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Article

Penalty kick success is unaffected by direction: Insights from right-footed world-class soccer players

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SUMMARY

A penalty kick can decisively impact a soccer match by determining team advancement or final standings. Numerous studies have examined factors influencing penalty kick success. Proposed indicators of kick direction, such as foot and hip angles, may affect outcomes by enabling goalkeepers to anticipate the shot and increase save probability. Other research has shown that penalty takers often aim for specific zones within the goal. However, no study to date has examined whether scoring success differs when players kick the ball across versus away from the body's axis. In this study, we analyzed penalty kicks by right-footed players during men's World Cup matches from 1982 to 2022 to determine whether shooting direction (across or away from the body axis) impacts success. We hypothesized that players kicking away from the body axis would be most successful, based on prior research indicating that right-footed players achieve the greatest success when aiming to the right side of the goal. Additionally, other research has identified a right-oriented bias in high-pressure, time-constrained contexts among goalkeepers during penalty shootouts. Similar behavioral and movement tendencies may influence penalty takers. We analyzed 218 penalty kicks: 131 across the body axis (69.5% success), and 87 away from the body axis (69.0% success). A chi-square test yielded a p-value of 0.94, indicating that for these players, shooting direction relative to the body axis did not influence scoring success. These findings suggest that training should emphasize shot placement, psychological readiness, and consistency over shooting direction.

INTRODUCTION

Penalty kicks are an integral component of the game of soccer. Officials may award them during regular play when the defending team commits a foul inside its own penalty area or during extra time as part of a penalty shootout to determine the match outcome (1). Given the importance of penalty kicks to the game's outcome, researchers have conducted much research to identify the indicators of kick direction, as well as the factors that influence shooting success (2-9, 11-14).

Several studies have focused on the indicators of kick direction to identify pre-impact cues that could assist goalkeepers in saving penalty kicks. For example, an analysis of 27 possible indicators of kick direction revealed that the two most reliable indicators were planting foot angle and hip rotation during a kick (2). This finding was consistent with earlier research showing that hip and trunk alignment are predictive of kick direction (3). Further analysis revealed that the probability of shooting to the left was highest with a right-footed player whose left arm is abducted beyond 90° and whose support foot points to the left (4).

Another major focus of penalty kick research involves identifying factors and strategies that might improve goal-scoring success through retrospective performance analysis of professional players. Investigators analyzed optimal kicking strategies for penalty kicks from leading men's professional soccer leagues worldwide and found that the best shooting strategies are to aim towards the upper corners of the goal, which are more difficult for goalies to save (5). A separate research team reported comparable results in their analysis of penalty kicks from top English (Premier League) players, observing that kickers optimized penalty kick success when they aimed at the upper vertical sections of the goal (6). Likewise, other investigators, who analyzed penalty kick shootouts from World Cup matches from 1982 to 2018, observed that right-footed players perform best when targeting the top right corner (7). Interestingly, they also observed that left-footed players achieve the highest success rates when aiming at either the center or the top right corner. These findings may reflect differences in shot placement tendencies, body mechanics, or goalkeeper expectations when facing left-footed kickers. However, these investigators acknowledged a sample size limitation for left-footed players in their study, noting that the relatively small number of left-footed kickers prevented definitive conclusions about their performance.

Equally important, research has suggested that there may be a right-oriented bias at play during the penalty shootout. Based on previous analyses of penalty shootouts from World Cup matches, researchers observed that goalkeepers trailing in the match are more likely to dive to their right (8-9). This right-oriented bias may be due to high-pressure, highly time-constrained situations where accuracy is critical, such as the limited time the goalkeeper must react once the player kicks the ball, resulting in hardwired behavioral tendencies rather than carefully planned responses (8-9). Researchers also showed this right-oriented bias in experimental situations where they asked two groups of subjects to bisect a line as precisely as possible into two equal parts (8). One group had 1.5 seconds to bisect each line, while the other group had 4 seconds to bisect each line. The subjects in the time-constrained group who were eager to perform as accurately as possible displayed a greater number of right-oriented responses compared to the group with four seconds per task. The investigators concluded that individuals who are highly motivated to succeed in a task and who face pressure to react very quickly were more likely to favor the right side (8).

The studies mentioned above evaluated important factors

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that contribute to pre-impact cues that goalkeepers could rely on. They also examined the shooting strategies that could offer an advantage to the penalty kick taker, as well as possible reflexive biases that may exist due to the high-pressure atmosphere of the penalty shootout. However, no one has yet studied whether a difference exists in the success rate of shooting across the axis of the body compared to shooting away from the axis of the body. That is, for a right-footed player, the kicker strikes the ball such that it travels to the left side of the goal area (across the body axis) or to the right side of the goal area (away from the body axis).

In this study, we analyzed 218 penalty kicks by right-footed players in the men's Fédération Internationale de Football Association (FIFA) World Cup shootouts from 1982 to 2022, to compare the success rates of kicks directed across versus away from the body axis. We began with the 1982 tournament since it marked the introduction of the penalty shootout in the men's World Cup tournament (10). We hypothesized that penalty kicks by right-footed players directed away from the body axis (i.e., towards the right side of the goal) would result in a greater success rate as defined by the number of goals scored. We based this hypothesis on prior research suggesting that, for right-footed players, success was greatest when aiming toward the right side of the goal (from the kicker's perspective), which aligns with kicking away from the body axis (7). Furthermore, prior work identified a right-oriented bias under high-pressure, time-constrained conditions, most notably among goalkeepers during penalty shootouts (8, 9). Although this research focused on goalkeepers, it is plausible that the same behavioral and movement tendencies influencing goalkeeper decision-making under pressure may also affect penalty takers, who must similarly react quickly in high-stakes situations.

To isolate the primary variables of interest and ensure a focused analysis, we refined the study sample using two key exclusion criteria. We excluded left-footed players as well as penalty kicks directed towards the center of the goal. Previous studies found no difference in penalty kick success between left and right-footed players, which led us to limit the study to right-footed players (11-12). Additionally, we excluded penalty kicks directed towards the center of the goal because, within that scenario, the penalty taker is neither kicking across nor away from the body axis. Including penalty kicks towards the center of the goal would add a third, substantially different category of kicking action inconsistent with the two actions of interest (i.e., away versus across the body axis). Our analysis subsequently revealed that there was no difference in success rates between the two kicking directions. Success rates were nearly identical for penalty kicks across the body axis and for kicks away from the body axis. These findings indicate that for elite right-footed male soccer players, the direction of the kick relative to the body axis does not influence scoring success, suggesting that the direction of the kick relative to the shooter's body-axis may not play a decisive role under high-pressure conditions.

RESULTS

This study aimed to determine whether the direction of a penalty kick, either across or away from the shooter's body axis, affects scoring success among right-footed players. Based on prior research indicating higher success rates when right-footed players aimed toward the right side of the goal, as well as findings suggesting right-oriented biases under pressure, we hypothesized that players who kicked away from the body axis would result in a higher success rate. We analyzed 218 penalty kicks, drawn from 36 men's FIFA World Cup matches held between 1982 and 2022 (**Table 1**). We chose these matches for analysis because they featured top-level players, an extensive availability of game statistics, and video documentation. Our analysis focused on penalty kicks by right-footed players during penalty shootouts directed either across the body axis (to the left side of the goal) or away from the body axis (to the right side of the goal) (**Figure 1**).

Of the 218 penalty kicks, players took 131 across the body axis, scoring 91 goals (a 69.5% success rate). They took the remaining 87 kicks away from the body axis, scoring 60 goals (a 69.0% success rate) (**Figure 2**). We assessed the difference in scoring success between the two kick directions using a chi-square (χ^2) test for independence. The test revealed no statistically significant association between kick direction and scoring success, χ^2 (1, N = 218) = 0.006, p = 0.94 **(Figure 2**).

Match	Date	Link
W. Germany-France	8-Jul-1982	www.youtube.com/watch?v=jiY_j0CFFa8
France-Brazil	21-Jun-1986	www.youtube.com/watch?v=_nhvqIjgQ04
W. Germany-Mexico	21-Jun-1986	www.youtube.com/watch?v=UI46dXRrj9E
Belgium-Spain	22-Jun-1986	www.youtube.com/watch?v=1LbHLjauBE8
Ireland-Romania	25-Jun-1990	www.youtube.com/watch?v=eN54GFv-y8c
Argentina-Yugoslavia	30-Jun-1990	www.youtube.com/watch?v=VxE7JJNi7AI
Argentina-Italy	3-Jul-1990	www.youtube.com/watch?v=bNWjhpD9iJQ
West Germany-England	4-Jul-1990	www.youtube.com/watch?v=su0NGYMaYgM
Bulgaria-Mexico	5-Jul-1994	www.youtube.com/watch?v=kxBjNXEkGWg
Sweden-Romania	10-Jul-1994	www.youtube.com/watch?v=a7FUuoM636o
Brazil-Italy	10-Jul-1994	www.youtube.com/watch?v=7kWv6RNzWmE
England-Argentina	30-Jun-1998	www.youtube.com/watch?v=bezH7GOKnNs
France-Italy	3-Jul-1998	www.youtube.com/watch?v=1CCrQy_1UpY
Brazil-Netherlands	7-Jul-1998	www.youtube.com/watch?v=M2MV0JKTWbE
Spain-Ireland	16-Jun-2002	www.youtube.com/watch?v=FXbLa3b25jM

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S. Korea-Spain	22-Jun-2002	www.youtube.com/watch?v=Nxxkd_LtQHw
Ukraine-Switzerland	26-Jun-2006	www.youtube.com/watch?v=BBZvVuUxNf4
Germany-Argentina	30-Jun-2006	www.youtube.com/watch?v=AU9yfAXU09k
Portugal-England	1-Jul-2006	www.youtube.com/watch?v=bIOKU4Y8J_Q
Italy-France	9-Jul-2006	www.youtube.com/watch?v=nELaL14ms7A
Paraguay-Japan	29-Jun-2010	www.youtube.com/watch?v=Mger-g-Swbo
Uruguay-Ghana	2-Jul-2010	www.youtube.com/watch?v=f5M9mzcjZ_8
Brazil-Chile	28-Jun-2014	www.youtube.com/watch?v=nwlPPxmOekU
Costa Rica-Greece	29-Jun-2014	www.youtube.com/watch?v=qpkzqOfTWIY
Netherlands-Costa Rica	5-Jul-2014	www.youtube.com/watch?v=ooZLYNQOqk4
Netherlands-Argentina	9-Jul-2014	www.youtube.com/watch?v=ETt-vJnoyVI
Spain-Russia	1-Jul-2018	www.youtube.com/watch?v=ETt-vJnoyVI
Croatia-Denmark	1-Jul-2018	www.youtube.com/watch?v=IO36Q8Uj2bE
Colombia-England	3-Jul-2018	www.youtube.com/watch?v=NtvUzy00DuU&t=40s
Russia-Croatia	7-Jul-2018	www.youtube.com/watch?v=IGRy2R8LULI&t=36s
Japan-Croatia	5-Dec-2022	www.youtube.com/watch?v=axslnNbMiuI
Morocco-Spain	6-Dec-2022	www.youtube.com/watch?v=yF5mHzhRBWE
Croatia-Brazil	9-Dec-2022	www.youtube.com/watch?v=vQFBcWNk4Ng
Netherlands-Argentina	9-Dec-2022	www.youtube.com/watch?v=KoiXYX7tui4
Argentina-France	18-Dec-2022	www.youtube.com/watch?v=jxP73Zqvq0I

Table 1: Penalty shootout matches analyzed. This table lists all the soccer matches that were analyzed in this study from the men's FIFA World Cup tournaments. For each analyzed match, the competing teams, date of match, and YouTube video link are listed.

DISCUSSION

Our study analyzed whether there was a difference in scoring success among right-footed players when taking penalty kicks either across the axis of the shooter's body or away from the axis of the shooter's body during the men's World Cup games between 1982 and 2022. While prior studies have shown that vertical shot placement (e.g., upper vs. lower corners) influences penalty outcomes (5–7), our analysis focused exclusively on lateral direction relative to the body axis. This decision reflects the study's aim to evaluate whether body orientation during shot execution, rather than precise vertical targeting, affects scoring success. The results of this study indicate that among right-footed men's world-class professional soccer players, there was no statistically significant difference in scoring success whether the player kicked across the axis of the body or away from the axis of the body.

Prior research has shown that certain biomechanical cues, such as planting foot angle and hip rotation, can help goalkeepers anticipate the direction of a penalty kick before ball contact (2-3). However, even if these cues are present, they may not consistently translate into an advantage for the goalkeeper. Given our finding that scoring success did not differ between kicks across versus away from the body axis among right-footed kickers, several possibilities arise. One is that right-footed elite players distribute these biomechanical cues similarly across shot directions, making it harder for goalkeepers to act decisively on them. Alternatively, skilled kickers may use deceptive body mechanics to reduce the predictive value of these cues. Future research should investigate how goalkeepers interpret and respond to such cues in real time, and whether doing so leads to improved save outcomes under high-pressure conditions.

We excluded two subgroups of penalty kick data from this analysis: left-footed penalty kicks and kicks directed toward the center of the goal. We chose to exclude left-footed players from this analysis to keep the comparison of shot direction relative to the body axis as consistent as possible. Some earlier studies have shown that left- and right-footed players tend to favor different goal zones or use different approach angles when taking penalty kicks (12-13). However, these studies also found that footedness by itself doesn't have a meaningful effect on overall penalty kick success. For example, one study found no significant difference in scoring rates between left- and right-footed players (13). Another group of investigators analyzed which areas of the goal produced the highest success for each type of kicker (6). Their results showed that right-footed players scored most often when aiming for the top right corner, while left-footed players had more success when aiming at either the top right or the center. However, they didn't compare overall success rates between footedness groups and they noted that a small sample size of left-footed players (n = 56) limited any conclusions. In the present study, the total number of left-footed kicks excluded from analysis was 59. Given the prior research showing that footedness alone doesn't have a meaningful effect on overall penalty kick success (11-12), and our finding that there is no meaningful relationship between kick direction and scoring success for right-footed penalty kicks, we would not expect the inclusion of left-footed penalty kick data into our analysis to alter the study's conclusions. To test this assumption, future researchers should analyze penalty kicks by left-footed players.

With respect to kicks taken towards the center of the goal, our study focused exclusively on penalty kicks taken either across the kicker's body axis or away from it. Centrally placed kicks, where the ball travels along the body's midline, were not consistent with the objectives of the study and we therefore excluded them from the analysis. In total, we excluded 15 centrally placed attempts from the analysis. Nonetheless, previous research provides relevant evidence

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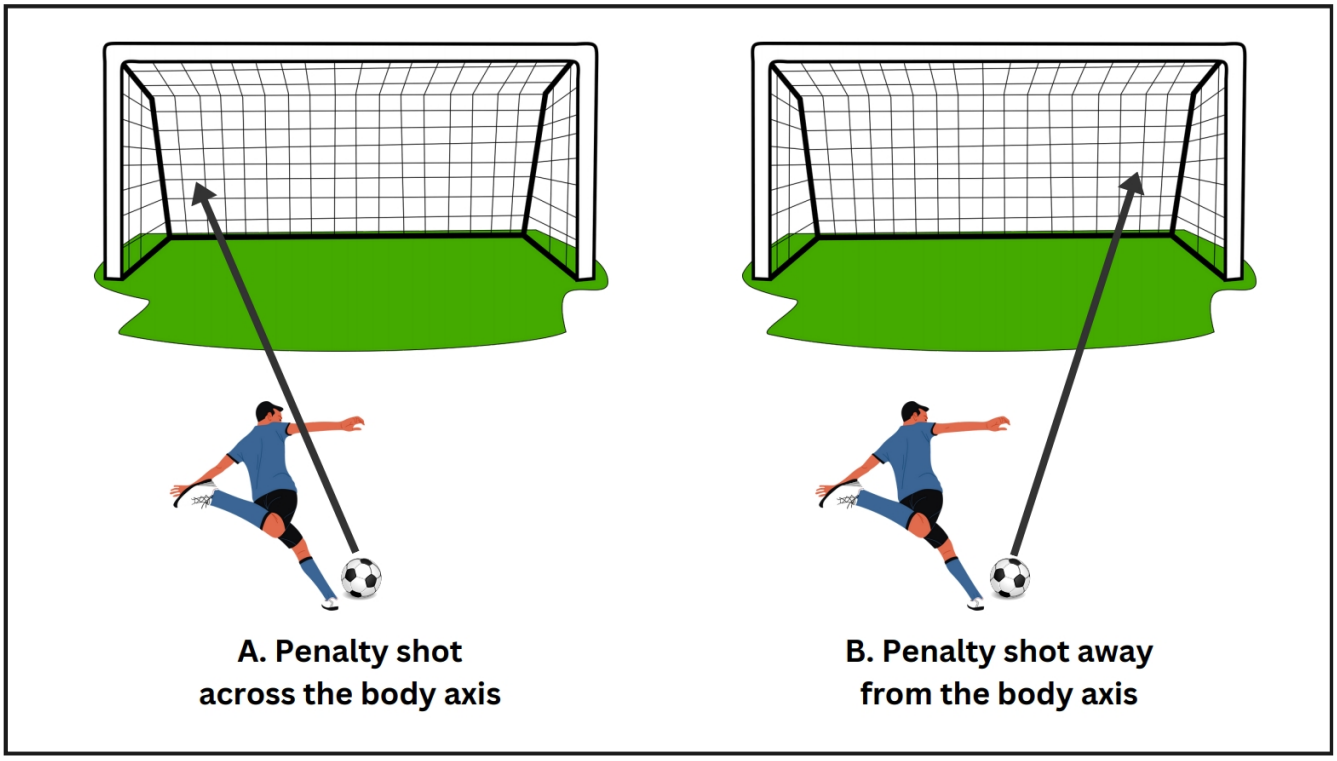

Figure 1: Illustration of the two different right-footed soccer penalty kick techniques analyzed. Panel A illustrates the player's kicking motion where the leg sweeps across the body from outside to inside, causing the ball to cross the body towards the left corner of the goal. Panel B illustrates the player's kicking motion where the leg sweeps in an outward direction, causing the ball to move away from the body towards the right corner of the goal. The figure was created using images from Canva and OpenClipart.org.

that penalty shots directed towards the center of the goal were least successful (59.6%) compared to shots towards the right (76.8%) or left (69%) side of the goal (7). Interestingly, the investigators also found that goalkeepers had the lowest save rate (25%) when staying in the center as compared to diving right (31.6%) or left (29.9%). These results highlight a noteworthy dilemma: even though goalkeepers save the fewest shots aimed at the center, this strategy is still the least successful for penalty takers. Nonetheless, players occasionally take penalty kicks towards the center of the goal. Additional research is needed to identify why players choose this strategy and to develop techniques that could improve its likelihood of success.

While the results of our study offer insights regarding the role of penalty kick direction as it relates to scoring success during penalty shootouts, there are other variables that may impact penalty kick performance that the present study did not address. For example, factors such as player fatigue, goalkeeper-penalty-taker familiarity, penalty shootout score at the time of the kick, and crowd noise might impact penalty kick outcomes. Although the assessment of these variables was beyond the scope of the present study, it is necessary to acknowledge the complex circumstances that may affect penalty shootouts.

One factor that may impact penalty kick success is player fatigue at the time of the penalty shootout. Investigators analyzed penalty kick outcomes from several major soccer tournaments based on the duration of time played immediately prior to the penalty shootouts (13). The investigators assessed outcomes for players who played 1-30 minutes, 31-90 minutes, and 91-120 minutes. The investigators hypothesized that penalty kick performance would decrease as playing time and, by inference, fatigue increased. Their analysis showed no statistically significant differences in penalty kick outcomes among the three playing time periods; however, they observed a slight trend towards increased scoring success with less playing time. To resolve this uncertainty, future studies need to examine the link between player fatigue and scoring success more directly.

In the present study, prior experience between goalkeepers and penalty takers could have provided a slight advantage to one or the other opposing player during the penalty shootouts, thereby potentially influencing the penalty shootout results. When a goalkeeper has had prior experience facing a penalty taker, they might recall features of style or body position the penalty taker uses (2, 11-13). Such prior knowledge may improve the possibility of diving in the correct direction. Alternatively, the penalty taker who is familiar with the goalkeeper might also know about the goalkeeper's habits and can attempt to alter their usual penalty kick technique. Researchers should further examine the impact of prior experience between goalkeepers and penalty takers on penalty kick performance.

When a player takes a penalty kick during a penalty shootout, the kicker's team match status may be winning, losing, or tied. Depending on the match status, the kicker may experience varying levels of psychological stress that could impact their decision-making and, thus, the outcome of

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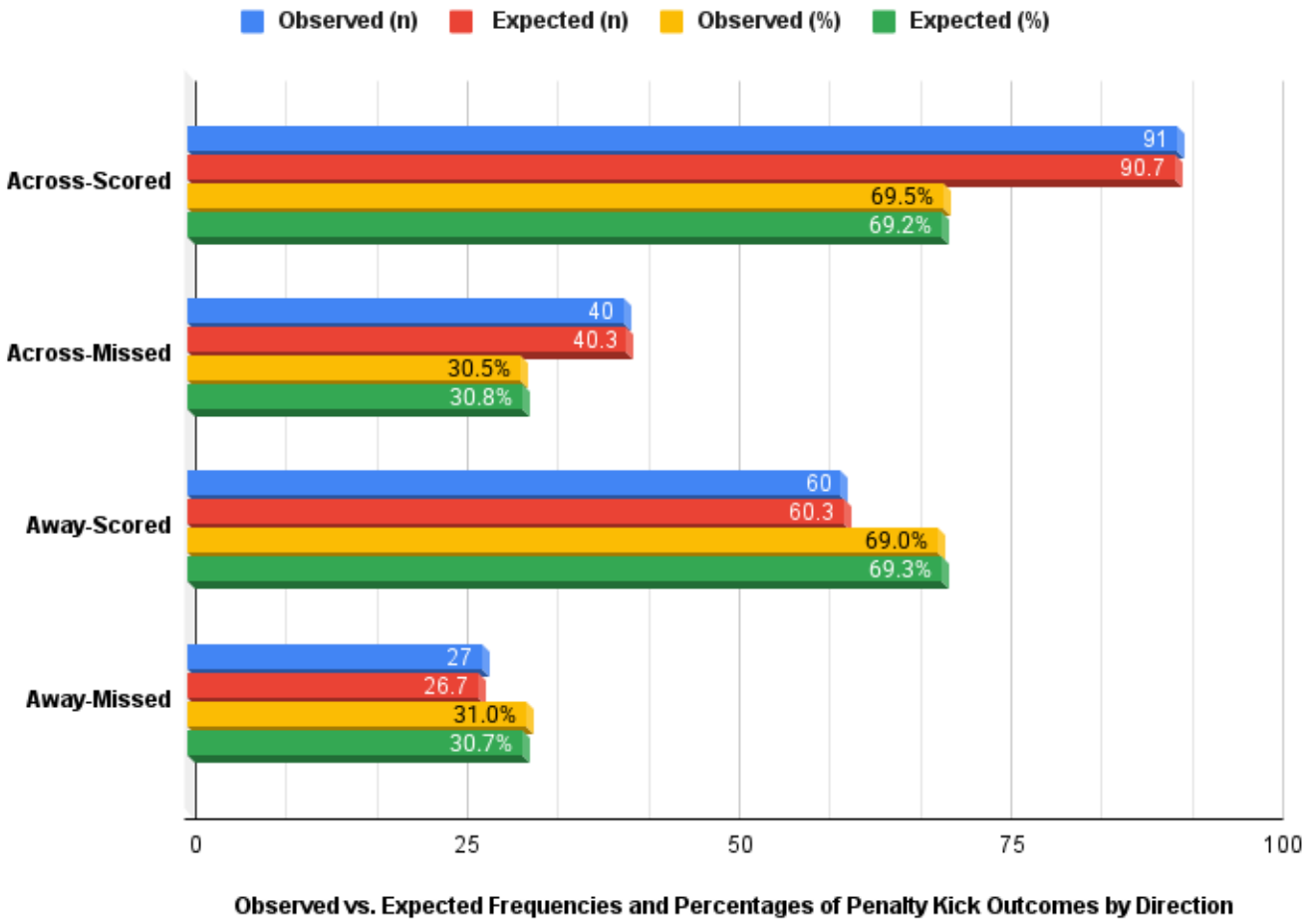

Figure 2: Distribution of observed and expected penalty kick outcomes by kick direction. Bar chart showing the number and percentage of goals scored and missed for penalty kicks taken across and away from the body axis. Observed values are compared against the expected values. Chi-square test for independence showed no statistically significant difference between the kick directions (χ^2 (1, N = 218) = 0.006, p = 0.94).

the kick. Researchers studied the impact of match status on penalty kick outcomes in European championship matches involving 536 penalties kicks and found no statistically significant effect (12). A separate analysis of 941 penalty kicks in the highest division of the Spanish soccer league confirmed this result (14). These findings suggest that match status does not significantly affect penalty kick outcomes among professional soccer players. Accordingly, it is reasonable to conclude that match status was not a decisive factor in the penalty shootouts analyzed in the present study.

Crowd noise and on-field distractions (e.g., from the opposing team) during a penalty shootout could distract penalty takers and goalkeepers. The extent of such distractions would depend on the number of supporters for a particular team, how loud and hostile they are, and their locations in the stands relative to the goal. By using artificially generated crowd noise, researchers evaluated this effect on penalty kick performance in a laboratory setting (15). Negative crowd noise resulted in meaningfully reduced kick accuracy compared to no noise, whereas, there was no significant difference in kick accuracy between negative and positive crowd noise. Thus, the presence of noise itself, whether positive or negative, can impact penalty kick accuracy. In the present study we did not analyze crowd noise or other potential auditory distractions. Thus, we cannot rule out the possibility such distractions did not impact penalty kick performance. In view of the high stakes surrounding penalty shootouts and the emotionally charged atmosphere in the stands and on the field, we believe this is an area of investigation that deserves additional attention.

This experiment relied on a retrospective analysis of penalty kicks taken by world-class, professional men's soccer players. Although this research sheds light on penalty kick performance in high-pressure World Cup shootouts among elite professional soccer players, we should be cautious in generalizing these findings to amateur players, where skill level, training, and experience differ significantly. An alternative approach would involve a prospective study of videotaped analysis of penalty kicks by amateur-level soccer players. However, we would expect the analysis of data from world-class, professional soccer players to exhibit less variability and thus provide more reliable results. Moreover, the practice of studying world-class, professional soccer players is common in the field of penalty kick analysis (4-7, 9, 12, 14). Nonetheless, since penalty kicks often determine the outcome of a game, additional research is necessary to identify the most effective strategies for shot placement, execution, and psychological preparation at all skill levels. Furthermore, such studies should include the analysis of

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penalty kicks by female players, where to date, there has been considerably less soccer research.

This study found no significant difference in scoring success between penalty kicks taken across versus away from the body axis among right-footed players during penalty shootouts in men's FIFA World Cup matches. These findings suggest that, at the elite level, lateral shot direction relative to the kicker's body orientation may not be a determining factor in penalty shootout success. Instead, factors such as shot placement precision, psychological preparedness, and the use of deceptive techniques may play a more critical role. While our analysis focused on body-axis orientation, numerous additional influences, such as crowd noise, player fatigue, and prior familiarity between goalkeepers and shooters, may also influence outcomes and merit further investigation. Ultimately, developing evidence-based strategies for penalty execution and training could have practical implications for improving performance under high-stakes conditions.

METHODS

Data Collection

For this analysis, we reviewed YouTube videos of penalty kick shootouts from the men's 1982 through 2022 World Cup matches (**Table 1**). World Cup matches were selected for analysis due to the involvement of top-level players, the extensive availability of game statistics, and video documentation. Videos were selected for analysis based on several criteria. All of the matches that ended in a tie and qualified for penalty shootouts were analyzed. We selected videos only if the camera angle allowed for a complete view of the direction of the shot relative to the body axis of the penalty kick taker. Additionally, the opening of the goal had to be clearly visible to determine whether the attempt was scored or missed. Each match video had to include all participants from the penalty kick shootout. This was verified by comparing the penalty shootout participants shown in the match videos against an independent source of World Cup penalty shootout lineups (16). All of the videos and penalty kicks analyzed met our selection criteria, with no data discarded.

Data Analysis

The analysis consisted of an assessment of whether the player kicked the ball across the axis of the body or away from the axis of the body (**Figure 1**), and if they scored. Data were entered into a Google spreadsheet, utilizing the following data categories: player name, player team, date of the game, disqualified attempts (left-footed or centered kick), across the body axis attempt (Scored/Missed), and away from the body axis attempt (Scored/Missed). The differences in scoring success between the players who kicked across the axis of the body and those who kicked away from the axis of the body were compared using a chi-square (χ^2) test for independence (Google Sheets). A 2-sided p value of <0.05 was used to indicate statistical significance.

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