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Analysis of Penalty Kick Performance in the Spanish Football League: A Longitudinal Study

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Abstract: (1) Background: the penalty kick is an action in football that decides many matches. The aim of this research was to establish the success rate of penalty kicks in Spain between the seasons 2012/2013 and 2019/2020 considering different key performance variables. (2) Methods: A total of 941 penalty kicks were analysed from eight seasons of the first division of the Spanish men's football league (La Liga). An observational methodology was used and, in order to obtain the results, different analytical techniques were employed: descriptive and chi square with a significance level of $p < 0.05$. (3) Results: The effectiveness of penalty kicks was 76.7%. Most of the penalties were taken by the home team (60.9%), with a tie on the scoreboard (44.2%) and within the last 30 min of the match (41.9%). The highest success rate was observed for balls kicked to the upper side of the goal (100%), even though the highest number of penalties were taken low, to one of the two sides of the goal (57.0%). Up to 5.6% of the penalties were not kicked inside the goal. (4) Conclusions: Effectiveness does not depend on home–visitor status, player laterality, score or remaining match time, studied independently. A loss of effectiveness is observed when the match scores of both teams are close and in critical moments of the match.

Keywords: performance analysis; soccer; success rates; key performance indicators; match analysis



Citation: Prieto-Lage, I.; Argibay-González, J.C.; Bezerra, P.; Cidre-Fuentes, P.; Reguera-López-de-la-Osa, X.; Gutiérrez-Santiago, A.

Analysis of Penalty Kick Performance in the Spanish Football League: A Longitudinal Study. *Appl. Sci.* **2024**, *14*, 7046. <https://doi.org/10.3390/app14167046>

Academic Editors: Gian Mario Migliaccio and Luca Russo

Received: 20 June 2024

Revised: 8 August 2024

Accepted: 9 August 2024

Published: 11 August 2024



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1. Introduction

The penalty kick is an action in a football game in which there is a direct confrontation between two opponents, the kicker and the goalkeeper [1]. Despite its infrequent occurrence in a season, it is important to study the penalty kick because it plays a decisive role in determining the outcome of a match, since football is a low-scoring sport [2]. The kicker has a success rate that varies according to research in the range of 70–85% [1,3–7]. In executing the penalty kick, different factors influence its success rate. We can differentiate between execution factors (direction of the shot, side to which the goalkeeper moves), the strategy (independent/dependent on the goalkeeper), the situation (phase of the competition, place of the match, state of the match and period of the match), the individual (footedness, age, position) or the psychology (team status, kick importance) [1]. These factors have been analysed in different research, although performance factors, followed by situational factors, seem to be the most decisive in performance success [5].

As for the direction of the shot, the probability of the ball being saved by the goalkeeper seems to decrease when the shot is directed towards the upper areas of the goal [3,8]. If the ball is kicked low, goalkeepers save a greater number of shots [1,6,9]. Other researchers stated that these zones are not safe for shots unless the goalkeeper starts moving too

early [2]. As regards the player's laterality, better scoring percentages were observed in left-footed players [6,10]. Shots that are kicked to the natural side of the kicker (in the case of a right-footed kicker, a shot aimed to the goalkeeper's right side) are the most likely to go into the goal and the most difficult for the goalkeeper to save [8].

When analysing the moment of the match when this action occurs, several authors observed that the majority of penalties take place in the last 30 min of the match [4,5,11]. This phenomenon may be attributed to various factors, including player fatigue, increased aggressiveness in the pursuit of results, and tactical decisions that lead to riskier situations inside the penalty area [4,12]. Some studies analysed the match result at the time when the penalty kick occurred (winning, losing or tying), and there is no clear evidence that this variable influences the success of the penalty kick [5,8]. Being the home or visitor team may be another aspect to consider, as it has been observed that home teams are awarded a higher percentage of penalties [5].

While it is true that different studies on the penalty kick have agreed on certain findings, there are also many contradictions on key issues, such as the most appropriate place to direct a penalty kick for maximum effectiveness. Different studies suggest different zones [1,3,10].

One of the drawbacks of the research on penalty kicks pointed out by the specific literature is that it has not been taken into account that the success rate of a penalty kick may depend on the league or country in which it is taken, due to the idiosyncrasies of each national competition [7,13,14]. Furthermore, other studies are carried out in a context in which unpredictable factors have a significant influence on the final performance of the penalty kick, due to the fact that they analyse penalty shoot-outs from European Championships, World Championships, the Champions League or other similar events [1,2], in which some of the shots are executed by non-specialist players [7].

Based on the above, the aim of this study was to evaluate the degree of effectiveness of penalty kicks through a longitudinal investigation of eight seasons in the first division of the Spanish league (La Liga), considering in the analysis, in addition to the usual performance indicators, different behavioural patterns for in-depth study. To date, although there is evidence from studies that have investigated the penalty in football, longitudinal studies have been scarce [7]. Moreover, the few that have been conducted have focused on competitions in other countries [5,15]. For this reason, a longitudinal study is proposed within the context of a national competition to understand the idiosyncratic characteristics of football in the analysed country, and to minimise biases associated with research that focuses on non-regular knockout competitions and/or a single season. This analysis will identify the specific factors that influence success rates in penalty kicks in the Spanish football league, and how these factors impact those success rates.

2. Materials and Methods

2.1. Design

An observational methodology [16] was used to study the actions of football penalties in the Spanish league. The observational design [17] used was nomothetic (all penalties were studied independently), follow-up (eight seasons), and unidimensional (one level of response).

2.2. Sample

The unit of analysis of this research was the penalty in Spanish league matches from the 2012/2013 season to the 2019/2020 season. A total of 941 penalties were analysed (107 in the 2012/2013 season, 115 in the 2013/2014 season, 109 in the 2014/2015 season, 97 in the 2015/2016 season, 121 in the 2016/2017 season, 113 in the 2017/2018 season, 130 in the 2018/2019 season and 149 in the 2019/2020 season).

The penalties were analysed in accordance with the ethical principles of the Helsinki Declaration using audio-visual material in the public domain [18]. According to the American Psychological Association [19], an observational study in a natural environment

with public videos obtained from the mass media that does not imply experimentation does not require informed consent from the competitors. The study was approved by the Ethics Committee of the Faculty of Education and Sport Science (University of Vigo, Application 08-280722).

2.3. Instruments

The observation instrument used for this study was the one used in other previous research into the English league with similar objectives [5]. It consists of a system of categories that contemplates in its criteria the different possible ways of analysing penalty kicks. This instrument is composed of eight criteria that form a system of categories fulfilling exhaustive and exclusive conditions (see Table 1 and Figure 1).

Table 1. Observational instrument.

| Criteria | Category | Description |
|---|----------|---|
| Time | T1 | The penalty is kicked at 0–15 min. |
| | T2 | The penalty is kicked at 16–30 min. |
| | T3 | The penalty is kicked at 31–45+ min. |
| | T4 | The penalty is kicked at 46–60 min. |
| | T5 | The penalty is kicked at 61–75 min. |
| | T6 | The penalty is kicked at 76–90+ min. |
| Result | T | The team that kicks the penalty is tying. |
| | L | The team that kicks the penalty is losing. |
| | W | The team that kicks the penalty is winning. |
| Scoreboard | TIE | The team that takes the penalty is tying the match. |
| | L1 | The team that kicks the penalty is losing by 1 goal. |
| | L2 | The team that kicks the penalty is losing by 2 goals. |
| | L3 | The team that kicks the penalty is losing by 3+ goals. |
| | W1 | The team that kicks the penalty is winning by 1 goal. |
| | W2 | The team that kicks the penalty is winning by 2 goals. |
| Stadium | W3 | The team that kicks the penalty is winning by 3+ goals. |
| | LC | The team that kicks plays as the home team. |
| Laterality | VS | The team that kicks plays as the visitor team. |
| | RF | The kicking player is right-footed. |
| Direction—Goal (depending on the view of the kicker) | LF | The kicking player is left-footed. |
| | LT | Left-Top |
| | LM | Left-Medium height |
| | LD | Left-Down |
| | CT | Centre-Top |
| | CM | Centre-Medium height |
| | CD | Centre-Down |
| | RT | Right-Top |
| | RM | Right-Medium height |
| | RD | Right-Down |
| | PCO | Post, crossbar or outside |
| Direction—Laterality (depending on the view of the kicker) | KT | Penalty kick to the kicker side (top) |
| | KM | Penalty kick to the kicker side (medium height) |
| | KD | Penalty kick to the kicker side (down) |
| | MT | Penalty kick to the middle side (top) |
| | MM | Penalty kick to the middle side (medium height) |
| | MD | Penalty kick to the middle side (down) |
| | FT | Penalty kick to the far side (top) |
| | FM | Penalty kick to the far side (medium height) |
| | FD | Penalty kick to the far side (down) |
| | PCO | Post, crossbar or outside |
| Effectiveness | SUC | Successful penalty |
| | UNS | Unsuccessful penalty |

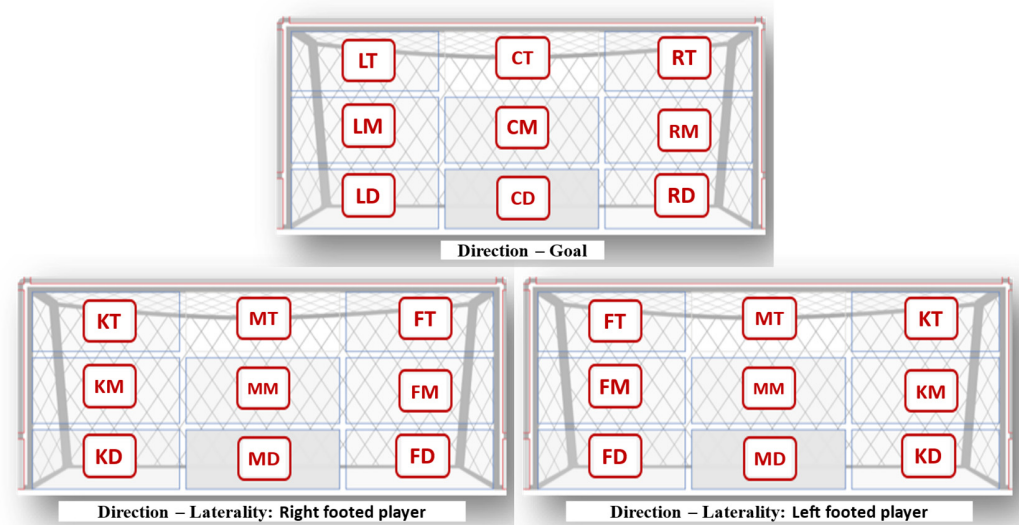


Figure 1. Goal areas according to direction-goal and direction-laterality criteria.

The registration instrument used was LINCE v1.4. [20]. This software is a free multimedia interactive programme that allows for simultaneous viewing and registering of the filmed material in a computer that is used to support the observational analysis in a systematic way. This software has been used in numerous investigations related to football [11].

2.4. Procedure

The penalties analysed in this study were extracted from InstatScout [21], an online football scouting platform. Subsequently, the video clips were edited in such a way that eight files (one per season)—in which the penalties of all the teams were arranged in alphabetical order and by match day—were obtained. iMovie software version 9.0.9 was used to edit the files. By doing so, user-friendly files were created for use with the registration tool.

After conducting training in the use of the instruments, in order to guarantee rigour in the recording process [22], data quality was controlled by calculating intra- and inter-observer compliance using the kappa coefficient [23], calculated with LINCE software version 1.4. The intra-observer compliance was previously calculated with one-fifth of the penalties that were part of the research ($n = 200$; not belonging to the final sample), obtaining a kappa value of 0.94 for observer 1 and 0.96 for observer 2. Subsequently, the inter-observer agreement achieved a kappa value of 0.93. Afterwards, the data were recorded by observer 2.

After recording all the penalties, an Excel file was obtained with the sequence of the behaviours. The versatility of this file made it possible to perform successive transformations for the different analyses [24,25].

2.5. Data Analysis

All the statistical analyses were carried out using the IBM Statistical Package for the Social Sciences, version 25.0 (IBM-SPSS Inc., Chicago, IL, USA). Statistical significance was assumed as $p < 0.05$.

A descriptive analysis of the study variables was carried out globally. The χ^2 test was used to contrast the existing differences between the categories of each criterion used (intra-criteria analysis) as well as to compare the existing differences between the different criteria according to effectiveness (inter-criteria analysis). In addition, a sequential study was carried out to contrast the degree of efficiency of certain patterns of kicking behaviour, using a frequency analysis with prior segmentation and selection of cases.

3. Results

3.1. Traditional Statistical Analysis

Table 2 presents the descriptive analysis of the study.

Table 2. Descriptive analysis, chi-square intra-criteria and chi-square inter-criteria test.

| Criteria | Category | n | % | Effectiveness | χ^2 Intra-Criteria | χ^2 Inter-Criteria |
|----------------------|----------|-----|------|---------------|-----------------------------------|-----------------------------------|
| Season | S12–13 | 107 | 11.4 | 84.1 | $\chi^2 = 15,217$ $p = 0.033$ | $\chi^2 = 15,775$ $p = 0.027$ |
| | S13–14 | 115 | 12.2 | 69.6 | | |
| | S14–15 | 109 | 11.6 | 78.0 | | |
| | S15–16 | 97 | 10.3 | 72.2 | | |
| | S16–17 | 121 | 12.9 | 72.7 | | |
| | S17–18 | 113 | 12.0 | 71.7 | | |
| | S18–19 | 130 | 13.8 | 81.5 | | |
| | S19–20 | 149 | 15.8 | 83.2 | | |
| Time | T1 | 88 | 9.4 | 78.4 | $\chi^2 = 54,152$ $p < 0.000$ | $\chi^2 = 4397$ $p < 0.494$ |
| | T2 | 144 | 15.3 | 77.8 | | |
| | T3 | 161 | 17.1 | 77.6 | | |
| | T4 | 154 | 16.4 | 79.2 | | |
| | T5 | 184 | 19.6 | 71.2 | | |
| | T6 | 210 | 22.3 | 78.6 | | |
| Result | T | 416 | 44.2 | 77.6 | $\chi^2 = 53,027$ $p < 0.000$ | $\chi^2 = 0.209$ $p < 0.901$ |
| | L | 284 | 30.2 | 76.4 | | |
| | W | 241 | 25.6 | 76.3 | | |
| Scoreboard | TIE | 416 | 44.2 | 77.6 | $\chi^2 = 830,684$ $p < 0.000$ | $\chi^2 = 3534$ $p < 0.739$ |
| | L1 | 180 | 19.1 | 73.9 | | |
| | L2 | 73 | 7.8 | 83.6 | | |
| | L3 | 31 | 3.3 | 74.2 | | |
| | W1 | 147 | 15.6 | 74.8 | | |
| | W2 | 61 | 6.5 | 78.7 | | |
| | W3 | 33 | 3.5 | 78.8 | | |
| Stadium | LC | 573 | 60.9 | 75.9 | $\chi^2 = 44,660$ $p < 0.000$ | $\chi^2 = 0.030$ $p < 0.352$ |
| | VS | 368 | 39.1 | 78.5 | | |
| Laterality | RF | 696 | 74.0 | 77.3 | $\chi^2 = 216,154$ $p < 0.000$ | $\chi^2 = 0.195$ $p < 0.659$ |
| | LF | 245 | 26.0 | 75.9 | | |
| Direction—Goal | LT | 32 | 3.4 | 100 | $\chi^2 = 839,946$ $p < 0.000$ | $\chi^2 = 228,483$ $p < 0.000$ |
| | LM | 48 | 5.1 | 83.3 | | |
| | LD | 294 | 31.2 | 76.5 | | |
| | CT | 30 | 3.2 | 100 | | |
| | CM | 60 | 6.4 | 93.3 | | |
| | CD | 77 | 8.2 | 74.0 | | |
| | RT | 44 | 4.7 | 100 | | |
| | RM | 60 | 6.4 | 93.3 | | |
| | RD | 243 | 25.8 | 75.7 | | |
| | PCO | 53 | 5.6 | 0 | | |
| Direction—Laterality | KT | 37 | 3.9 | 100 | $\chi^2 = 871,933$ $p < 0.000$ | $\chi^2 = 228,644$ $p < 0.000$ |
| | KM | 58 | 6.2 | 89.7 | | |
| | KD | 317 | 33.7 | 74.1 | | |
| | MT | 30 | 3.2 | 100 | | |
| | MM | 60 | 6.4 | 93.3 | | |
| | MD | 78 | 8.3 | 74.4 | | |
| | FT | 39 | 4.1 | 100 | | |
| | FM | 50 | 5.3 | 88.0 | | |
| | FD | 219 | 23.3 | 79.0 | | |
| | PCO | 53 | 5.6 | 0 | | |
| Effectiveness | SUC | 724 | 76.9 | - | $\chi^2 = 273,166$ $p < 0.000$ | - |
| | UNS | 217 | 23.1 | - | | |

Statistically significant differences were found between the categories of all the criteria studied (intra-criteria χ^2 test) as well as when relating the variables season, direction-goal and direction-laterality to the effectiveness variable, with no differences for the rest of the criteria analysed (inter-criteria χ^2 test). It was observed that more penalties were awarded in the last 30 min of the match, especially in favour of the home team. In almost half of the cases (44.2%), the match was tied at the moment the penalty was kicked. More than half of the penalties (65.2%) were sent to the low area of the goal (to the centre or towards either side of the goal). Almost one penalty was missed out of every four penalties kicked (23.1%). Since the introduction of Video Assistant Referee (VAR) technology in the 2018–2019 season and the rule change regarding goalkeeper positioning at the moment of the kicker's impact with the ball, the effectiveness of penalty kickers has increased significantly (an average of 74.7% between the 2012–2013 and 2016–2017 seasons, compared to 82.4% in the 2018–2019 and 2019–2020 seasons). Statistically significant differences were found when comparing both periods ($X^2 = 6.756$; $p = 0.009$).

Figure 2 shows an analysis of the effectiveness of the penalty takers according to the direction of the penalty kick (without considering the player's laterality), as well as an analysis considering the left- or right-footedness of the player (visually, the figure is presented as if for right-footed kickers; it should be noted that for left-footed kickers, the kicker side and far-side would be reversed (see Figure 1)).

All penalties. Criteria: Direction-goal (PCO: 53/941 – 5.6%)

| LEFT-TOP | CENTER-TOP | RIGHT-TOP |
|------------------------|-----------------------|------------------------|
| 32/941 (3.4%) | 30/941 (3.2%) | 44/941 (4.7%) |
| 32 (100%) 0 (0%) | 30 (100%) 0 (0%) | 44 (100%) 0 (0%) |
| LEFT-MEDIUM | CENTER-MEDIUM | RIGHT-MEDIUM |
| 48/941 (5.1%) | 60/941 (6.4%) | 60/941 (6.4%) |
| 40 (83.3%) 8 (16.7%) | 56 (93.3%) 4 (6.7%) | 56 (93.3%) 4 (6.7%) |
| LEFT-DOWN | CENTER-DOWN | RIGHT-DOWN |
| 294/941 (31.2%) | 77/941 (8.2%) | 243/941 (25.8%) |
| 225 (76.5%) 69 (23.5%) | 57 (74.0%) 20 (26.0%) | 184 (75.7%) 59 (24.3%) |

All penalties. Criteria: Direction-laterality (PCO: 53/941 – 5.6%)

| KICKER-TOP | MIDDLE-TOP | FAR-TOP |
|------------------------|-----------------------|------------------------|
| 37/941 (3.9%) | 30/941 (3.2%) | 39/941 (4.1%) |
| 37 (100%) 0 (0%) | 30 (100%) 0 (0%) | 39 (100%) 0 (0%) |
| KICKER-MEDIUM | MIDDLE-MEDIUM | FAR-MEDIUM |
| 58/941 (6.2%) | 60/941 (6.4%) | 50/941 (5.3%) |
| 52 (89.7%) 6 (10.3%) | 56 (93.3%) 4 (6.7%) | 44 (88.0%) 6 (12.0%) |
| KICKER-DOWN | MIDDLE-DOWN | FAR-DOWN |
| 317/941 (33.7%) | 78/941 (8.3%) | 219/941 (23.3%) |
| 235 (74.1%) 82 (25.9%) | 58 (74.4%) 20 (25.6%) | 173 (79.0%) 46 (21.0%) |

Figure 2. Effectiveness according to the direction-goal and direction-laterality criteria.

Penalties kicked into the upper part of the goal had a high effectiveness, as no shots were saved by the goalkeeper. In the intermediate zone (in relation to the height), there was a decrease in effectiveness, especially in the left-medium zone (83.3%) compared to 93.3% in the other two zones. It was found that the lower zone of the goal is where a greater loss of efficiency occurs, with the goalkeeper saving the most penalties in the right-down zone (75.7%) and the kicker-down zone (74.1%).

3.2. Analysis of Penalty Kick Patterns

Figures 3–5 show an analysis of penalty kick efficiency in the form of a pattern. The match situation is determined according to the score, the home-visitor status, the footedness of the kicker and the moment of the match according to the playing time and score (only critical moments of the match).

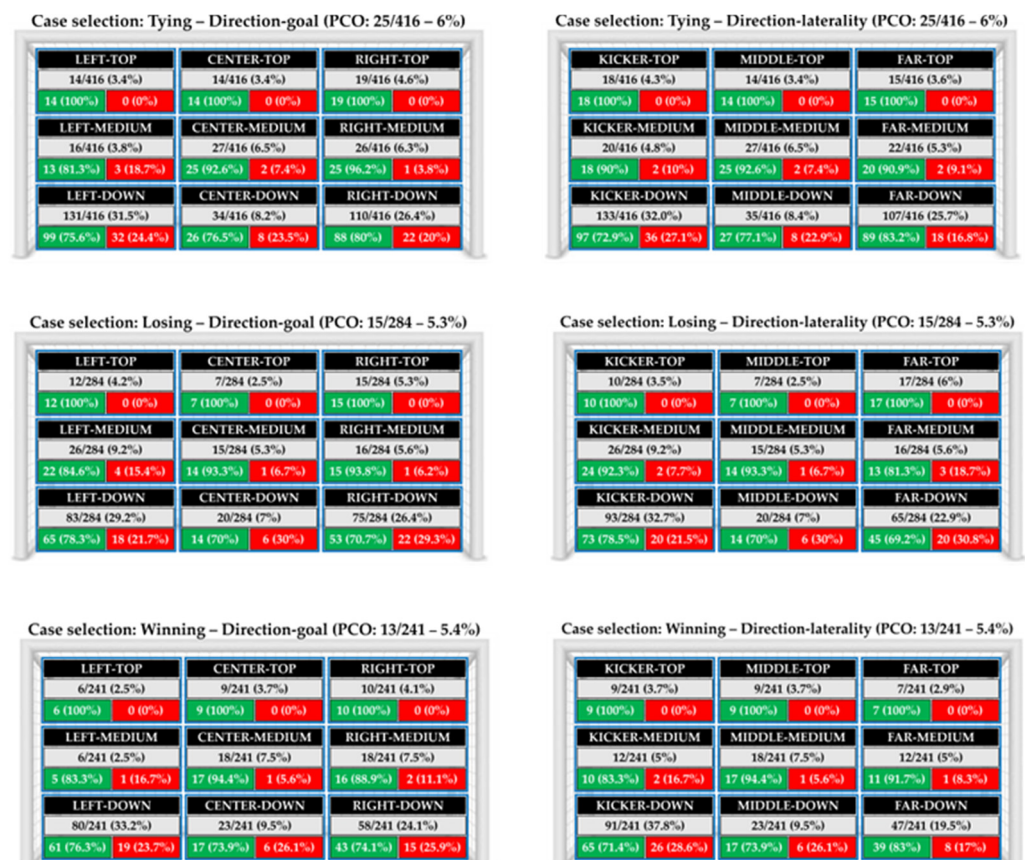


Figure 3. Effectiveness according to the result criteria (direction-goal and direction-laterality).

In a tie situation, the lowest rate of effectiveness was observed for shots to the left-down (75.6%) or kicker-down (72.9%) zones. On the other hand, when the team was losing, more shots were missed when directed to the centre-down and right-down zones (70% and 70.7%) or the far-down zone (69.2%). With a favourable result on the scoreboard, the kicker-down zone was again the least effective (71.4%), compared to 83%, for example, in the far-down zone.

Conversely, there was greater effectiveness in the shots of the visiting players (+2.6%). Of particular note is the 77.3% effectiveness of visitors in the left-medium zone compared to 95% in the other two intermediate zones (in relation to height) as well as 80% in the far-medium zone, compared to 92–95% in the other two zones. Depending on the footedness of the player taking the kick, a lower success rate was observed in left-footed players in the kicker-down (71.3%) and middle-down (71.4%) zones compared to the far-down zone (82.5%). In the lower zone of the goal and in right-footed players, effectiveness had a smaller range, of between 75.1% and 77.8%.



Figure 4. Effectiveness according to the stadium and laterality criteria (direction-goal and direction-laterality).

In the analysis of the critical moments of the match, there were contrasts between the 55% effectiveness seen in shots sent to the left-down zone in a tie situation and between minutes 60 and 75 of the match, and of 40% (centre-down zone) and 54.5% (right-down) in the same period of the match but when losing by one goal. In a tie situation, in the last 15 min of the match, the worst effectiveness was seen in the right-down zone (76.5%). This effectiveness in the same zone remained when the team was losing by one goal (75%), but decreased when shooting to the left-down zone (70%) and to the centre-down zone (66.7%). Taking into account the player's laterality, the kicker-down zone (52.4%) was the least effective in a tie situation between minutes 60 and 75 of play. In this period of the match, when losing by one goal, the middle-down (40%) and far-down (33.3%) zones were the two least effective. In the final stretch of the match, the kicker-down zone was once again the least effective in a tie situation (73.7%), as was the middle-down zone when losing by one goal (66.7%).



Figure 5. Effectiveness in critical moments during the match (direction-goal and direction-laterality).

4. Discussion

The aim of this research was to detect patterns of penalty kick effectiveness in the Spanish league through a longitudinal study of eight seasons.

The effectiveness rate of La Liga players between the 2012/2013 and 2019/2020 seasons (76.9%) was similar to that described in previous research in men's professional football leagues [1,5,6,26–29]. The success rate of the studies mentioned (70–85%) may be due to the specific training that players undergo to execute this free kick, although it may also be due to the nature of the action itself, in which the goalkeeper is at a clear disadvantage compared to the kicker [5]. Significant differences were found in the relationship between the season and effectiveness. Since the 2018/2019 season, an increase in the percentage of successful penalty kicks has been observed, likely due to the implementation of VAR [30]. This technology has allowed for the confirmation that several saved penalties were invalid because the goalkeeper had moved off the line before the player made contact with the ball, a phenomenon previously identified in the literature [11], but which could not be verified with such precision without the use of VAR.

This research confirms, as in other similar studies, that most of the penalties are awarded in the last 30 min of the match [1,4,5,11]. Penalty kick success oscillated in similar values throughout the different 15 min periods studied (approximately over 78%), with a slight decrease between minutes 61 and 75 (71.2%), returning to around 78% in the final minutes of the match. This contrasts with one of the investigations analysing this element of the game, in which a decrease was observed as the final period of the match began [8]. The increase in fatigue (both physical and psychological) and the associated loss of concentration do not appear to be variables that influence the success of the penalty kick. On the contrary, this could be one of the reasons why teams commit more fouls inside the penalty area and, consequently, more penalties are taken [5,15,31,32].

The result of the match at the time of the shot had no consequences, *a priori*, on the success rate. Thus, the values here ranged from 77.6% in the case of a tie to 76.3% with a favourable score and 76.4% with an unfavourable score, similar to those of other studies consulted [1]. According to some studies [5], the advantageous situation of the kicker or the ability of specialist kickers to withstand moments of pressure could be one of the explanations. But if we look closely at Figure 5, lower effectiveness rates can be observed if we consider only critical moments of the match (69% in a tie situation between minutes 61 and 75; 68% when losing by one goal between minutes 61 and 75; 72% in a tie situation between minutes 76 and 90+; 68% when losing by one goal between minutes 61 and 75). This indicates that the analysis of the data should not only consider the overall score (winning, losing or tying), but also the moment of the match and the specific result. It is possible that players experience increased pressure during critical moments of a match, which could explain why higher success rates are not achieved compared to those reported in previous studies where this variable was not considered [5,7]. In other research [7], the success rate was higher with respect to the score depending on the league studied (English league, higher rate when losing; Spanish and Italian leagues, tying, and German league, winning). This corroborates the idea that this aspect needs to be studied further from more specific perspectives.

Previous studies have shown that the player's footedness has no influence on the success rate of penalty kicks [1,5]. This study corroborates previous studies, with no significant differences in effectiveness between right-footed and left-footed players (77.3% vs. 75.9%). In any case, some previous studies pointed out that left-footed players have a higher success rate [33–35] and another noted that it depends on the league analysed [7]. On the other hand, it has been observed that right-footed players execute the most penalty kicks (74% vs. 26%), but this is probably due to the generally higher number of right-footed players. Although there is no agreement among the studies consulted, research has also been conducted into whether players have a greater tendency to kick the penalty to their natural side and whether this results in greater effectiveness [1,5,8]. In our case, considering only the penalty kicks that are directed between the posts (888 out of 941), it was observed that players have a greater tendency to kick the penalty to their natural side (46% to their natural side, 19% to the centre of the goal and 35% to their unnatural side). In terms of effectiveness, a lower success rate on the natural side was evident (79% vs. 83%), which was also the case in the longitudinal study conducted in the English league [5]. This may be because goalkeepers choose to dive to the natural side of the player, as they are aware that a higher percentage of penalties are sent to that side.

In general, players tend to send the ball to the low area of the goal and to one of the two sides (57% of all shots), with low delivery to the player's dominant side prevailing (33.7%). In the English league, this trend was confirmed, with 31% of shots being sent in this way [5]. Although effectiveness to the upper side of the goal was 100% in this study and there is evidence that this occurs in other similar competitions [1,3,7], players do not choose these areas because they are much riskier shots due to their technical difficulty, and because they have the highest probability of not being directed into the goal [36]. As pointed out by some researchers [3,37], players tend to avoid risky options in order not to

be perceived as unskilled. They instead prefer that the goalkeeper saves the penalty kick than not send it between the posts.

4.1. Practical Implications

The technical staff of teams should analyse the different patterns of effectiveness found in this study in order to be able to adapt specific training for penalty kicks. It has been shown that kicks to the top of the goal are 100% effective, so we suggest exercises training kicks to that area, even if it is the most complex to execute. It is also recommended that exercises are carried out in which the player is exposed to a fictitious situation of shooting under pressure, as it has been proven that there is a clear decrease in effectiveness at critical moments of the match. Goalkeepers should be aware that a shot to the low zone and to the player's dominant side is the most likely option for saving a penalty (one third of penalties).

The results obtained from La Liga could be valuable for coaches in other European leagues, as significant similarities in penalty patterns and dynamics have been identified despite contextual and cultural differences. The observations from La Liga provide a solid foundation for anticipating that similar phenomena could occur in other European competitions, thereby offering a broader understanding of the factors influencing the frequency and effectiveness of penalties in football.

4.2. Limitations

Despite the large sample analysed, this study only considers data from the Spanish league, which do not allow for a contrast, beyond the discussion of the study itself, with the other most important European leagues. Penalties not kicked at goal were assigned to a category called "post, crossbar or outside", but no account was taken of the area closest to the goal to which they were sent. Perhaps this could have been an interesting data point for research.

4.3. Future Perspectives

In future research, it would be relevant to analyse whether the introduction of VAR has increased the number of penalties and their effectiveness. In light of the results obtained in this study, it would be of great interest to conduct investigations focusing on decisive penalty shootouts, such as those involving direct elimination or where scoring or missing a penalty determines whether a team advances to the next round or is eliminated. It would also be useful to conduct a more detailed analysis of missed shots that hit the post or missed the goal, in order to obtain more precise information.

It would be of great interest to conduct comparative and longitudinal studies across various European league competitions. This would allow for the identification of both similarities and differences in behaviour patterns, particularly following the introduction of VAR. Analysing the impact of VAR in different leagues would provide a more comprehensive understanding of its effects on match dynamics.

5. Conclusions

The results of this study are broadly in line with those of other studies with similar objectives in professional European football leagues. The success rate was around 75%. An increase in the effectiveness of kickers has been observed since the introduction of VAR. For the most part, more penalties are taken at the end of matches, in a tie situation and on home ground. The effectiveness of the penalty kick does not depend on the moment of the match, the result, the specific score or the player's laterality, although a notable loss of effectiveness was observed when the variables of score and the match being at a "critical situation" were combined. Sending the ball to the upper area of the goal is the most effective, as well as to the player's far side. The most likely option for saving a penalty kick is the player's low kicker side.

This longitudinal analysis of penalty kicks in La Liga provides valuable insights for match analysis and strategy development in football. By gaining a better understanding

of the patterns and trends in penalties, coaches and analysts can make more informed decisions and adjust their strategies in both defence and attack. This study not only expands the knowledge of penalties, but also offers practical tools to improve decision-making in football.

Author Contributions: Conceptualisation, I.P.-L., J.C.A.-G., P.C.-F., X.R.-L.-d.-I.-O. and A.G.-S.; data curation, I.P.-L., J.C.A.-G. and A.G.-S.; investigation, I.P.-L., J.C.A.-G., P.B., P.C.-F., X.R.-L.-d.-I.-O. and A.G.-S.; methodology, I.P.-L., J.C.A.-G., X.R.-L.-d.-I.-O. and A.G.-S.; project administration, I.P.-L., J.C.A.-G., X.R.-L.-d.-I.-O. and A.G.-S.; resources, I.P.-L., J.C.A.-G., P.C.-F. and A.G.-S.; software, I.P.-L., J.C.A.-G., X.R.-L.-d.-I.-O. and A.G.-S.; supervision, I.P.-L., P.B. and A.G.-S.; validation, J.C.A.-G., P.C.-F. and X.R.-L.-d.-I.-O.; visualisation, J.C.A.-G. and P.C.-F.; writing—original draft, I.P.-L., P.B. and A.G.-S. All authors have read and agreed to the published version of the manuscript.

Funding: This study was funded by the Ministerio de Cultura y Deporte (<https://www.culturaydeporte.gob.es/portada.html> (accessed on 20 June 2024)), Consejo Superior de Deportes (<https://www.csd.gob.es/es> (accessed on 20 June 2024)) and European Union (https://european-union.europa.eu/index_es (accessed on 20 June 2024)) under Project “Integración entre datos observacionales y datos provenientes de sensores externos: Evolución del software LINCE PLUS y desarrollo de la aplicación móvil para la optimización del deporte y la actividad física beneficiosa para la salud (2023)” EXP_74847 to A.G.-S. and I.P.-L.

Institutional Review Board Statement: The study was approved by the ethics committee of the Faculty of Education and Sport Science (University of Vigo, application 08-280722).

Informed Consent Statement: Not applicable.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Acknowledgments: This publication was made possible thanks to the research stays during the years 2023 and 2024 at the Instituto Politécnico de Viana do Castelo [IPVC]—Escola Superior de Desporto e Lazer.

Conflicts of Interest: The authors declare no conflicts of interest.

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