LEADING ARTICLE

Sports Med 1999 Oct; 28 (4): 221-236
0112-1642/99/0010-0221/$08.00/0

Home Advantage in Sport

An Overview of Studies on the Advantage of Playing at Home

Alan M. Nevill[1] and *Roger L. Holder*[2]

1 Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, England
2 School of Mathematics and Statistics, University of Birmingham, Birmingham, England

Abstract

This review identifies the most likely causes of home advantage. The results of previous studies have identified 4 factors thought to be responsible for the home advantage. These can be categorised under the general headings of crowd, learning, travel and rule factors. From the accumulated evidence, rule factors were found to play only a minor role (in a limited number of sports) in contributing to home advantage. Studies investigating the effect of learning factors found that little benefit was to be gained from being familiar with the local conditions when playing at home. There was evidence to suggest that travel factors were responsible for part of the home advantage, provided the journey involved crossing a number of time zones. However, since high levels of home advantage are observed within countries where travel distances are not great, travel factors were not thought to be a major cause of home advantage. The evidence from studies investigating crowd factors appeared to provide the most dominant causes of home advantage.

A number of studies provide strong evidence that home advantage increases with crowd size, until the crowd reaches a certain size or consistency (a more balanced number of home and away supporters), after which a peak in home advantage is observed. Two possible mechanisms were proposed to explain these observations: either (i) the crowd is able to raise the performance of the home competitors relative to the away competitors; or (ii) the crowd is able to influence the officials to subconsciously favour the home team. The literature supports the latter to be the most important and dominant explanation. Clearly, it only takes 2 or 3 crucial decisions to go against the away team or in favour of the home team to give the side playing at home the 'edge'.

For the first time in their history, France won the soccer World Cup in 1998. Never having reached a world cup final before, France's only other previous major international soccer success, that of winning the European Cup in 1984, also occurred on home soil. Did these supreme sporting achievements reflect France's true ability, that coincidentally occurred in front of their home supporters, or do they simply provide further examples of the already overwhelming evidence of home advantage?

Before attempting to answer this question, it is important to be clear what is meant by home advantage. In their seminal review, Courneya and Carron[1] defined home advantage as 'the consistent finding that home teams in sports competitions win over 50% of the games played under a balanced home and away schedule'. Provided the competition is balanced, with teams competing an equal number of games both home and away, the home advantage for the entire competition can be assessed

as the number of games won by teams playing at home, expressed as a percentage of decided games. An alternative definition would be to score 2 points for a win, 1 point for a draw and 0 for a loss and to then calculate the percentage of points accrued by the team when playing at home. However, care needs to be taken with subsequent statistical analyses when adopting this second definition. Some authors have incorrectly investigated home advantage using chi-squared tests where total points have been confused with total frequencies. Another analytical error made when including tied games in chi-squared tests has been to assume, in the absence of a home advantage, that the 3 possible outcomes (win, draw and loss) are equally likely. Both will lead to grossly inflated chi-squared test statistics.

The straightforward approach of calculating home advantage using the percentage of games won by home teams throughout the competition is suitable, since the quality of the opposition effect, the other major factor likely to influence the game outcome, is effectively eliminated by counterbalancing the game location. However, more recent research into home advantage has not been restricted by this holistic approach. The work of Clarke and Norman[2] has enabled individual team home advantage to be assessed that should, in theory, provide a more sensitive measure of home advantage for further research. More recently, the work of Nevill et al.[3] and Holder and Nevill[4] has proposed an alternative approach to assessing home advantage in competitions that are not balanced, such as international golf and tennis tournaments. Interestingly, by applying these methods to the results of the 1998 soccer World Cup, we are able to answer the question posed in the opening paragraph: did France enjoy a home advantage in winning the 1998 World Cup?

The purpose of this literature review is to provide a comprehensive overview of these and other studies investigating the advantage of playing at home. Adopting the conceptual framework proposed by Courneya and Carron,[1] we shall assess whether we are any closer to answering the ultimate question: why does home advantage exist? We shall also provide directions and recommendations for future research.

1. The Existence of Home Advantage

1.1 Balanced Competitions

Provided games are played under a balanced home and away competition, the evidence that home advantage exists is overwhelming.[1,5-15] The collective results reporting a home advantage prior to 1992 are given by Courneya and Carron.[1] The additional evidence since that date is listed in table I.

An updated composite home advantage table that combines the results of the major team sports reported by Courneya and Carron[1] and those given in table I (using a weighted average) is summarised in table II.

Clearly, this evidence of home advantage is huge and still growing. The home winning percentage deviates significantly from the assumption of no advantage (the null hypothesis; $p = 0.5$) in all major team sports using a simple binomial test. For example, assuming no home advantage in baseball, the expected number of home wins would be $\mu = n \cdot p = 66\,780$ (SD $\sigma = \sqrt{npq} = 182.7$, where $\sqrt{}$ = square root, n = number of games, p = probability of win at home and $q = 1 - p$). The number of home wins was considerably greater, observed as 72 523 (54.3% × 133 560). Expressed as a standard score, this becomes $z = (72\,523 - 66\,780)/182.7 = 31.4$ (p

Table I. Home winning percentages (HWP) in sports competitions since 1992

Authors	Level of sport	Seasons	Number of games	HWP[a] (%)	HWP[b] (%)
Adams and Kupper[12]	Major league baseball	1900-91	133 560		54.3
Agnew and Carron[13]	Major junior-A ice hockey	1986-88	990	58.8	61.5
Moore and Brylinsky[14]	College basketball	1992-93	90		64.4
Nevill et al.[15]	Soccer	1992-93	3291	57.6	60.4

HWP[a] = home winning percentage (2 for a win, 1 for a draw and 0 for a loss); **HWP[b]** = home winning percentage (drawn games excluded).

Table II. The combined home winning percentages (weighted) for the major team sports

Sport	Number of studies	Number of games	HWP[a] (%)	HWP[b] (%)
Baseball	1	133 560		54.3
American football	5	2592	57.3	57.3
Ice hockey	5	5312	59.5	61.2
Basketball	9	13 686		64.4
Soccer	3	40 493	63.9	68.3

HWP[a] = home winning percentage (2 for a win, 1 for a draw and 0 for a loss); **HWP[b]** = home winning percentage (drawn games excluded).

< 0.0001), assuming the usual normal approximation to the binomial distribution.

1.2 Home Advantage of Individual Teams in Balanced Competitions

As described in section 1.1, the existence of home advantage for balanced competitions, measured by the percentage of matches won by the home teams, is now well documented. Courneya and Carron[1] suggest that future research should be directed towards the causes of home advantage rather than its existence. However, Clarke and Norman[2] suggest that one way to assess the possible causes of home advantage in balanced competitions would be to assess an individual team's home advantage, so that this degree of home advantage can be related to playing characteristics of each team.

In order to correctly calculate the home advantage of individual teams, the ability of the opposition must also be included. Clarke and Norman[2] proposed the following mathematical model to describe the goal difference or winning margin at the end of each game, w_{ij} (the home and away team effects being identified by the subscripts i and j, respectively):

$$w_{ij} = u_i + h_i - u_j + e_{ij}$$

where u_i is the home team's ability (u_j being the away team's ability), h_i is the home team's advantage when playing at home and e_{ij} is the unexplained random error.

Clarke and Norman[2] fitted the above model to the results of English soccer matches using standard linear regression, defining the winning margin as the response variable and using dummy/indicator variables to estimate the team ability u_i and home advantage parameters h_i. However, they go on to show that precisely the same parameter estimates can be obtained using only a calculator and the results from the final league table/ladder. The authors applied these above methods to all English soccer matches (Divisions 1, 2, 3 and 4) from the 1981/1982 to the 1990/1991 season, providing individual team h_i estimates for all 94 teams over the 10 years.

Surprisingly, due to the large variation in the individual team (h_i) estimates, very little additional insight was obtained as to the causes of home advantage. Apart from the highly significant evidence that home advantage was worth just over 0.5 of a goal per match, the only other significant finding was the year effect. The home advantage was 10% higher in the 1982/1983, 1983/1984 and 1985/1986 seasons, but 10% lower in the 1981/1982, 1987/1988 and 1989/1990 seasons. We note that such a year effect could have been identified without calculating the home advantage parameters of the individual teams, i.e. simply using a chi-square test of independence (analysing the frequencies of home *vs* away over the 11 years).

The work of Clarke and Norman[2] was extended by Clarke[16]to cover the seasons from 1991 to 1996. The results echoed the findings of Clarke and Norman.[2] One interesting finding of both studies, although not quite significant in Clarke and Norman,[2] was the significantly lower home advantage of the 13 London clubs (0.29 goals per match) compared with the 81 non-London clubs (0.44 goals per match). Interestingly, even this finding had been anticipated by Pollard[10] who observed a significantly lower home advantage in local 'derby' soccer matches. A surprising finding of the study by

Clarke[16] was the lack of consistency in the home advantage parameters h_i from one year to the next. The correlations were very low and sometimes negative, suggesting that individual team home advantage is a relatively transient or random effect. This may explain why very little additional insight into the causes of home advantage was obtained using this approach and, as such, may question the benefit of calculating individual team home advantage as a more sensitive measure of home advantage.

However, the assumption by Courneya and Carron[1] that the descriptive phase of the enquiry into home advantage is complete may have been premature, especially when considering unbalanced competitions such as individual golf majors and tennis grand slam tournaments,[3,4] and the final games of championship play-offs.[17-19] These subtle and not-so-subtle differences in home advantage revealed by such studies may provide a valuable insight into the causes of home advantage.

1.3 Home Advantage in Unbalanced Competitions

Does the same home advantage, observed in balanced major team sports, exist in unbalanced competitions such as grand-slam tennis tournaments, golf majors and world cup soccer finals? A number of studies have examined this question but with quite different conclusions. McCutcheon[20] found a small but significant home advantage with high school cross-country runners (53.5%). A similar home advantage was observed with high school wrestlers.[21] Bray and Carron[22] also found some evidence of home advantage when studying World Cup alpine skiing. However, it is not clear how these studies attempted to overcome the serious methodological problem that the observed home advantage may have been simply due to the home competitors being better athletes than the away competitors. It is this problem that Nevill et al.[3] addressed when attempting to identify home advantage in international tennis and golf tournaments.

As stated earlier, the holistic approach of calculating home advantage using the percentage of wins by teams playing at home in a balanced competition is appropriate, since the quality of the team effect, the other major factor likely to influence the game outcome, is effectively eliminated by counterbalancing the game location. However, when considering home advantage in unbalanced competitions, such as individual golf majors and tennis grand slam tournaments, there is a need to adjust the tournament results for the quality or standard of the competitors prior to the competition before any home advantage can be assessed. For example, if all the British golfers competing in the British Open were better (higher world ranked) golfers than the visiting competitors, an apparent home advantage would be inferred if the results of the British golfers were significantly better than their foreign counterparts. Clearly, there is a need to adjust the tournament results to take into account the standard of all the golfers prior to the competition before valid inference into the existence of home advantage can be made.

Using the world rankings of the competitors prior to competitions as their relative standard or quality, Nevill et al.[3] investigated the presence of home advantage in the international grand slam tennis and major golf tournaments in 1993. Regression analysis (defining log-transformed performance rank as the response variable) was used to detect any home advantage associated with competitors representing the host country (home competitors) in comparison with their visiting counterparts (away competitors). The proposed test, to compare the regression parameters of the home and away regression lines, is similar to traditional analysis of covariance (ANCOVA), to compare the home and away competitors' tournament result ranks using the log of their world ranks as the covariate, i.e. adjusting all competitors to have the same world rank.

Home advantage would be present if the regression line parameters differed significantly and the results of home competitors were located below the results of the away competitors, i.e. the majority of the results of the home competitors were numerically lower than the results of the away competitors. Because the assumptions required for the regression analyses would not be met precisely, i.e. the dependent variable (log transformed result ranks)

will not be exactly normally distributed with constant error variance, more complex distribution-free tests could be applied.[4] Interestingly, this made no difference to the conclusions described below.

The results provided little evidence of home advantage in either the 4 grand slam tennis tournaments or the 4 golf major tournaments held in 1993. The only possible evidence of home advantage was found in the Wimbledon tennis championships and the US Open golf championships. In both cases, some of the lower (numerically higher) ranked home competitors, who were given privileged (e.g. wild card) entry to the tournaments, had a greater opportunity to perform above their anticipated world rankings. Hence, Nevill et al.[3] concluded that provided the entry into tennis and golf tournaments is truly 'open' (without restriction) to both the host nation's representatives and foreign competitors alike, home advantage was not a major factor likely to influence the competitors' performance in such competitions.

Using these regression methods described by Nevill et al.,[3] we can now answer the question posed in the opening paragraph of the introduction: did France's success, by winning the 1998 World Cup, simply provide another example of home advantage? The FIFA/Coca-Cola world rankings, obtained from the internet (http://www.fifa2.com) as of 20 May 1998, and the final results/finishing positions recorded as ranks (e.g. losing quater-finalists were allocated the rank 6.5 = (5+6+7+8)/4 etc.) were obtained from *The Independent* newspaper (13 July 1998). These results, together with the log transformed ranks, are listed in table III.

Clearly, because there is only one home team, we can only test whether there exists a significant difference in the intercepts between the away team's regression line and the line, with the same slope, passing through the home team's result. We shall therefore define home advantage in this context as significantly different intercepts. This is equivalent to determining if the data point of France would fall on the regression line fitted to all the remaining teams. The plot of the log-transformed result ranks against the log-transformed world ranks are given in figure 1.

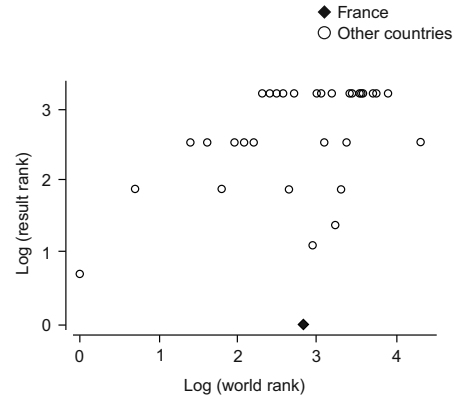

Fig. 1. Log-transformed result ranks plotted against the log-transformed world ranks for France and all other countries from the 1998 World Cup.

The analysis identified a significant difference in the intercept parameters for France compared with the remaining competing nations ($p < 0.001$). This was confirmed using the distribution free permutation methods proposed by Holder and Nevill.[4] While France was identified as the most significant outlier in a common regression for all 32 teams ($p < 0.033$), Croatia was the next largest outlier. This is also evident when observing the results of France (and Croatia) in figure 1. The 2 regression models explaining $R^2 = 48.5\%$ of the variance are given as follows:

lnresrank (France) = –1.06 + 0.375 lnwrank

lnresrank (others) = +1.62 + 0.375 lnwrank

where lnresrank = log (result rank) and lnwrank = log (world rank).

Based on their relatively low world ranking prior to the competition (17th), France's success was significantly better ($p < 0.001$) than all other nations competing and, as such, enjoyed a significant home advantage in winning the 1998 soccer World Cup.

1.4 Home Advantage or Disadvantage in Championship 'Play-Offs'

There is still fierce debate as to the existence of a possible home disadvantage, when the home team

Table III. The FIFA/Coca-Cola world rankings prior to, and the final results/finishing positions (recorded as ranks) after, the 1998 World Cup finals held in France

Country	World rank	Result rank	Home	lnwrank [log (world rank)]	lnresrank [log (result rank)]
Brazil	1	2.0	0	0.00000	0.69315
Germany	2	6.5	0	0.69315	1.87180
Mexico	4	12.5	0	1.38629	2.52573
England	5	12.5	0	1.60944	2.52573
Argentina	6	6.5	0	1.79176	1.87180
Norway	7	12.5	0	1.94591	2.52573
Yugoslavia	8	12.5	0	2.07944	2.52573
Chile	9	12.5	0	2.19722	2.52573
Colombia	10	24.5	0	2.30259	3.19867
USA	11	24.4	0	2.39790	3.19458
Japan	12	24.5	0	2.48491	3.19867
Morocco	13	24.5	0	2.56495	3.19867
Italy	14	6.5	0	2.63906	1.87180
Spain	15	24.5	0	2.70805	3.19867
France	17	1.0	1	2.83321	0.00000
Croatia	19	3.0	0	2.94444	1.09861
Korea	20	24.5	0	2.99573	3.19867
Tunisia	21	24.5	0	3.04452	3.19867
Romania	22	12.5	0	3.09104	2.52573
South Africa	24	24.5	0	3.17805	3.19867
Netherlands	25	4.0	0	3.21888	1.38629
Denmark	27	6.5	0	3.29584	1.87180
Paraguay	29	12.5	0	3.36730	2.52573
Jamaica	30	24.5	0	3.40120	3.19867
Austria	31	24.5	0	3.43399	3.19867
Saudi Arabia	34	24.5	0	3.52636	3.19867
Bulgaria	35	24.5	0	3.55535	3.19867
Belgium	36	24.5	0	3.58352	3.19867
Scotland	41	24.5	0	3.71357	3.19867
Iran	42	24.5	0	3.73767	3.19867
Cameroon	49	24.5	0	3.89182	3.19867
Nigeria	74	12.5	0	4.30407	2.52573

appears to 'choke' on their own territory in the final games of a championship play-off. This concept was first introduced by Baumeister and Steinhilber,[17] who examined archival data from the baseball World Series from 1924 to 1982. They found that when the home team was close to victory, as in the decisive seventh game of the series, they won only 39% of the games. Their arguments appeared even more compelling in the light of data from basketball play-offs being generally consistent with the data from baseball. Independent archival investigations by other researchers have found similar effects in golf[23] and ice hockey.[24]

However, a number of authors have questioned the concept of 'home field championship choke'.[1,18,25,26] Courneya and Carron[1] argue that the whole concept is, at the very least, a tenuous assertion in light of the number of games on which it is based. Indeed, Schlenker et al.[18] go on to report that since 1982, 4 baseball World Series went to a seventh game and every one of these was won by the home team. Since 1982, similar findings were observed in basketball, with the 6 final and semi-final championships that went to 7 games all won by home teams. Arguments and counter-arguments followed in the literature[17-19,27] and the debate is

clearly set to continue for some time. However, one conclusion from this debate seems reasonable. There does appear to be strong evidence of a *reduced* home advantage in the latter stages of championship games. This had been observed by Pollard[10] when reporting the home advantage in the FA Cup from 1960 to 1984. He noted a greatly reduced home advantage of 50.5% in the sixth round of the competition, a finding that supports the assertion that home advantage is diluted at the crucial stages of a competition.

2. Game Location Factors Associated with Home Advantage

Courneya and Carron[1] identified 4 game location major factors likely to effect the degree of home advantage. These are crowd factors, learning/familiarity factors, travel factors and rule factors. We shall assess the relative importance of these factors and, in the light of recent research, examine to what extent this research has adopted the 3 approaches recommended by Courneya and Carron[1] as 'possible future directions' for further research. Briefly, the following 3 approaches were recommended: (i) selecting a game location factor (e.g. crowd size) and observing the way home advantage varies for the home and away teams with different levels of the factor; (ii) observing differences in home advantage when only 1 game location factor is present (or absent); and (iii) observing how differences in home advantage, such as the number of fouls, vary with differences in crowd behaviour, such as cheering or booing.

We recognise that the approaches above are not true experimental designs, but are often referred to as *quasi-experimental* designs. Nevertheless, their purpose is to fit the investigations into a real world setting while controlling as many as possible of the confounding effects that could threaten the internal validity of the study.

2.1 Crowd Factors

There has been conflicting evidence as to how important crowd support is in contributing to home advantage. Studies by Dowie[8] and Pollard[10] found very little evidence that home advantage varied with crowd density (percentage of ground capacity). Based on the home advantage across the 4 divisions of the English football (soccer) league, the authors found little difference in home advantage even though the average crowd density increased from 20% in division 4 to 70% in division 1.

In contrast, Schwartz and Barsky[5] found that the home advantage in major league baseball increased with crowd density. The trend in home winning percentage increased from a home advantage of 48% in relatively empty stadia (less than 20% capacity), to 55% when the stadia were between 20 and 40% capacity and to 57% when crowd density was greater than 40%. Interestingly, Schwartz and Barsky[5] recognised the need to partition out the effects of *both* home advantage and team quality. Assuming constant additive effects, the authors were able to show that the home advantage had a marginally stronger effect than the quality of team effect when comparing the number of runs scored by division 1 and division 2 teams.

Further evidence that crowd density effects the home advantage in major junior-A ice hockey comes from a study by Agnew and Carron.[13] Multiple regression was used to investigate the predictive effect of the main effects, crowd size (entered both as absolute size and as a percentage of the arena capacity), time of year (first or second half of the season), opponent's division (2 divisions of data were available) and all interactions between these factors. Using the results (game outcome) of 990 games as the response variable (2 for a win, 1 for a draw and 0 for a loss), the regression analysis found that crowd density was significantly related to home advantage ($R^2 = 0.011$, $p < 0.001$). The authors concluded that only a small (but nevertheless significant) percentage of the variance in home advantage could be explained by crowd factors.

Moore and Brylinsky[28] seized on a unique opportunity to assess the effect of crowd support on team performance in college basketball. During the 1988/1989 season, a measles epidemic resulted in a quarantine that caused 11 North Atlantic Conference basketball games for 2 teams (Siena and Hart-

ford) to be played without spectators. When the results for both teams were analysed, evidence of an improved performance in the total number of points scored, field goal percentage and free throw percentage was found when no crowd was present. This result was counter-intuitive to the findings described above, but the authors acknowledged that the power of the statistical test used to analyse the data was low. Furthermore, the quality of the opposition effect, the other major factor known to influence performance outcomes, was not incorporated into the analysis and, as such, the findings of the study may be misleading.

Evidence that the crowd may be able to influence the number of fouls and turnovers, and hence the home advantage, in college basketball, comes from a study by Thirer and Rampey.[29] The authors found that during normal crowd behaviour, the visiting teams committed more infractions, (i.e. committed more fouls and lost more possessions or turnovers). However, home teams committed more infractions during antisocial crowd behaviour (swearing, chanting obscenities). The authors concluded that 'anti-social behaviour from the crowd had a detrimental effect on the home team'.

Greer[30] also assessed the effect of crowd behaviour (spectator booing) on the performance outcomes of home and away teams (points scored, turnovers, violations and composite score comprising of points scored minus turnovers and violations). Greer[30] observed that during normal crowd behaviour, home teams were better on all 4 performance outcomes. During those instances when the crowd were booing (for longer than 15 seconds), the home team's superiority increased further in all 4 performance outcomes, 2 being significant. Greer[30] speculated that the observed increase in the home team's performance measures (home advantage) was because of either a decrement in the visiting team's performance or to referee bias resulting from intimidation by the home crowd (since most of the booing was directed at the officials).

Further support for an association between home advantage and crowd support comes from a study by Nevill et al.[15] Using results from the end-of-season (1992/1993) league tables, overall home advantage was confirmed in the 8 major divisions of the English and Scottish football (soccer) leagues. Furthermore, the degree of home advantage was found to be associated significantly with the mean attendance of each division. In an attempt to explain these findings, the number of sendings-off or penalties scored were recorded. The overall frequency of both sendings-off and penalties scored favoured the home side, but again this was not constant across the divisions. In divisions with large crowds, the percentage of home sendings-off was relatively small (30%) in contrast to no difference (50%) in divisions with smaller crowds. Similarly, the percentage of penalties scored by home sides in divisions with the largest crowds was large (>70%) in contrast to little or no advantage in divisions with smaller crowds. Nevill et al.[15] argued in the discussion that the reason why their findings conflict with the results of the studies by Dowie[8] and Pollard[10] might well have been due to the inclusion of the semi-professional leagues (G.M. Vauxhall league) and the 3 Scottish leagues where crowd sizes are considerably smaller. In support of these findings, Pollard[10] did acknowledge little evidence of home advantage (52.6%) with games of less importance (i.e. F.A. Sunday Cup games), when attendances would have been relatively small.

In order to help explain why officials make more subjective decisions in favour of the home side, Nevill et al.[31] investigated whether a crowd's reaction to various tackles/challenges (recorded on videotape during televised soccer games) were able to influence knowledgeable observers' opinions of what should be the correct decision. Eleven knowledgeable observers (semi-professional footballers, qualified referees and coaches) viewed 52 tackles/challenges from a televised football match, of which 26 were made by the home player and 26 by the away player. Six of the participants observed the video tape with no background crowd noise whilst the remaining 5 observed the video tape in the presence of background crowd noise. An analysis of the number of fouls awarded by the observers (excluding the referee's data) using the analysis of

Table IV. Frequency of home and away wins by the English and Scottish leagues/divisions for the 11 seasons from 1985 to 1996

League/division	Home wins (%)	Away wins (%)	Total wins
English Premier	2183 (64.3)	1211 (35.7)	3394
English 1st	2789 (66.0)	1438 (34.0)	4227
English 2nd	2887 (64.8)	1565 (35.2)	4452
English 3rd	2670 (64.0)	1500 (36.0)	4170
GM Vauxhall	2245 (60.5)	1466 (39.5)	3711
Scottish Premier	1025 (59.4)	702 (40.6)	1727
Scottish 1st	1137 (56.9)	860 (43.1)	1997
Scottish 2nd	1217 (58.2)	874 (41.8)	2091
Scottish 3nd	138 (50.4)	136 (49.6)	274
Total	16291 (62.6)	9752 (37.4)	26043

variance (ANOVA) identified a significant 2-way interaction between 'noise group' and 'team representation' ($F_{1,9} = 8.2$, $p = 0.019$). The noise of the crowd would appear to influence observers to award fewer fouls against home players, and more against away players (noise group), when compared with a group receiving the visual stimulus alone (no noise group), a tendency which was echoed by the match referee. Assuming that the decisions of officials may be affected in a similar way to the knowledgeable observers, these results provide the first experimental/empirical evidence of how official decisions may be influenced by crowd reactions in favour of the home side or against the away side, thus contributing to the explanation of home advantage.

Finally, Nevill et al.[15] observed that the division with the greatest home advantage in percentages of home wins, away players being sent off and home penalties scored was not the English premier league, but the English first division, where crowd sizes were considerably less. Similarly, based on the combined results of the 11 seasons from 1985 to 1996 (see table IV), the greatest percentage of home wins was also found in the English league division 1 (66.0%) and not in the premier league (64.3%).

Furthermore, when the percentage of home wins was examined separately for each season, the premier league had the highest percentage in only 2 of the 11 seasons. These results suggest that once the crowd has reached a certain size or consistency (the balanced nature of the crowd), a peak in home advantage is observed. These observations will be discussed in section 5, with special reference to the reduced home advantage observed in the latter stages of baseball and basketball championship play-offs,[17] and in the latter stages of the FA Cup and 'local derbies'.[10]

2.2 Learning/Familiarity Factors

Various authors have studied the contribution to home advantage made by familiarity with local conditions. Schwartz and Barsky[5] argued that if familiarity with local playing conditions was an important factor contributing to home advantage, we would expect it to be more important in ice hockey and basketball, where home advantage is most decisive, compared with baseball and American football, where it is least important (see table II). However, the authors acknowledged that the evidence seemed to go in the opposite direction. Familiarity with the playing area is clearly more relevant in baseball, where large differences exist in the stadium backdrop, playing surface, etc. from one baseball stadium to another. This apparent contradiction lead the authors to question the relevance of familiarity as a major factor when assessing the factors associated with home advantage.

Pollard[10] also noted that in English soccer there was no direct evidence that home advantage was affected by the relatively small differences in playing surfaces (predominantly grass). Dowie[8] commented on the large differences in the size of football league pitches, but the teams with the smallest (Bristol Rovers and Halifax Town) and largest playing areas (Manchester City and Car-

lisle) gained a similar home advantage (65.6%) to the rest of the league (64.5%), over the seasons from 1981 to 1984. Indeed, Queens Park Rangers, the only team playing on an artificial turf at home during that period, gained a home advantage of 63.9%, again no different from the rest of the league. Clarke and Norman[2] argued that the conclusions by Pollard[10] might have been affected by the relative strengths of the clubs (team ability). Taking team ability into account, Clarke and Norman[2] reassessed the home advantage of the 5 clubs (Bristol Rovers, Halifax Town, Manchester City, Carlisle and Queens Park Rangers) over the 11 seasons from 1981 to 1991 to find some evidence that these teams had a higher than average home advantage ($p = 0.076$). This evidence was strengthened by the results of a study by Barnett and Hilditch,[32] who found that teams playing on artificial pitches during the 1980s (Queens Park Rangers, Luton Town, Oldham Athletic and Preston North End) did indeed have a home advantage and, when reported to the Commission of Enquiry for the Football League in 1989, was of a sufficient scale to be a cause of concern. For this reason, artificial pitches are no longer permitted in the English and Scottish football leagues. The issue of whether home advantage exists for teams playing on artificial turf in baseball and American football did not appear to be a topic considered worthy of investigation by any of the studies identified by this review.

Moore and Brylinsky[14] seized on yet another unique opportunity to assess the effect familiarity with local playing conditions has on home advantage. During the 1992/1993 season, Western Michigan University basketball teams, both men and women, played their home games at 5 different locations while the new home stadium was being built. The results showed that home advantage was not diluted for either the men's or women's teams and was greater than the conference as a whole.

2.3 Travel Factors

The assumption that travel will be detrimental to the performance of visiting athletes, thought to experience fatigue and a disruption of familiar routines/habits, has been studied by various authors. However, the evidence is not overwhelming and has been conflicting. Snyder and Purdy[9] found a home winning percentage of 58.8% (based on 64 games) for visiting basketball teams travelling less than 200 miles. In contrast, for teams travelling over 200 miles, the home winning percentage was 84.6% (based on 26 games). The evidence of an additional home advantage for home teams competing against visiting teams that travel over 200 miles should be treated with some caution. Clearly, the number of games used by the study was very small. Using a much larger sample (3496 games), Pollard[10] found distance unimportant, with the same home advantage of 64.3% for teams travelling under and over 200 miles.

As stated earlier, inference from such studies is problematic since other confounding variables such as team ability, number of time zones crossed, number of days between games, etc., will affect performance simultaneously. In an attempt to overcome such problems, Courneya and Carron[33] and Pace and Carron[11] used multiple regression to identify those factors which were associated with home advantage in baseball and ice hockey respectively. Using game outcome as the response variable, the explanatory variables were entered as both main effects, such as distance travelled, number of time zones crossed, together with the 2-way interactions between the main effects. When all the variables and 2-way interactions were forced into the regression model used by Courneya and Carron[33] to predict the home advantage in basketball, the saturated model explained less than 1.2% of the variance in win/loss outcome. The only variable that was remotely related to home advantage was the length of the visiting teams' road trips.

Similar results were obtained when Pace and Carron[11] used multiple regression to identify those factors associated with home advantage in ice hockey. On this occasion, the authors used a stepwise process to identify a reduced model that explained 1.5% of the variance. The variables selected by the stepwise regression analysis were: (i) the interaction between time zones crossed × prepara-

tion time; and (ii) the visitors game number on the road. The authors concluded that only a small proportion of the variance in home advantage could be explained by travel-related factors. This type of approach has obvious advantages over the relatively simplistic approach adopted by Snyder and Purdy[9] and Pollard.[10] The only reservation we have with their statistical methods concerns the use of their discrete categorical variables, such as the number of time zones crossed, as continuous main effect and interaction covariates. Clearly, more valid results would have been obtained by entering these variables as dummy/indicator variables.

Various authors have examined the effect that travelling across time zones has on American football[34,35] and basketball team performance.[36] For American football games played during the day, Jehue et al.[34] observed a decline in the home advantage of west coast teams when travelling to both central and east locations. In contrast, when central and east teams travelled, there was little or no change in their home advantage. One explanation proposed was that adaptation to travelling across time zones occurs more rapidly with westbound travel compared with eastbound travel. Interestingly, Steenland and Deddens[36] observed a decline in the home advantage, in the National Basketball Association over the 8 seasons from 1987 to 1995, found to be associated with fewer free throws being scored by the home team. Assuming the number of free throws scored reflects the number of free throws being awarded as penalties, the observed association confirms the importance of officials' decisions in determining the degree of home advantage in basketball, a finding similar to the association observed by Nevill et al.[15] in soccer.

2.4 Rule Factors

Since the comprehensive review by Courneya and Carron,[1] there has been very little work focusing on the contribution that rule factors have made in explaining the home advantage. This will almost certainly reflect the limited evidence that such rules benefit the home side and the limited number of sports where such a rule exists (batting last in baseball and the last line change in ice hockey). As stated earlier, one of the major problems in assessing the impact of various game location factors on home advantage is the confounding effects of all the other factors that will be operating simultaneously on the performance/match outcomes. Courneya and Carron[37] carried out one of the few studies that has managed to control most, if not all, of the other major game location factors when investigating the effect of rule differences on home advantage. To test whether home teams in baseball have an advantage by batting last, they studied the results from a recreational slow-pitch softball tournament where all games were played as double headers with teams alternating home and away status. The results indicated that there was very little benefit to be gained from batting last.

3. Critical Psychological States

Clearly, in order for the game location factors described above to translate into a quantifiable aspects of home advantage (performance outcomes), as in points, goals, fouls, penalties, etc., they must have an impact on the competitors, coaches and/or officials, in either their thoughts and/or their deeds. Courneya and Carron[1] refer to the thought process as 'critical psychological states' and, if subsequently translated into deeds, as 'critical behavioural states'.

Very limited research has focused on the critical psychological states that may lead to home advantage. One such study by Jurkovac,[38] cited by Courneya and Carron,[1] examined college basketball players' perceptions of playing at home and away. The results showed that the players reported feelings of playing better in front of a loud and active crowd at home (97%) compared to playing away (74%). The players also felt that they were more confident (76%) and more motivated by visual signs of support such as banners (89%) when playing in front of a home crowd. Follow-up interviews of 14 of the athletes identified that crowd support was a motivational factor that resulted in greater confidence but created more pressure to win. Although criticised by Courneya and Carron[1] for not assessing more psychological states and adopt-

ing a retrospective questionnaire design (athletes had to recall their feelings/experiences after the games), they recognised the need for this type of research to assess athletes' perceptions in an attempt to explain the home advantage. Probably the most important finding from this research was the confirmation that competitors are more confident when playing at home in front of a supportive audience. Consequently, because competitors are more *confident* when playing at home, they *believe* they will be more successful and, as such, play better at home as part of the 'self-fulfilling philosophy'.

Bar-Eli et al.[39] studied how perceived spectator behaviour in competition might influence the psychological arousal and subsequent performance of competitors. The researchers proposed that an athlete's psychological state could be termed either 'crisis' or 'non-crisis', and that athletes perceived their psychological states in association with spectator response, their own actions and the game location. Specifically, the psychological state of an athlete was significantly vulnerable to high arousal and crisis as a result of negative responses from the audience after unsuccessful action or poor performance at home. This work does appear to provide some support for the findings of Baumeister and Steinhilber[17] on home field disadvantage.

4. Critical Behavioural States

As with critical psychological states, there has been very little systematic research into the critical behavioural states associated with home advantage, although a number of studies have examined the behavioural states of competitors and officials.

4.1 Competitors' Behavioural States

There are a number of behavioural states that might be associated with home advantage, including aggressiveness, effort expended, body posture and verbal/non-verbal communication. However, the majority of research into this area has focused on aggression. Although not unanimous, most studies have observed that visiting teams commit more fouls (probably the most commonly adopted measure of aggression) than home teams.[7,40-43] Courneya and Carron[1] cite the study by Schwartz and Barsky[5] as providing contrasting evidence that home teams are more aggressive. Upon more careful examination, however, the authors provide no data to support this statement and admit that 'while we cannot prove it directly, the bits of evidence we have been able to piece together suggest that teams win more games at home because they play more aggressively in their home territories'. The only studies that do not support the assumption that away teams are more aggressive are by McGuire et al.[44] and Russell,[45] who found no differences. These findings may not be contradictory, however, in that there may well be no difference in aggression between home and visiting competitors, but the observed difference in fouls may be simply a result of officials awarding more decisions in favour of the home side, for whatever reason (either bias, or more probably due to the subconscious influence of the home crowd[31]).

When studying home advantage in college basketball, Varca[7] distinguished between functional (increasing the chance of winning) and dysfunctional (decreasing the chance of winning) aggressive behaviour. The results support the hypothesis that home teams outperform visiting teams in terms of rebounds, blocks and steals (so-called functional aggressive behaviour) while visiting teams committed more fouls (dysfunctional aggressive behaviour). This work was supported by Glamser,[40] when investigating player misconduct and race in English soccer. The author concluded that 'the hostile atmosphere of an away game where such (social) support is lacking can clearly produce a dysfunctional aggressive response on the part of the visiting player and a less-than-objective view on the part of officials'.

4.2 Officials' Behavioural States

Although not unanimous, a number of studies have observed that officials consistently make more subjective decisions in favour of the home team.[7,30,40-43,46] In contrast, a recent study by Dennis and Carron[47] failed to find evidence of officiating bias in National Hockey League games when

comparing infractions (called *vs* not called) for both home and away players. In an attempt to understand why officials tend to make more decisions in favour of the home side, a recent study by Nevill et al.[15] was able to confirm that not only do officials in English and Scottish soccer make more subjective decisions (penalties and sendings-off) in favour of the home side, but the observed imbalance appears to increase in divisions with larger crowds. A number of studies, including Sumner and Mobley,[46] have recognised that this association may not be due to officiating bias in favour of the home side. Due to various reasons, visiting teams may deserve to be penalised more frequently (e.g. visiting teams spend more time defending). As such, the observed association may be the result of such defensive play rather than the cause of the home advantage.

In order to assess whether referees would feel pressure from the crowd to award fewer fouls against star players, Lehman and Reifman[48] adopted a quasi-experimental design to examine the association between player status (star *vs* nonstar) and the number of fouls called against professional basketball players both home and away. The results found that star players were penalised significantly less at home than away from home. In contrast, no differences were found for nonstar players. Lehman and Reifman[48] concluded that 'this pattern may reflect officials' reacting to pressure from the home crowd', a conclusion not dissimilar to that of Glamser[40] described above, i.e. resulting in 'a less-than-objective view on the part of officials'.

5. Conclusions

In their review, Courneya and Carron[1] suggested that the descriptive phase of the enquiry into home advantage is complete. However, based on the evidence from this review, this conclusion may have been a little premature. By examining the differences in home advantage both between and within sports, valuable insights into the causes of home advantage were obtained. For example, the lack of evidence of home advantage in individual sports such as golf majors and tennis grand slam tournaments,[3,4] when crowd sizes are considerable, may reflect the relatively objective nature of the scoring systems used in tennis and golf, unlike the subjective influence of officiating decisions on the outcome of team games such as soccer, basketball and ice hockey.

Another conclusion by Courneya and Carron,[1] that the magnitude of home advantage within each sport is consistent and has remained relatively stable over time, is also open to some debate. Schwartz and Barsky[5] found considerable differences in home advantage in major league baseball, with home advantage increasing from 48% in relatively empty stadia (less than 20% capacity) to 57% when crowd density was greater than 40%. Indeed, despite reporting that home advantage varied little across the 4 divisions of the English football league from 1970 to 1981 (approximately 64%), Pollard[10] acknowledged that there was a reduced home advantage in semi-professional leagues (approximately 60% in the Vauxhall-Opel League) and games of less importance (i.e. F.A. Sunday Cup; home advantage = 52.6%) when attendances would have been relatively small. Pollard[10] also reported a reduced home advantage in the latter stages of the FA Cup between 1960 and 1984, with no home advantage (50.5%) in the sixth round (quarter-finals, the last round before games are played on neutral grounds) when attendances would have been near capacity. This latter observation supports the findings of Baumeister and Steinhilber[17] that the home advantage is diluted at the crucial stages of a competition. Pollard[10] also noted a reduced home advantage in 'derby games', when a team plays against another team from the same town or city, when attendances are also relatively large (based on local derby matches in London from 1970 to 1981, when the home advantage was 56.1% compared with other games where home advantage was 64.1%).

These results are entirely compatible with the differences in home advantage observed by Nevill et al.[15] in the English and Scottish soccer leagues/divisions, and further supported by the results for the 11 seasons from 1985 to 1996 (see table IV).

The table reveals little or no home advantage in the Scottish third division (semi-professional) where crowd sizes are relatively small. Thereafter, the trend in home advantage increases to a maximum in the English first division (home advantage = 66%), but then declines in the English premier division (home advantage = 64%) where crowd sizes are at their greatest but also likely to be more balanced (with a greater proportion of away supporters). Indeed, we would anticipate similar, more balanced crowd support in local derbies, the final games of championship play-offs in baseball and basketball, and the final rounds of the FA Cup, where a reduced home advantage has already been reported. Clearly, if the home crowd were able to influence either the home competitors (to perform better than the away competitors) or the officials (to penalise the away side more frequently than the home side), the observed reduction in home advantage would naturally occur when the number of home and away supporters was more equal. Although such a conclusion seems entirely reasonable and plausible, as yet, no study has investigated the effect of crowd consistency (proportion of home and away supporters) on home advantage. As such, we recommend that crowd consistency should be a topic for future research into factors associated with home advantage.

The present review of the home advantage literature has provided crucial evidence to help solve the mystery of home advantage. From the evidence accumulated, we shall discuss the various game location factors in ascending order of importance.

Rule factors play a very minor role in contributing to the home advantage in only a minority of sports. In baseball, one of the few sports where batting last is thought to offer some advantage to the home team, Wright and House[49] 'guesstimated' that about 5% of the home field advantage was because of the strategic advantage of batting last. Even this relatively minor contribution might be an over-estimate if the findings of Courneya and Carron,[37] who found no advantage in batting last in recreational softball, can be extrapolated to major league baseball. Furthermore, since there are no strategic rules that favour the home team in most team sports where home advantage is greatest (basketball and soccer), we feel confident that rule factors are not the cause of home advantage.

The majority of studies investigating the effect of learning/familiarity factors on home advantage concluded that little advantage was gained from being familiar with the local playing conditions of the stadium. The only study that found familiarity with local playing conditions advantageous[32] identified that teams playing on artificial pitches (Queens Park Rangers, Luton Town, Oldham Athletic and Preston North End) had a distinct advantage compared with other teams in the leagues. For this reason, artificial pitches were banned in the English and Scottish football leagues following the Commission of Enquiry by the Football League in 1989. With this notable exception, the findings from the majority of studies suggest that familiarity with local playing conditions is not a major factor when assessing the home advantage phenomenon.

Again, the majority of studies investigating the effect of travel factors on the home advantage found only limited evidence that travel fatigue was responsible for the home advantage. However, studies examining the effect of travelling across time zones did identify significant fluctuation in home advantage.[34-36] All 3 studies identified jet lag as the likely cause of home advantage and, in particular, that west coast teams had an additional advantage when playing east coast teams on Monday nights, due to playing at a time closer to their circadian peak time of day. Once again, although travel across time zones will undoubtedly have some effect on the home advantage in competitions where long distances (trans-meridian) are involved, the home advantage still remains extremely high within countries where travel distances are not great. For example, Stefani[50] reported home advantages of 76.1 and 76.3% in Italian and Spanish soccer leagues, respectively. As such, travel factors are unlikely to be the major cause of home advantage.

On the other hand, evidence from studies investigating crowd factors appears to be the most fruitful and likely dominant cause of home advantage. Although not unanimous, there is strong evidence

that home advantage increases with crowd size until the crowd has reached a certain size or consistency, after which a peak in home advantage is observed. If the home crowd is able to influence the team's home advantage, as the crowd size gets larger, the home advantage would naturally increase. As the crowd size increases further, as is likely with additional away supporters attending local derbies and final rounds of knock-out competitions, the influence of the reactions of the home and away supporters would become more balanced and correspondingly reduce the size of home advantage. This is compatible with the observation of Baumeister and Steinhilber[17] that home advantage is diluted at the crucial stages of a competition.

There are 2 possible ways the crowd might influence home advantage: either the crowd can provide a psychological lift to raise the home competitors' performance relative to the away competitors, and/or the crowd are able to influence the officials to favour the home team. Jurkovac[38] provides some evidence that crowds are able to increase competitors' confidence to perform better in front of the home crowd. However, the lack of evidence of home advantage in individual sports such as golf majors and tennis grand slam tournaments, where crowd sizes are considerable, suggests that the crowd's ability to influence officials' decisions that favour the home team may be the more dominant cause of home advantage. This was precisely the conclusion reached by Wright and House,[49] when studying the home advantage in baseball. They 'guesstimated' that only about 5% of the home advantage was due to the psychological lift provided by the crowd, but approximately 40% (the largest single factor) of home advantage was due to officials' bias toward the home team. However, the present authors would question their use of the word 'bias'. Based on the work described in the present review, the crowd is more likely to be subconsciously influencing the officials' decisions rather than causing them to display overt bias.

The evidence that the crowd is able to influence officials' decisions in favour of the home side comes from studies such as Lehman and Reifman,[48] Glamser[40] and Nevill et al.[15] Clearly, it would only take 2 or 3 crucial decisions to go either against the away side or in favour of the home side, to give the home side the 'edge' during the game. Just how the crowd is able to influence the officials' decisions is, as yet, unclear. However, a recent study by Nevill et al.[31] suggests that a crowd's reaction to various tackles/challenges recorded on videotape during televised soccer games was able to influence knowledgeable observers' opinions of when a foul had occurred. The results confirmed that the observers had a tendency to award more fouls for challenges committed by the away player (compared with the home player) in the presence of the crowd reactions, a tendency or bias that disappeared when the crowd's reaction was absent. The authors concluded that crowd reactions appeared to influence observers to be more severe or aggressive when viewing challenges by the away players, compared with challenges by the home players. If we can extrapolate the observers' decisions to officials, then these results provide some evidence of how officials' decisions may be influenced by crowd reactions in favour of the home side, and thus provide a possible mechanism to help explain the home advantage phenomenon.

References

1. Courneya KS, Carron AV. The home advantage in sport competitions: a literature review. J Sport Exerc Psychol 1992; 14: 13-27
2. Clarke SR, Norman JM. Home ground advantage of individual clubs in English soccer. Statistician 1995; 44: 509-21
3. Nevill AM, Holder RL, Bardsley A, et al. Identifying home advantage in international tennis and golf tournaments. J Sports Sci 1997; 15: 437-43
4. Holder RL, Nevill AM. Players performance at international tournaments: is there a home advantage? J R Stat Soc 1997; 46: 551-9
5. Schwartz B, Barsky SF. The home advantage. Soc Forces 1977; 55: 641-61
6. Edwards J. The homefield advantage. In: JH Goldstein, editor. Sports, games and play: social and psychological viewpoints. Hillsdale (NJ): Erlbaum, 1979: 409-30
7. Varca P. An analysis of home and away game performance of male college basketball teams. J Sport Psychol 1980; 2: 245-57
8. Dowie J. Why Spain should win the World Cup. New Scientist 1982; 94: 693-5
9. Snyder EE, Purdy DA. The home advantage in collegiate basketball. Sociol Sport J 1985; 2: 352-6
10. Pollard R. Home advantage in soccer: a retrospective analysis. J Sport Sci 1986; 4: 237-48

11. Pace A, Carron AV. Travel and the home advantage. Can J Sport Sci 1992; 17: 60-4
12. Adams RD, Kupper SJ. The effect of expertise on peak performance: the case of home-field advantage. J Sport Behav 1994; 17: 108-19
13. Agnew GA, Carron AV. Crowd effects and the home advantage. Int J Sport Psychol 1994; 25: 53-62
14. Moore JC, Brylinsky J. Facility familiarity and the home advantage. J Sport Behav 1995; 18: 302-11
15. Nevill AM, Newell SM, Gale S. Factors associated with home advantage in English and Scottish soccer. J Sport Sci 1996; 14: 181-6
16. Clarke S. Home advantage in balanced competitions: English soccer 1991-1996. 3rd Conference on Mathematics and Computers in Sports; 1996 Sep 30-Oct 2; Queensland, Australia, 111-6
17. Baumeister RF, Steinhilber A. Paradoxical effects of supportive audiences on performance under pressure: the home field disadvantages in sports championships. J Personal Soc Psychol 1984; 47: 85-93
18. Schlenker BR, Phillips ST, Boniecki KA, et al. Championship pressures: choking or triumphing in one's own territory? J Personal Soc Psychol 1995; 68: 632-43
19. Baumeister RF. Disputing the effects of championship pressures and home audiences. J Personal Soc Psychol 1995; 68: 644-8
20. McCutcheon LE. The home advantage in high school athletics. J Sport Behav 1984; 7: 135-8
21. Gayton WF, Langevin G. Home advantage: does it exist in individual sports? Percept Mot Skills 1992; 47: 706
22. Bray S, Carron A. The home advantage in alpine skiing. Aust J Sci Med Sport 1993; 25: 76-81
23. Wright EF, Christie SD, McGuire GR, et al. The home-course disadvantage in golf championships: further evidence for the undermining effect of supportive audiences on performance under pressure. J Sport Behav 1991; 14: 51-60
24. Wright EF, Voyer D, Wright RD, et al. Supporting audiences and performance under pressure: the home-ice disadvantage in hockey championships. J Sport Behav 1995; 18: 21-8
25. Gayton WF, Matthews GR, Nickless CJ. The home field disadvantage in sports championships: does it exist in hockey? J Sport Psychol 1987; 9: 183-5
26. Kornspan AS, Lerner BS, Etzel EF, et al. The home disadvantage in the National Football League's conference championship games. Percept Mot Skills 1995; 80: 800-2
27. Schlenker BR, Phillips ST, Boniecki KA, et al. Where is the home choke? J Personal Soc Psychol 1995; 68: 649-52
28. Moore JC, Brylinsky JA. Spectator effect on team performance in college basketball. J Sport Behav 1993; 16: 77-84
29. Thirer J, Rampey M. Effects of abusive spectator behaviour on the performance of home and visiting intercollegiate basketball teams. Percept Mot Skills 1979; 48: 1047-53
30. Greer DL. Spectator booing and the home advantage: a study of social influence in the basketball arena. Soc Psychol Q 1983; 46: 252-61
31. Nevill A, Balmer N, Williams M. Crowd influence on decisions in association football [letter]. Lancet 1999; 353 (9162): 1416
32. Barnett V, Hilditch S. The effect of an artificial pitch surface on home team performance in football (soccer). J R Stat Soc 1993; 156: 39-50
33. Courneya KS, Carron AV. Effects of travel and length of home stand/road trip on the home advantage. J Sport Exerc Psychol 1991; 13: 42-9
34. Jehue R, Street D, Huizenga R. Effect of time zone and game time changes on team performance: National Football League. Med Sci Sports Exerc 1993; 25: 127-31
35. Smith RS, Guilleminault C, Efron B. Circadian rhythms and enhanced athletic performance in National Football League. Sleep 1997; 20: 362-5
36. Steenland K, Deddens JA. Effect of travel and rest on performance of professional basketball players. Sleep 1997; 20: 366-9
37. Courneya KS, Carron AV. Batting first versus last: implications for the home advantage. J Sport Exerc Psychol 1990; 12: 312-6
38. Jurkovac T. Collegiate basketball players' perceptions of the home advantage [thesis]. Bowling Green (OH): Bowling Green State University, 1983
39. Bar-Eli M, Tenenbaum G, Levy-Kolker N. A crisis related analysis of perceived spectator behaviour in competition. Can J Sport Sci 1992; 17: 288-98
40. Glamser FD. Contest location, player misconduct, and race: a case from English soccer. J Sport Behav 1990; 13: 41-9
41. Lefebvre LM, Passer MW. The effects of game location and importance on aggression in team sport. Int J Sport Psychol 1974; 5: 102-10
42. Silva JM, Andrew JA. An analysis of game location and basketball performance in the Atlantic Coast Conference. Int J Sport Psychol 1987; 18: 188-204
43. Underwood GL, Whitwood JR. Aggression in sport: a study of an English first division soccer team. Fed Int Educ Phys Bull 1980; 50: 31-9
44. McGuire EJ, Courneya KS, Widmeyer WN, et al. Aggression as a potential mediator of the home advantage in professional ice hockey. J Sport Exerc Psychol 1992; 14: 148-58
45. Russell GW. Crowd size and density in relation to athletic aggression and performance. J Soc Behav Personal 1983; 11: 9-15
46. Sumner J, Mobley M. Are cricket umpires biased? New Scientist 1981; 91: 29-31
47. Dennis PW, Carron AV. The relationship between game location and officiating decisions in National Hockey League officials [abstract]. J Sport Exerc Psychol 1998; 20: S63
48. Lehman DR, Reifman A. Spectator influence on basketball officiating. J Soc Psychol 1987; 127: 673-5
49. Wright CR, House T. The diamond appraised. New York: Simon and Schuster, 1989
50. Stefani RT. Observed betting tendencies and suggested betting strategies for European football pools. Statistician 1983; 32: 319-29

Correspondence and reprints: Professor *Alan M. Nevill,* Research Institute for Sport and Exercise Sciences, School of Human Sciences, Liverpool John Moores University, Henry Cotton Campus, 15-21 Webster Street, Liverpool L3 2ET, England.
E-mail: a.m.nevill@livjm.ac.uk