

## **The Importance of the Penalty Kick in the Modern Game of Football**

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Key points of paper:

1. Understand the rules regarding penalty taking in football
2. Understand the relevance of winning a penalty at different stages of the game
3. Understand the implications of a successful penalty on the outcome of a game of football

### **Conflict of Interest:**

None of the authors have any conflicts of interest associated with any of the information or discussed in this manuscript.

## **ABSTRACT**

The penalty kick in football is a seemingly simplistic play; however, it has increased in complexity since 1997 when the rules changed allowing goalkeepers to move laterally along their goal line before the ball was kicked. Prior to 1997 goalkeepers were required to remain still until the ball was struck. The objective of this study was to determine the importance of the penalty kick in the modern game of football. A retrospective study of the 2002, 2006 and 2010 World Cup and the 2000, 2004 and 2008 European Championship tournaments was carried out, assessing the importance of the penalty kick in match play and shootouts and the effect of the time of the game on the shooter's success rate. This study demonstrated the conversion rate of penalties was 73% in shootouts and 68% in match play. Significantly more penalties were awarded late in the game: twice as many penalties in the second half than the first and close to four times as many in the fourth quarter vs. the first. Teams awarded penalty kicks during match play won 52%, drew 30% and lost 18% of the time; chances of winning increased to 61% if the penalty was scored, but decreased to 29% if missed. Teams participating in either the World Cup or European Championship final match had roughly a 50% chance of being involved in a penalty shootout during the tournament. Penalty shots and their outcome significantly impact match results in post 1997 football.

*Keywords:* Football, Penalty Shot, Performance

## INTRODUCTION

Football's governing rules date back to a meeting at the Freemason's Tavern in London, on the 26<sup>th</sup> October 1863, but the penalty kick was only incorporated into the game during the 1891-1892 season [1]. Originally and until 1902, when the penalty spot was introduced, the ball was kicked from anywhere along a 12-yard line. The penalty kick rules remained unchanged from 1902 onwards, until 1997 when goalkeepers were allowed to move laterally along their goal line before the ball was kicked. Prior to 1997, goalkeepers were required to remain still until the ball was struck. Although this change seems trivial, it has had a significant impact on the game, as it has given goalkeepers a greater chance of stopping penalties and it has led to the development of new strategies for both shooters and goalkeepers alike.

Reflecting upon the 2010 World Cup finals draw, one thing stands out: the face of elite international soccer is changing. Fourteen of the 32 teams who qualified for the last World Cup finals had played in fewer than five World Cup tournaments (there have been 19 World Cup tournaments in total since 1930) and the skill disparity between nations is shrinking. Set-pieces such as penalty kicks are increasing in importance as they may be the only advantage a team gains during a match. Many major tournaments, including most recently the 2006 World Cup finals, and the 2005, 2008 and 2012 Champions League finals have been decided by penalty shootouts.

McGarry and Franks published the first study on penalty shootouts in soccer with the aim of determining the optimal strategy for penalty shootout success through a computer simulation. As part of the development of the computer simulation, they examined the effect of match play versus shootout conditions on conversion rates, and the effect of penalty kick importance (stress) on performance. The penalties examined taken during both the 1982-98 World Cup and 1996

European Championships tournaments. With respect to match play versus shootout conditions, McGarry and Franks found that penalty shots were successfully converted (scored) 85.2% of the time during open play and 75.6% of the time in shootouts. Statistically, the success rates in both situations were similar [2].

In shootouts specifically, penalty kick importance was quantified as the probability of winning the shootout given that the penalty kick was successful minus the probability of winning the shootout given that the penalty kick was unsuccessful. Using this definition, kicks taken later in the shooting order were determined to be more important and associated with greater stress, than kicks taken earlier in the order. McGarry and Franks predicted that they would see a regression in performance as the importance of penalty kicks increased due to stress. Upon examination of penalty kicks taken during shootouts in the 1982-98 World Cups and the 1996 European Championships, McGarry and Franks found that there was a trend towards a greater success rates for individual players who shot earlier in the order (i.e. took less important penalty shots; 1<sup>st</sup>: 0.778, 2<sup>nd</sup>: 0.806, 3<sup>rd</sup>: 0.861, 4<sup>th</sup>: 0.657, 5<sup>th</sup>: 0.720, 6<sup>th</sup>: 0.500) [2]. The observed trend was felt to be mostly consistent with the inverted-U relationship describing progression and regression in skilled performance before and after an optimal level of arousal [3] and supported the hypothesis that shots taken later in the order (4<sup>th</sup>, 5<sup>th</sup> or 6<sup>th</sup>) were associated with higher levels of stress because of the increasing importance of the shot. McGarry & Franks cautioned that their results may have been confounded by the inclusion of the 6<sup>th</sup> shooter. 6<sup>th</sup> shots are only taken in penalty shootouts if the score remains tied after the first five shots have been taken. 6<sup>th</sup> shots are fewer in number and taken by less skilled players as teams habitually select their most skilled penalty shooters first, therefore 6<sup>th</sup> shots are susceptible to statistical bias [2].

In 2007, a study by Jordet, Hartmen, Visscher & Lemmink examined the effects of stress, skill, fatigue and chance as factors capable of influencing penalty kick outcomes in a retrospective

study of penalty shootouts taken in the World Cup, European Championships and Copa America tournaments. The overall success rate of penalty shots in these tournaments was 78.9% [4].

Stress was defined by two variables (i) the importance of the tournament and (ii) individual shooting order. The number of television viewers watching each tournament was used to measure importance; hence the World Cup was considered to be the most important because it had the largest worldwide television audience, followed by the European Championships and the Copa America tournaments respectively. Penalty shots that were immediately decisive for the final outcome of the shootout (4<sup>th</sup> and 5<sup>th</sup> shots) and the sudden death shots (6<sup>th</sup> to 9<sup>th</sup>) were considered to be associated with higher stress than shots taken earlier (1<sup>st</sup> to 3<sup>rd</sup>). Using these two criteria, stress was found to have a significant impact on penalty shot outcomes [4]. Without denying that stress is a key factor in taking penalties, a review of Jordet *et al.*'s findings leads one to question the validity of their conclusions. The World Cup, with the largest audience worldwide had the lowest penalty kick success, but it would be difficult to prove that individual players are under more pressure to score in a World Cup tournament than they would be in any other tournament which affects the future of their international careers. Stress due to shooting order, whereby penalties taken later were more stressful, was concluded to have a negative effect on shooter's success rates (1<sup>st</sup> = 86.6%; 2<sup>nd</sup> = 81.7%; 3<sup>rd</sup> = 79.3%; 4<sup>th</sup> = 72.5%; 5<sup>th</sup> = 80.0%; 6-9<sup>th</sup> = 64.3%), even though the absolute success rate of the 5<sup>th</sup> shooter was higher than those of either the 3<sup>rd</sup> or 4<sup>th</sup> shooters and the difference between groups was not statistically significant [4]. The authors felt that results from the 6<sup>th</sup> to 9<sup>th</sup> shooters supported their conclusion, despite the small sample size and skill difference associated with this group.

Individual skill did not have an effect on penalty shot outcome [4]. Regrettably, skill was determined by players' position and strikers were assumed to have greater skill than midfielders and defenders. Scoring a penalty kick, taken from a stationary ball under pressure is a different

act entirely than scoring during open match play. In order to properly analyse the effect of skill on performance, a different classification based upon a penalty related characteristics (e.g. habitual penalty taker or not), should have been used.

Fatigue, measured by the length of time players had been on the pitch, did not influence penalty kick outcome either [4]. Although this may be an accurate conclusion, its validity is limited by the fact that the majority of players studied had played at least 90 minutes. Without a diverse sample, this analysis suffers from a strong inherent population bias and is not a robust test of fatigue.

Kuss *et al.*, examined whether or not various factors influenced players decision to take awarded penalty kicks themselves (self-taking) and whether or not the same factors were associated with goal scoring. Penalty kicks awarded for fouls committed in the German Premier football league (First Bundesliga) between August 1995 and February 2005 were included in the analysis and a wide array of variables were examined. Younger, less experienced players were found to be more likely to take their own penalties, but none of the variables were found to affect conversion rates. Kuss *et al.* suggested that there may have been a strong self-selection process operating – that is, players who typically take penalties had similar psychological attributes and were resistant to external influences[5].

In 2008, Dohmen published a study looking at factors, which may influence failure in scoring penalties professional soccer players. Dohmen included all of the penalty shots taken in the German Premier Football league (First Bundesliga) between the leagues inception in 1963 until the end of the 2003/2004 season in this study. Both performance pressures (i.e. match importance in the league standings, probability of winning if the penalty kick was scored) and social pressures (i.e. crowds, opponents, coaches, talent scouts) were considered in this analysis, as was the

impact of the rule change in 1997 which allowed goalkeepers to move along the goal line before the ball is kicked[6]. Of all the factors considered, the only one associated with an increased likelihood of missing was playing at home. Home teams had a significantly higher rate of missing than visiting teams, and this was attributed to the pressure created from positive public expectations. Under higher performance pressure (a tie game or a one goal difference), shooters were less likely to miss the net, while scoring rates remained relatively constant. In fact the miss rates were lowest when the score was close (tied or within one goal) and the penalty kick was awarded near the end of the match. Player experience was also found to decrease the likelihood of missing penalty shots [6].

Prior to the rule change in 1997, penalty shot miss rates overall were decreasing throughout the league. After the rule change, these rates did not continue to decrease, but they did not increase either. Therefore, the new rule was determined to have created a structural change on the rate of missing penalty shots, although the change was not statistically significant [6].

Jordet and Hartman conducted another study in 2008 to look at the valence (positive or negative) of penalty shots and how this impacted performance. Penalty shots from World Cup (1974-2006), European Championship (1972-2004) and UEFA Champions League (1992-2006) penalty shootouts were included in the study. Penalty shots with positive valence were defined as shots where a goal would lead to instant victory, while shots with a negative valence were shots in which a miss would result in instant defeat. Neutral valence shots were considered as a control, and in these shots success or failure did not instantly impact the match result. Shooting performance and the presence of approach (walking backwards from the ball while facing the goalkeeper) or avoidance (turning around and directing one's face away from the goalkeeper) behaviours were used to evaluate the impact of valence [7]. On negative valence shots, players were found to perform worse (scored 30% fewer goals than on positive valence shots) and to

exhibit more avoidance behaviours. Interestingly, performance was equal between approach and avoidance behaviours. Understandably, the authors concluded that the results were important, but more research was needed to determine if objective valence corresponded with subjective experience. Additionally, it would be important to determine if facing or avoiding the goalkeeper was really an indication of approach and avoidance behaviours, or if it was simply a part of shooter's strategies [7].

The literature published to date has been summarised in Table 1. Apart from the study by Dohmen, none of these studies truly represent post 1997 penalty taking, because they all include data that was collected before the rule change in 1997. Dohmen's study assessed the effect of the rule change in 1997 and found it had a structural effect, but then did not differentiate between pre- and post-1997 penalty kicks in the analysis of penalty misses [6]. This particular study has been designed to evaluate the success rates of penalties taken during both match play and penalty shootouts after 1997 only, and to determine the importance of the penalty kick in post 1997 football. The hypotheses to be tested were that the penalty kick success rate is not affected by factors such as fatigue and stress, and that the successful conversion of a penalty kick can significantly impact the match result.

**Table 1: Summary of Current Literature on Success Rates of Penalty Conversion in Elite Football**

Publication	Level of Play	Dates	Conversion Rate (Match Play)	Conversion Rate (Penalty Shoot Out)
<b>McGarry &amp; Franks 2000</b>	1) World Cup 2) European Championship	1)1982 -1998 2)1996	85.2%	75.6%
<b>Eichler, 2002</b>	Premier German football league (5 seasons)	1993/1994 season to 1997/1998 season	Non-tackled: 89.5% Tackled: 78.5%	
<b>Dohmen, 2008</b>	German Bundesliga	1963 season to 2003/2004 season	74.25%	
<b>Jordet et</b>	1) World Cup	1970 – 2004		78.9%



<b>al., 2007</b>	2) European Championship 3) Copa America			
<b>Kuss et al., 2007</b>	German Bundesliga	August 1993 – February 2005	Non-tackled: 74.6% Tackled: 72.6%	
<b>Jordet &amp; Hartman, 2008</b>	1) World Cup 2) European Championship 3) UEFA Champions League	1) 1974 – 2006 2) 1972 – 2004 3) 1992 – 2006		73.8%

## METHODS

This is a retrospective study; all data was collected from results published on the FIFA ([www.fifa.com](http://www.fifa.com)) and UEFA ([www.uefa.com](http://www.uefa.com)) websites. The analysis was divided into two sections; the first dealing with penalties taken during open match play and the second dealing with penalties taken in penalty shootouts.

Penalties in the match play analysis were collected from the 2002, 2006 and 2010 World Cup and the 2004 and 2008 European Championship (EURO) tournaments. The 2000 EURO was not included in this analysis because some of the data (i.e. time of missed penalties) was not available. Match play penalties were those awarded during regulation time (90 minutes plus extra time awarded at the end of each half for stoppages of play) and added extra time (AET) of elimination rounds. Matches were divided into four quarters based on the number of minutes played (i.e. 1<sup>st</sup> quarter: 0 – 23min, 2<sup>nd</sup> quarter: 24 – 45min, 3<sup>rd</sup> quarter: 46 – 68min, 4<sup>th</sup> quarter: 69 – 90min). If extra time/injury time was added to either half, it was considered to be part of the last quarter of that half (i.e. 2<sup>nd</sup> or 4<sup>th</sup> quarters). AET in elimination rounds was considered to be its own category that included all penalties awarded during AET.

Penalty shootout data was taken from the 2002, 2006 and 2010 World Cup and the 2000, 2004 and 2008 EURO tournaments. Penalty shootouts could have occurred in the quarter-finals, the

semi-finals or the final matches (first place or consolation finals) of either tournament. Penalty shootouts could also have occurred during the round of 16 elimination matches in the World Cup.

Penalty shots from match play and penalty shootouts were classified as either a goal or a miss/save as some of the databases did not differentiate between misses and saves in their results.

Statistical and graphical analyses were completed using SPSS 16.0 (www.spss.com) and Graph Pad Prism 5 software (www.graphpad.com). The data is reported in actual values and percent of the total. Binomial, chi-square and Kruskal-Wallis tests were used for statistical comparisons between groups. The significance value for all analyses was  $\alpha = 0.05$  unless otherwise stated. In the match play analysis, a significance value of  $\alpha = 0.10$  was also considered as this has been used as the threshold of practical significance in previous penalty shot publications [6, 7].

## RESULTS

### OVERALL RESULTS

Because the overall number of teams participating in World Cup is greater than in the EURO and because an extra knock out round takes place in the World Cup, the summary statistics are reported as the number of penalty shots awarded per match and the number of penalty shootouts occurring per match (Table 2).

**Table 2: Summary of the Average Number of Penalty Kicks Awarded Per Match and the Average Number of Shoot Outs That Took Place Per Match in the Recent World Cup and European Championship Tournaments (2002 – 2010)**

	During Match Play	During Group Stages	During Final Stages	Penalty Shoot Outs
<b>World Cup</b>	0.260	0.257	0.271	0.167

<b>European Championships (EURO)</b>	0.210	0.271	0.00	0.286*
<b>OVERALL</b>	0.248	0.243	0.210	0.203*

\*Penalty shoot out (PSO) data was collected from the European Championships (EURO) in 2000, 2004 and 2008. Match play penalty (MPP) data was only collected from the 2002 and 2008 EURO as the 2000 EURO MPP results were not available.

A similar number of penalties were awarded in the two competitions, both overall (group and elimination matches) and in the group stages alone with approximately one penalty awarded for every four matches (Overall: World Cup = 1 per 3.8 matches; EURO = 1 per 4.8 matches ( $p=0.500$ ); Group stage: World Cup = 1 per 3.9 matches; EURO = 1 per 3.7 matches, ( $p=0.851$ )). It seemed that the number of penalty shootouts were less frequent during the World Cup (1 penalty shootout every 6 matches) than during the EURO (1 penalty shootout every 3.5 matches) but the difference was not significant ( $p=0.515$ ).

#### MATCH PLAY PENALTY SHOTS

During the 2002, 2006 and 2010 World Cup and the 2004 and 2008 EURO tournaments, penalties were awarded in 57 games out of 254 games played. The total number of penalties awarded was 63, one penalty was awarded in 51 games and two penalties were awarded in 6 games. All of the penalties were awarded during regulation time (90+ minutes), except for two in the 2010 World Cup knock out stages, which were awarded in AET. AET penalty shots (3.2%) were not included in the statistical analyses to avoid the risk of sample size bias.

**Table 3: Number of Penalty Kicks Awarded During Match Play in the 2002, 2006 and 2010 World Cup Tournaments, and the 2004 and 2008 European Championships**

<b>Quarter of Play</b>	<b>Number of PK Awarded</b>	<b>% of total PK Awarded</b>
1 ( $\leq 23$ min.)	6	9.5%

2 (24 – 45+ min.)	14	22.2%
3 (46 – 68 min.)	18	28.6%
4 (69 – 90+ min.)	23	36.5%
Added Extra Time (>90 min.)	2	3.2%
<b>Total</b>	<b>63</b>	<b>100%</b>

Matches were divided into four quarters based on the number of minutes played as shown in Table 3. The fewest number of penalties (9.5%) was awarded in the first 23 minutes of play (1<sup>st</sup> quarter) while the highest number of penalties (36.5%) was awarded in the last 22 minutes (4<sup>th</sup> quarter) of play. In the middle quarters (23-45minutes and 46-68 minutes) the number of penalties awarded was similar at 22.2% and 28.6% respectively. Whereas, the overall difference in the number of penalties awarded per quarter was not significant at the 5% significance level statistical significance, it trended towards significance at the 10% significance level ( $p=0.120$ ), the trend was, therefore, investigated further. The value of 10% has been taken as the threshold of practical significance and has been used as the level of significance in previous penalty shot publications [6, 7]. Individual comparisons between quarters revealed a number of significant differences. Significantly fewer penalties were awarded in the 1<sup>st</sup> quarter than in the 3<sup>rd</sup> ( $p = 0.023$ ) and 4<sup>th</sup> ( $p = 0.002$ ) quarters. Similarly, significantly more penalties were awarded in the 2<sup>nd</sup> half of the match (41) than in the 1<sup>st</sup> half (20) ( $p=0.010$ ). Proportionally more penalty kicks were awarded in the latter stages of matches (i.e. in the second half, and in the last quarter particularly).

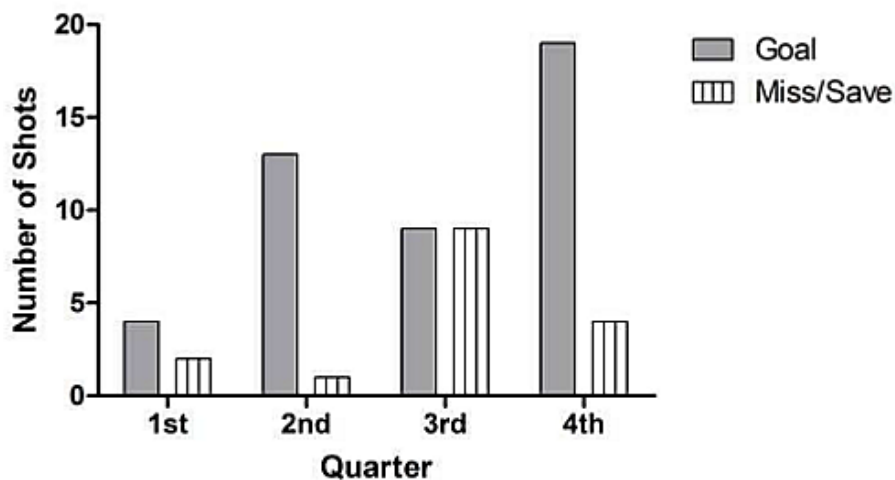
Comparison of the number penalties scored versus the number of penalties missed revealed that there was not a significant difference in the percentage of penalties converted ( $p = 0.406$ ), but there was a trend towards higher penalty kick success rates later in the halves (2<sup>nd</sup> and 4<sup>th</sup>

quarters) and in the 2<sup>nd</sup> half of matches (Table 4; Figure 1). If fatigue influenced conversion rates, one would expect the conversion rate to drop either in the later part of each half (2<sup>nd</sup> and 4<sup>th</sup> quarters) or in the later part of the game (2<sup>nd</sup> half, 4<sup>th</sup> quarter), which was definitely not the case. Consequently, it can be postulated that player fatigue did not have had a significant impact on penalty kick success.

**Table 4: Comparison of Penalty Shot Results by Match Quarter.**

Match Period	Total Shots	Results		Percentage	
		Goal	Miss/Save	Goal	Miss/Save
1 (≤23 min.)	6	4	2	66.7%	33.3%
2 (24 – 45+ min.)	14	13	1	92.9%	7.1%
3 (46 – 68 min.)	18	9	9	50.0%	50.0%
4 (69 – 90+ min.)	23	19	4	82.6%	17.4%
Added Extra Time (>90 min.)	2	1	1	50.0%	50.0%
<b>Total</b>	<b>63</b>	<b>46</b>	<b>17</b>	<b>73.0%</b>	<b>27.0%</b>

**Figure 1: Comparison of penalty shot results by match quarter.**  
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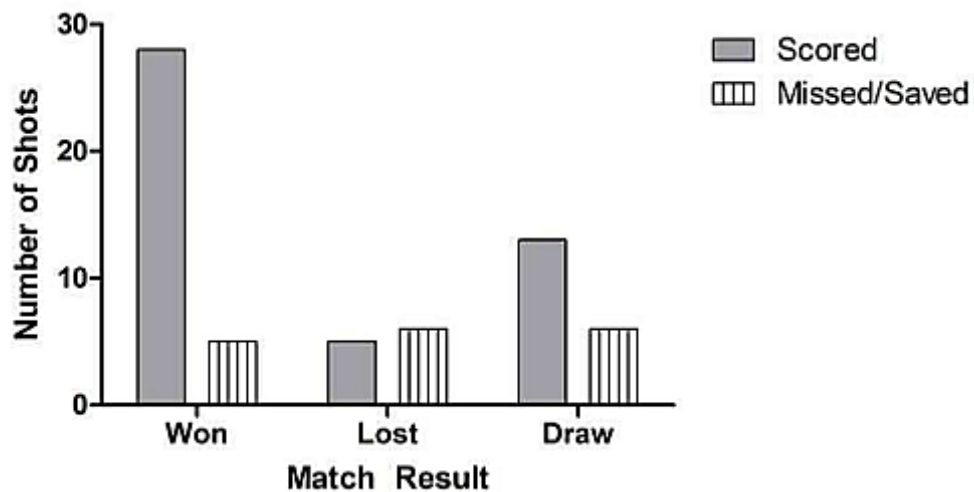
In matches where a penalty was awarded, the team awarded the penalty ended up winning in 52.3% of cases, or at least earning points (win or a draw) in 82.5% of cases (Table 5). If the awarded penalty kick was successfully converted, the shooting team won 60.9% of the time, drew 28.2% of the time and lost only 10.9% of the time. On the other hand, teams who failed to convert their penalty kicks won 29.4% of the time, drew 35.3% of the time and lost 35.3% of the time. Teams who converted penalty shots won significantly more matches ( $p=0.0277$ ) than when they missed their penalty shots (Figure 2).

Considering that most matches average between 2 to 3 goals a game, this is not an unexpected result. What was unexpected in this analysis was the fact that missing a penalty kick tripled a team's chance of losing the match (Probability of a loss; penalty scored =10.9%, penalty missed/saved =35.3%). This result suggests that perhaps there is a psychological aspect associated with missing penalty kicks that can affect the entire team's performance.

From a goalkeeper's perspective saving a penalty kick would significantly increase the (goalkeeper's) team's chance of winning from 39.1% (when the penalty is scored) to 70.6% (when the penalty is saved / missed).

**Table 5: Match Results When a Penalty was Awarded and Either Scored or Missed/Saved**

	Total	Number of Games			Percentage of Games		
		Win	Loss	Draw	Win	Loss	Draw
<b>Penalties Scored</b>	<b>46</b>	28	5	13	60.9%	10.9%	28.2%
<b>Penalties Missed/Saved</b>	<b>17</b>	5	6	6	29.4%	35.3%	35.3%
<b>Penalties Awarded</b>	<b>63</b>	33	11	19	52.3%	17.5%	30.2%



**Figure 2: Match results sorted by penalty shot outcome.**

Based upon the results above it is evident that penalty kicks have a very significant impact on the outcome of matches. This was further explored through an analysis of matches where the penalty shot result (goal, miss/save) was deemed to directly impact the final result. The penalty kick was considered to directly impact the result when:

- a) A goal was scored and the shooting team won by one goal
- b) A goal was scored and the match resulted in a draw
- c) A goal was missed and the match resulted in a draw
- d) A goal was missed and the shooting team lost by one goal

Using these criteria, penalty kicks directly impacted match outcome 61.9% of the time (39 of 63 matches). That is to say, nearly two-thirds of penalty kicks taken directly impact the match result.

#### PENALTY SHOOTOUTS

One hundred and twenty penalty shots were taken during 13 penalty shootouts (18.8% of matches) in the 2002, 2006, and 2010 World Cup and the 2000, 2004, and 2008 EURO

tournaments (3 x round of 16, 8 x quarter-finals, 1 x semi-final, 1 x final). Out of the shots taken, 68.3% (82) were scored and 31.7% (36) were missed/saved (Table 6). On average, five shots from each team were needed to determine a winner.

To win a World Cup teams must win four single elimination matches (round of 16, quarter-final, semi-final and final); to win a European Championship they must win three elimination matches (quarter-final, semi-final and final). Although the overall probability of a shootout occurring in any one game was relatively low (0.188), the probability of the final two teams in either tournament having being involved in at least one penalty shootout en-route was much higher. Teams in the World Cup final had a 56.5% chance of being involved in at least one penalty shootout, while teams in the EURO final had a 46.5% chance. To put it another way, one of the two teams in the final of either tournament would have likely had to win a penalty shootout to get there.

Previous studies have postulated, but not demonstrated, that stress could have a significant negative impact on penalty kick success rates [2, 4, 8]. The previous investigations analysed stress by measuring the success rate of shooters stratified by shooting order, and the same analysis was conducted in the present study (Table 6, Figure 3). The data from the 6<sup>th</sup> to 9<sup>th</sup> shooters has been included in Table 6 for information purposes, but was not included in the comparative statistical analysis for two reasons: (1) very few shots were taken by the 6<sup>th</sup> to 9<sup>th</sup> shooters (6 in total), leading to insufficient statistical power and possible sample size bias, and (2) 6<sup>th</sup> to 9<sup>th</sup> shooters are not likely as skilled at penalty shots as the first five shooters, making it impossible to evaluate the effects of stress independently of the effects of skill.

Within the first 5 shooters, success rates ranged from a low of 45.8% for the 4<sup>th</sup> shooter to a high of 100.0% success for the 5<sup>th</sup> shooter. There was a significant difference in the overall success

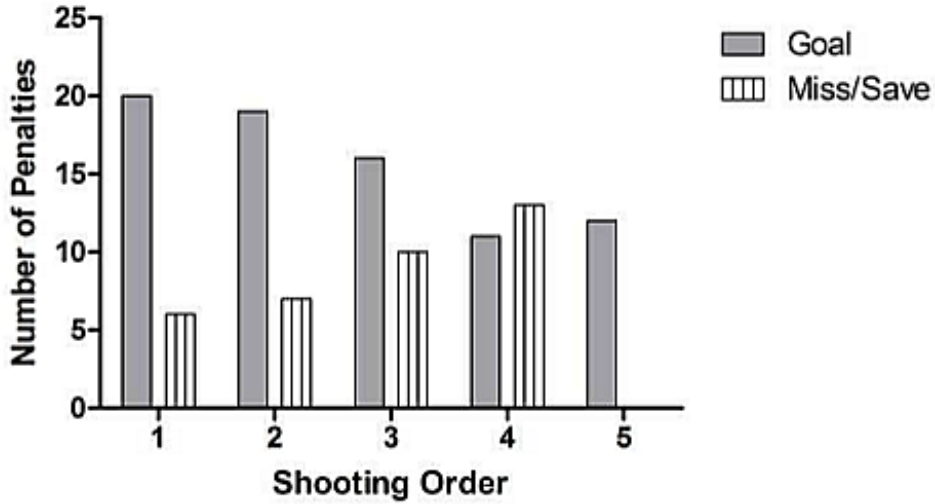


rate of shooters ( $p < 0.05$ ), associated with a number of individual differences. 1<sup>st</sup> shooters (success rate 76.9%) scored significantly more penalties than the players shooting 4<sup>th</sup> (success rate = 45.8%;  $p = 0.040$ ). While players shooting 5<sup>th</sup> (success rate = 100.0%), scored significantly more penalties than those shooting 3<sup>rd</sup> (success rate = 61.5%;  $p = 0.016$ ) and 4<sup>th</sup> (success rate = 45.8%;  $p = 0.002$ ). 5<sup>th</sup> shooters seemed to score more penalties than players shooting 2<sup>nd</sup>, (success rate = 73.0%;  $p = 0.074$ ) however the difference was not statistically significant. Shooting 5<sup>th</sup> has been previously suggested as being associated with the most stress and the lowest success rate by some authors, but the results of the current study contradicts this hypothesis as 5<sup>th</sup> shooters actually had the highest success rates.

In addition to their success rate, the valence of 5<sup>th</sup> shooters' penalty shots was determined using Jordet and Hartman's definition [7]. 71.4% of 5<sup>th</sup> shooters' penalty shots had positive valence and 26.6% had negative valence. In this particular study, stresses attributed to valence did not appear to impact performance because all 5<sup>th</sup> shooters were successful.

**Table 6: Comparison of Shooters' Results by Shooting Order in Penalty Shoot Outs Taken in the 2002, 2006 and 2010 World Cup Tournaments and the 2000, 2004 and 2008 European Championships**

Shooting Order	Total Shots	Results		Percentage	
		Goal	Miss/Save	Goal	Miss/Save
1	26	20	6	76.9%	23.1%
2	26	19	7	73.0%	26.9%
3	26	16	10	61.5%	38.5%
4	24	11	13	45.8%	54.2%
5	12	12	0	100.0%	0.0%
6 – 9	6	4	2	66.7%	33.3%
<b>Total</b>	120	82	38	68.3%	31.7%



**Figure 3: Effect of shooting order on penalty shot success.**

A sub-analysis of the goalkeepers' success rate, again stratified by shooting order, was completed for the 2002, 2006 and 2010 World Cup tournaments (Table 7); miss versus save data was not available from the EURO tournaments therefore they were not be included. Data from 6<sup>th</sup> to 9<sup>th</sup> shooters was not included in this analysis as none of the penalty shootouts examined lasted beyond five shooters. On average, goalkeepers had a penalty shot save percentage (GK success rate) of approximately 17.1%, although this varied from a low of 0.0% for the 5<sup>th</sup> shot faced to a high of 26.7% for the 4<sup>th</sup> shot faced. These differences were not statistically significant ( $p = 0.347$ ), likely because of the small sample size.

**Table 7: Comparison of Goalkeepers' Results by Shooting Order:**

Shooting Order	Total Shots	Results			Percentage		
		Goal	Miss	Save	Goal	Miss	Save
1	26	20	6	0	76.9%	23.1%	0%
2	26	19	7	0	73.1%	26.9%	0%
3	26	16	10	0	61.5%	38.5%	0%
4	24	11	13	0	45.8%	54.2%	0%
5	12	12	0	0	100%	0%	0%

<b>1</b>	16	13	0	3	81.3%	0.0%	18.8%
<b>2</b>	16	11	4	1	68.8%	25.0%	6.3%
<b>3</b>	16	9	3	4	56.3%	18.8%	25.0%
<b>4</b>	15	8	3	4	53.3%	20.0%	26.7%
<b>5</b>	7	7	0	0	100.0%	0.0%	0.0%
<b>Total</b>	70	48	10	12	68.6%	14.3%	17.1%

## DISCUSSION

The importance of the penalty shot in football is undeniable. The findings of the current study clearly demonstrate this point, both when considering the frequency and influence of penalty shots in match play, and the high likelihood for teams winning major tournaments to be involved in at least one penalty shootout. A penalty shot was awarded every four matches in the World Cup and every five matches in the European Championships. Furthermore, a team reaching the final of either the World Cup or European Championships had approximately a 50.0% chance of being involved in a penalty shootout.

From a tactical, team preparation perspective, it is important to keep in mind that significantly more penalties were awarded later in the game: twice as many penalties were awarded in the 2<sup>nd</sup> half (41) than in the 1<sup>st</sup> half (20), and nearly four times as many penalties were awarded in the 4<sup>th</sup> quarter (23) than in the 1<sup>st</sup> quarter (6). This could have several causes including: (i) teams taking greater risks to get results, (ii) players' fatigue leading to miss-timing of challenges, (iii) players' and/or referees' stress leading to rushed, erroneous decisions or (iv) referees awarding a penalty for a later foul, when players have been previously warned earlier fouls. Whatever the reasons for more penalties being awarded in the later stages of matches, it is important that coaches convey this information to players, giving tactical advice to defenders on how to minimize the

chances of giving away penalties late in the game, while at the same time encouraging attacking players to drive into the penalty area late in the game to capitalise on opportunities.

Previous studies have shown that penalty shots are successfully converted between 70-90% of the time [2, 4, 8, 9], while the current study found that the conversion rates of penalty kicks were somewhat lower – 68% of the time during match play and 73% of the time in penalty shootouts. The lower successful conversion rate may be a direct result of the FIFA rule change in 1997 that permitted goalkeepers to move laterally along their goal line before the ball is struck. All the previous studies reviewed have included data from tournaments both before and after the rule change, while the current study only collected data from tournaments occurring after the rule change.

Being awarded a penalty shot in a match is clearly an advantage: it results in victory 52% of the time and defeat only 18% of the time. However, the assumption that the awarding of a penalty shot is the sole determining factor in deciding match success is inaccurate; conversion of the penalty kick is actually the determining factor. Scoring from the penalty spot in regulation play more than doubled the team's chances of winning (61% when scored compared to 29% when missed), while missing an awarded penalty shot increased a team's chances of losing approximately three-fold (11% when scored compared to 35% when missed). These statistics clearly point to the importance of preparing players technically, tactically and psychologically to take penalties and how to respond after the shot, particularly if it was missed. A secondary analysis of matches where the penalty kick was considered to have a significant effect on the final score demonstrated that penalty kicks had a direct effect on the outcome of the match in almost two-thirds (62%) of all games where a penalty kick was awarded. In these matches, the goal scored (or missed) on the shot was a definitive goal in determining the result.

Various studies have investigated the impact of factors such as stress and fatigue on penalty shot success rates with mixed success [2, 4, 6, 7]. This study seemed to indicate that fatigue does not significantly affect conversion rates; instead a trend towards higher conversion rates at the end of the 1<sup>st</sup> half (2<sup>nd</sup> quarter) and at the end of the match (4<sup>th</sup> quarter) was found, even though the difference was not statistically significant. The trend is consistent with Dohmen, which demonstrated that players were less likely to choke on (miss) penalty shots awarded towards the end of matches [6]. Players were also less likely to choke on penalty shots awarded in the latter half of the season [6].

Analysis of 13 World Cup and EURO penalty shootouts in the current study does not support the theory that stress caused by shooting order negatively affects performance. Statistically significant differences ( $p < 0.05$ ) were found in shooter success rates, but the 5<sup>th</sup> shooters had the highest success rates (100.0%) followed by the 1<sup>st</sup> shooters (76.9%); the 4<sup>th</sup> shooters (45.8%) had the lowest success rates. Rather than resembling an inverted-U relationship [3], the current data resembled a normal U shape, with the highest success rates found at the either end (1<sup>st</sup> and 5<sup>th</sup> shooters).

Kuss *et al.* suggested that a strong self-selection process operated amongst penalty shooters, at least during match play, and players who typically take penalties have similar psychological attributes including resistance to external influences [5]. Furthermore, Dohmen demonstrated that experience and performance pressure (stress) reduced the likelihood that players would choke on a penalty shot [6]. Players chosen for penalty shootouts are typically among the top five penalty shooters in a team, making it likely that they would best cope with the negative effect of the influence of stress associated with shooting order. Additionally, the performance pressure attributed to shooting later in a shootout may be one of the reasons that 5<sup>th</sup> shooters had the

highest overall success rates. Valence (positive or negative) did not seem to impact performance of 5<sup>th</sup> shooters in this situation, as 100.0% of the shooters were successful.

Regrettably this study did not look at other factors that may impact penalty kick performance, such as individual player's skill levels, coaches' individual strategy decisions or any of the multitudes of other factors that can impact performance on a given day. Without considering the impact of these other factors, it is virtually impossible to truly understand the impact of stress on performance. What this study does demonstrate is that the traditional metrics, used in previous studies of stress and penalty kick performance, do not accurately represent the impact of stress on performance. Significantly more research is needed to understand the impact of stress on performance in both match play and penalty shootouts.

## **CONCLUSION**

Scoring a penalty shot in match play more than doubled a team's chance of winning, while missing the same shot more than tripled a team's chance of losing, further highlighting the importance of the penalty shot in post 1997 football. The prevalence of the penalty shot is very high; they are awarded in 25% of tournament matches, and one of the two teams in the final of either the World Cup or the European Championships is likely to have been involved in a penalty shootout en-route to the final.

More penalties were awarded in the latter parts of matches when players are willing to take greater attacking and defensive risks and when fatigue and/or stress can impact the performance or decision making of both players and referees alike. It is recommended that coaches adapt their tactics to minimise the number of penalties awarded against their team while maximising the number of penalties awarded for their team in the later stages of matches. Coaches must also

prepare their players, both technically and psychologically, to take penalty kicks and optimise their chance of achieving success.

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