competitions (N=6084 two-leg knock-out rounds) and reported the probability of winning at the end of two legs for the second-leg home team of 54.98%[29]. In another study, Eugster, Gertheiss, Kaiser[30] found 56% of the probability of winning

in favour of the team having the return match at home in the UEFA Champions League. Despite the similarity found among the studies, it is important to note that comparisons between them require some caution because the calculations used to assess second-leg HA may influence the HA interpretations. For instance, Lidor, Bar-Eli, Arnon, Bar-Eli[31] used a multiple Chi-square analyses suggesting that teams which play the second game at home had a substantially higher chance of advancing to the next round than the teams playing the first game at home[31]. On the other hand, using a regression model and a discriminant analysis, García-Rubio, Gómez, Lago-Peñas, Ibáñez[20] found no effect in the success of the team that plays this match at home[20]. Similarly, although the naive analysis performed by Eugster, Gertheiss, Kaiser[30] allows to find a probability of winning in favour of the team having the return match at home of 56%, by a refined statistical data analysis the authors suggested no evidence for the second-leg HA occurrence in the UEFA Champions League[30]. The authors argue that the differences in frequencies of winning between teams first playing away and those which are first playing at home may be explained by their performances on the group stage and by the teams' general strength. They also suggested that the draw is not completely random and a higher percentage of victories for the second-leg home team over the two legs could be a result of differences in teams' ability. This could occur because in the round of 16 the effect of having the return match at home cannot be separated from the teams' performances on the group stage. In fact, by the UEFA regulations, group winners automatically play runners-up and have the return match at home. Thus, since a group winner tends to be a stronger team than a second-place finisher, it can be assumed that it is more likely that a group winner reaches the next round. So, even if there was no effect of having the second-leg at home/away, counting only the number of ties where the team succeeds which is playing the return match at home would produce results in favour of those teams. It is important to emphasize that the refined statistical model used by Eugster, Gertheiss, Kaiser[30] was not possible to be applied in the present study because, in opposite to the team coefficient proposed by the UEFA, the CLA does not have this team coefficient. Therefore, the refined statistics cannot be used in the present study. The CONMEBOL could create a South American ranking and future studies would compare the second-leg HA by refined statistical analysis between UEFA and CLA.

In opposite to our hypothesis that second-leg HA would to be reduced in advanced stages of the competition due to better teams go forward in the competition and suffer lower than worse eliminated teams from factors that affect HA, the results of CLA did not sustain this thought. Although the argue of Eugster, Gertheiss, Kaiser[30] that "since a group winner tends to be a stronger team than a second-place finisher it can be assumed that it is more likely that a group winner reaches the next round", it seems incorrect for the CLA because observational data indicates that since 2005 - when CONMEBOL established the rule that the best team of the group phase would play the second game in your home – from the 11 teams that finish the group phase in first, 4 (36.36%) were eliminated in the round of 16, 2 (18.18%) in quarter-finals, 3 (27.27%) in semi-finals, only 2 (18.18%) going ahead until the final phase, and only one (9.09%) won the CLA. Furthermore, from the 11 champions, 6 (54.55%) were the 8 worst teams during the group phases [Santos-BR 9º (2011); Estudiantes-ARG 10º (2009), Boca Juniors-ARG 11º (2007), LDU Quito-EQU 11º (2008), San Lorenzo 15º (2014), River Plate 16º (2015)] whereas the other 5 champions (46,45%) were the 8 better equips during the group phases [Atlético Mineiro 1st (2013), Internacional 2nd (2006), Corinthians 2nd (2012), São Paulo 5th (2005), and Internacional 6th (2010)]. Although it was expected that the HA should reduce during each advanced phase of the competition, this behavior seems to occur only in UEFA Champions League but not in CLA. Probably, differences in cultural aspects, people education, distance travel, territoriality, and crowd effect can justify these variances in HA between Europe and South America.

The higher second-leg HA found in penalty-shot than full-time or goals away rule decisions in the present study was curious because it is well established that team history (previous win or lose)[35]; uniform colour[36]; fatigue overcoming after the match[37]; players selection[38]; temporal preparation for the penalty kick[39]; pre-penalty kick gaze [36]; body language[40]; nonverbal behaviour of the player[41]; run-up direction[38]; skill of the player[42]; anticipatory taker and goalkeeper movements[43], public appraisal[39], and emotional contagion[40] may affect the penalty shoot-out performance. Therefore, it was expected that these aforementioned aspects could impair penalty shoot-out performance for both home and away teams. However, our results suggest that home teams seem to have additional advantage to decide the final decision by penalty shoot-out in their home, whereas away teams showed lower success than home teams.

Despite the originality of the present study to investigate the second-leg HA in CLA, this area remains open to several investigations and has become an interesting research topic for soccer science, especially in South America.

Conclusion

Summarizing, overall second-leg HA found in the present study showed a light evidence for second-leg HA with semi-finals bringing the lower second-leg HA, whereas the final phase brings the highest. Penalty shots seemed to affect positively the second-leg HA in comparison to wins occurred during full-time or by goals away rule. Our results contradict the common belief that there is a higher advantage to play the second match of a two-leg tie at home in all competition phases. Opposite to this belief, our results suggest that a good performance in the group phases is not always related to success in the competition, nor does it mean an easier route to the final. In practical terms, soccer coaches and managers need to think of strategies to maintain soccer players´ concentration, motivation and attention as high as possible, game after game, independently of the competition´s phase or adversary. In addition, it would be interesting to prepare away teams better for final decided by penalty shoot-outs.

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