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Analysis of Corner Kick Success in Elite Football

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Abstract

This study analyzes corner kicks in elite football to determine their efficacy, identify shared characteristics and associated variables, and propose a model for predicting successful outcomes. In total, 1139 kicks taken in 124 matches in the 2010 FIFA World Cup (64 matches), UEFA Euro 2012 (31 matches), and the UEFA Champions League 2010-2011 (29 matches) were studied by univariate, bivariate, and multivariate analysis. Just 2.2% of the corners ended in goal, but this goal was responsible for the team winning or drawing the match on 76% of occasions. In general, kicks are delivered through the air to the near post, with 1 or 2 intervening attackers; the attack is organized statically and the defense is a combination of zone and man-to-man. The following variables were significantly associated with corner kicks resulting in a goal: time (p=0.04), number of intervening attackers (p=0.001), and offensive organization (p=0.02). The likelihood of a shot on goal or shot could be increased with the intervention of 3 or 4 attackers, a dynamic attack, and indirect delivery of the ball to the far post. This information could be of great interest for football professionals interested in improving corner kick performance.

***Key words**:* Football, Corner kicks, Observational methodology, Performance analysis

1. Introduction

Offensive performance indicators in football have been analyzed in numerous studies (Ardá, Maneiro, Rial, Losada, & Casal, 2014; Casal, 2011; Casal, Losada, & Ardá, 2015, Castellano, Álvarez, & Blanco-Villaseñor, 2013; Hook, & Hughes, 2001; Horn, Williams, & Ensun, 2002; Hughes & Churchill, 2005; Hughes & Franks, 2005; Jones, James, & Mellalieu, 2004; Maneiro, 2014; Scoulding, James, & Taylor, 2004; Taylor &

Williams, 2002), contributing to a better understanding of and ability to predict general and team performance in this sport.

Set plays, and corner kicks in particular, have been analyzed quantitatively in many studies, with reports indicating that an average of 10 corner kicks are taken per match (Table 1). Other studies have analyzed corner kick success by calculating the mean percentage of kicks that result in a goal (Table 2).

Corner kicks are relatively uncommon and largely ineffective, but they are frequently a determining factor in the outcome of a match between two teams of a similar level (Castelo, 2009).

Numerous studies have estimated that between 30% and 40% of goals come from set play. Mombaerts (2000) and Greghaine (2001) reported rates of 30% and 25%, respectively, while Bangsbo & Peitersen (2003) reported that 32% of goals scored in the 1990 World Cup in Italy and 25% of those scored in the US World Cup in 1994 were from dead ball situations. Casáis (2006) and Vázquez (2007a, 2007b) in turn, described success rates of 33.4% and 41.5%, and Acar, Yapicioglu, Arikan, Yalcin, Ates, & Ergun (2009) reported a set-play conversion rate of 37% for the 2006 World Cup in Germany, 29% for the 2002 World Cup in Korea and Japan, 24.6% for the 1998 World Cup in France, 27.3% for the 1986 World Cup in Mexico, and 26% for the 1982 World Cup in Spain. Finally, Silva (2011) found that 31.6% of all goals scored in the Spanish Liga in 2008-2009 were the result of set play.

The above figures would appear to justify the importance of analyzing dead ball situations in football. In this empirical study, we describe how corner kicks are taken by elite football teams, determine the efficacy of these kicks, and identify variables associated with success. Our findings could be of great interest for football coaches and players interested in improving corner kick performance.

Table 1. Studies reporting number of corner kicks per match

Author (year)	**Competition/matches**	**No. of corner kicks**
Noguera (1980)	Spanish First and Second Division, 76-77	12.7
Perlado (1992)	Spanish Second Division 90-91/91-92	10
Alonso (1995)	1994 FIFA World Cup (USA)	10.4
Pérez & Vicente (1996)	1994 FIFA World Cup (USA)	9.5
Olsen & Larsen (1997)	Matches by Norwegian National Squad 1994	10.4
Raya & Márquez (1998)	1998 FIFA World Cup (France)	9.58
Castelo (1999)	1990 FIFA World Cup (Italy)	13
Gómez López (2000)	Spanish First Division 98-99	10.6
Gómez López (2000)	1998 FIFA World Cup (France)	10.5
Ensum et al. (2000)	2000 UEFA European Football Championship	10.2
Hill & Hughes (2001)	2000 UEFA European Football Championship	10.9
Yamanaka et al. (2002)	Matches by Japanese squad in 1998 FIFA World Cup	10
Bangsbo & Peitersen (2003)	International matches	15
Taylor, James & Mellalieu (2005)	English Premier League 2001/2002	10.8
Borrás & Sáinz de Baranda (2005)	2002 FIFA World Cup (Korea and Japan)	9.72
Sainz de Baranda & López Riquelme (2011)	2006 FIFA World Cup (Germany)	10.2
Sainz de Baranda & López Riquelme (2012)	2006 FIFA World Cup (Germany)	10.21
Silva (2011)	Spanish First Division 2008/2009	10
Siegle & Lames (2012)	16 German First Division matches 2009/2010	10
Sánchez Flores et al. (2012)	Selection of competitions	9.54
Pulling, Robins & Rixon (2013)	50 English Premier League matches	8.78
Ardá, Maneiro, Rial, Losada & Casal (2014)	2010 FIFA World Cup (South Africa)	9.79
Maneiro (2014)	2010 FIFA World Cup (South Africa), 2012 UEFA European Football Championship, and Champions League 2010/2011	10.24
MEAN		**10. 49**

Table 2. Studies reporting percentage of corner kicks that end in a goal

Author (year)	Competition/matches	% of corner kicks resulting in goal
Alonso (1995)	1994 FIFA World Cup (USA)	1.25%
Pérez & Vicente (1996)	1994 FIFA World Cup (USA)	1.6%
Márquez & Raya (1998)	1998 FIFA World Cup (France)	2.28%
Castelo (1999)	Portuguese League	5%
Ensum et al. (2000)	2000 UEFA European Football Championship (Belgium and Holland)	9%
Borrás & Sainz de Baranda (2005)	2002 FIFA World Cup (Korea and Japan)	2.47%
Carling, Williams, & Reilly (2005)	2002 FIFA World Cup (Korea and Japan)	3.2%
Taylor, James, & Mellalieu (2005)	English Premier League 2001/2002	2.76%
Borrás & Sainz de Baranda (2005)	2002 FIFA World Cup (Korea and Japan)	2.47%
Mesonero & Sainz de Baranda (2006)	2002 FIFA World Cup (Korea and Japan)	9.93%
Casáis (2006)	Spanish First and Second Division	10.22%
Saraiva (2007)	First Portuguese Division 2005/2006 2006 FIFA World Cup (Germany)	33% 32%
Acar et al. (2009)	2006 FIFA World Cup (Germany)	8%
Sainz de Baranda, López Riquelme, & Ortega (2011)	2006 FIFA World Cup (Germany)	2.6%
Silva (2011)	Spanish First Division 2008/2009	1.3%
Sainz de Baranda, López Riquelme, & Ortega (2011)	2006 FIFA World Cup (Germany)	2.6%
Sánchez-Flores et al. (2012)	1994 FIFA World Cup (USA), 2010 FIFA World Cup (South Africa), 2008 UEFA European Football Championship (Austria and Switzerland), 2012 UEFA European Football Championship (Poland and Ukraine, 2011 Copa América	1.6%
Roxburgh & Turner (2008, 2009, 2010, 2011)	UEFA Champions League 2007-2012	8.33%
Ardá, Maneiro, Rial, Losada, & Casal (2014)	2010 FIFA World Cup (South Africa)	2.3%
Maneiro (2014)	2010 FIFA World Cup (South Africa), 2012 UEFA European Football Championship, and Champions League 2010/2011	2.2%

2. Method

2.1. Design

We employed an observational methodology design as it offers both the flexibility and scientific rigor required for this study. The design was nomothetic (observation of several teams), follow-up (recording of all matches and independent observation of both teams in each match), and multidimensional (analysis of several response levels) (Anguera & Mendo, 2013).

2.2. Sample

A total of 124 matches were analyzed in the following competitions:

- Final stage of the UEFA Champions League 2010-2011 (29 matches)
- Final stage of the 2010 FIFA World Cup (64 matches)
- UEFA European Championship 2012 (31 matches)

All corner kicks taken during the regulatory 90 minutes of play and sent to the shooting area with a maximum of four passes (Bate, 1988) were coded and included in the analysis. In total, 1139 kicks were included and 131 excluded.

2.3. Instruments

An ad hoc observation instrument combining a field format and category system (Anguera & Mendo, 2013) was created (Table 3). All data were analyzed using IBM SPSS Statistics 22.

Table 3. Category system and codes used in the observation tool

Criterion	Categories
Time (T)	0' - 30'(30) 31'- 60' (60) 61'- 90' (90)
Position of corner (LS)	Right (D) Left (I)
Laterality of corner (LG)	Natural: Right-foot kick from right wing or left-foot kick from left wing (LN) Switched: Right-foot kick from left wing or left-foot kick from right wing (LC)
No. of attackers (JA)	Two or three players on the team being observed are attacking and in a position to receive the ball (2-3) (4-5) (6 or more)
No. of defenders (JD)	Four or five players on the team not being observed are defending and in a position to recover the ball (4-5) (6 or more)
Delivery of ball (EDF)	Direct: The ball is sent to the shot zone with just one touch (ED) Indirect: The ball is sent to the shot zone after several touches (EI)
Path of ball (TB)	Ground: The ball is considered to be delivered to the shot zone along the ground when it rolls along the ground at all moments (TRS) Air: The ball is considered to be delivered to the end of play zone through the air when it leaves the ground at some point during its path (TA)
Type of marking (TD)	Man-to-man (IND) Zone (ZO) Combined (COM)
Interaction context (COI)	Numerical inferiority: The attacking team has fewer players than the defending team in the shot zone (INF) Numerical equality: The attacking team has the same number of players as the defending team in the shot finish zone (IGU) Numerical superiority: The attacking team has more players than the defending team in the shot finish zone (SUP)
No. of defenders on the posts (JP)	0 One Two
No. of intervening attackers (NJ)	One or two players on the team being observed interact with the ball (1-2) (3-4)
Zone to which pass is made (ZEPP)	Near post: Area between centre of crossbar and right sideline (PP) Far post: Area between centre of crossbar and left sideline (FP)
Shooting area (ZFJ)	Near post (PPP) Far post (SFP)

Table 3 continues on the next page

	Table 3 Continued
Offensive organization (MOO)	Static: The players on the team being observed stay in their set positions during the corner kick (MOE) Dynamic: The players vary their positions in the coded end of shot zone throughout the course of the corner (MOD)
Type of shot (FF)	Header (FC) Kick (FP)
Match status (RP)	Winning (GA) Drawing (EM) Losing (PE)

2.4. Procedure

The observers were trained following the protocols described by Losada & Manolov (2014). Eight initial observation sessions were held in which the observers were trained using the consensus agreement method in which data are recorded only when there is agreement between the observers (Anguera, 1990). The quality of the datasets generated from the observation instrument was also checked by calculating Cohen's kappa statistic for interobserver agreement. Based on the reference criteria proposed by Fleiss, Levin, & Paik (2003) interobserver agreement in the present study can be considered excellent (Table 4).

Table 4. Interobserver Agreement.

Categories	Ob_1-Ob_2	Ob_1-Ob_3	Ob_1-Ob_4	Ob_2-Ob_3	Ob_2-Ob_4	Ob_3-Ob_4
No. of attackers	0.87	0.81	0.70	0.58	0.7	0.79
No. of defenders	0.89	0.85	0.56	0.8	0.71	0.8
Delivery of ball	0.81	0.76	0.54	1	0.71	0.84
Type of marking	0.79	0.75	0.85	0,83	0,67	0,92
Interaction context	0.82	0,85	0,78	0,75	0,71	0,78
No. of intervening attackers	0.84	0.88	1	0.85	0.7	0.8
Zone pass is made	0.78	0.84	1	0.58	0.71	0.82
Shooting area	0.82	0.82	0.81	1	0.64	0.79
Offensive organization	0.81	0.81	0.45	1	0.64	0.78
K_{total}	0.83	0.82	0.74	0.82	0.69	0.81

We performed univariate descriptive analysis to describe the characteristics of corner kick execution (number of kicks and tactics used); bivariate analysis with contingency tables ($\chi^2$and association measures) to analyze the level of success of the kick; and binomial multivariate logistic regression to analyze the fit of different models predicting the likelihood of a corner producing a shot according to different variables.

3. Results

3.1. Descriptive Analysis

A mean of 10.24 corner kicks were taken per match (4-5 per team); 26% resulted in a shot, 9.8% resulted in a shot on goal, and just 2.2% resulted in a goal, but this goal meant a victory or a draw for the scoring team in 76% of cases.

Table 5 shows the relative frequencies for each of the variables related to the execution of corner kicks analyzed.

Table 5. Variables related to the execution of corner kicks

VARIABLES		COMPETITION				
		OVERALL SAMPLE	2010 FIFA World Cup	UEFA Euro 2012	UEFA Champions League 2010/11	χ^2
Time	0' - 30'	30%	29.2%	27.8%	34.6%	
	31'- 60'	32.9%	33.1%	33.8%	31.6%	3.40
	61'-90'	37.1%	37.7%	38.4%	33.8%	
Position of corner	Right	53.8%	54.8%	52%	54%	
	Left	46.2%	45.2%	48%	46%	0.64
Laterality of corner	Same	50%	47.7%	52.9%	51.5%	
	Opposite	50%	52.3%	47.1%	48.5%	2.58
No. of attackers	2-3	1.5%	1.9%	0.3%	2.1%	
	4-5	75.3%	75.4%	77.2%	72.6%	5.31
	6 or more	23.2%	22.7%	22.5%	25.3%	
No. of defenders	4-5	7.4%	5.9%	9.9%	7.6%	
	6 or more	92.6%	94.1%	90.1%	92.4%	4.83
Interaction context	Numerical inferiority	96%	96.9%	95.7%	94.5%	2.63
	Numerical equality	4%	3.1%	4.3%	5.5%	
Delivery of ball	Direct	81.9%	81.3%	84%	80.6%	
	Indirect	18.1%	18.7%	16%	19.4%	1.39
Path of ball	Ground	8.4%	10.1%	6.2%	7.6%	
	Air	91.6%	89.2%	93.8%	92.4%	4.36
Type of marking	Man-to-man	5%	4.5%	5.2%	5.9%	
	Zone	29.2%	31%	24%	32.1%	6.92
	Combined	65.8%	64.5%	70.8%	62%	
No. of defenders on the posts	0	28.5%	26%	23.4%	41.8%	
	1	52.2%	53.4%	54.5%	46%	29.12**
	2	19.3%	20.6%	22.2%	12.2%	
No. of intervening attackers	1-2	88.8%	87.9%	89.8%	89.5%	0.96
	3-4	11.2%	12.1%	10.2%	10.5%	
Zone to which pass is made	Near post	61.8%	62.4%	58.8%	64.6%	
	Far post	38.2%	37.6%	41.2%	35.4%	2.11
Shooting area	Near post	55.5%	55.6%	51.4%	60.8%	
	Far post	44.5%	44.4%	48.6%	39.2%	4.88

Offensive organization	Static	67.5%	67.8%	69.8%	63.7%	2.38
	Dynamic	32.5%	32.2%	30.2%	36.3%	
Type of shot	Header	66.9%	64.6%	65.1%	77.6%	3.02
	Kick	33.1%	35.4%	34.9%	22.4%	
Match status	Winning	20.9%	20.6%	18.5%	24.9%	11.74*
	Drawing	52.9%	56.5%	50.2%	47.7%	
	Losing	26.3%	22.9%	31.4%	27.4%	

*p<0.05; **p<0.01

Based on our findings, corner kicks in elite football have the following characteristics:

- They are taken when there are fewer attackers than defenders (96% of cases), in a set-up with between four and five attackers (75.3%) and six or more defenders (92.6%) in most cases.
- The ball is delivered directly (81.9%), through the air (91.6%), to the near post (91.6%).
- The type of defense is mostly a combination of man-to-man and zone defense (65.8%), with a defender positioned in the area of one of the two goal posts (52.2%).
- In general, the offensive organization is static (67.5%) and the kick involves between one and two attackers (88.8%) and ends in a header (66.9%).

On comparing the three competitions, significant differences were observed for just two variables: number of defenders at the posts (χ^2=29.12; p<0.001) and match status (χ^2=11.74; p<0.05). There was a greater tendency for no defenders at the posts in the UEFA Champions League. There were no clearly identifiable trends for match status.

3.2. Bivariate Analysis

In the bivariate analysis with contingency tables, the influence of the different study variables on corner kick success, classified as SHOT, SHOT ON GOAL, or GOAL, was analyzed. The application of χ^2 and calculation of the corresponding contingency coefficient showed several variables to be significantly associated with corner kick success. Table 6 shows the results for SHOT.

Table 6. Corner kick success analyzed by shot

VARIABLES		CRITERION 1:SHOT				
		% Yes	%No	χ^2	Sig.	Contingency Coefficient
Time	0' - 30'	26.1	73.9			
	31'- 60'	24.3	75.7	1.29	0.52	---
	61'-90'	27.9	72.1			
Position of corner	Right	29.4	70.6			
	Left	22.1	77.9	7.49	0.006	0.083
Laterality of corner	Same	30.1	69.9			
	Opposite	21.9	78.1	9.35	0.002	0.092
No. of attackers	2-3	17.6	82.4			
	4-5	24.9	75.1	3.23	0.19	---
	6 or more	29.9	70.1			
No. of defenders	4-5	22.6	77.4			
	6 or more	26.3	73.7	0.36	0.54	---
Interaction context	Numerical inferiority	25.7	74.3			
	Numerical equality	33.3	66.7	0.94	0.33	---
Delivery of ball	Direct	23.8	76.2			
	Indirect	35.9	64.1	12.28	<0.001	0.106
Path of ball	Ground	40.6	59.4			
	Air	24.6	75.4	10.86	<0.001	0.10
Type of marking	Man-to-man	28.1	72.9			
	Zone	28.5	71.5	1.89	0.38	---
	Combined	24.7	75.3			
Defenders on the posts	None	27.7	72.3			
	1	25.3	74.7	0.69	0.71	---
	2	25.5	74.5			
No. of intervening attackers	1-2	21.4	78.6			
	3-4	62.5	37.5	97.82	<0.001	0.284
Zone to which pass is made	Near post	23.6	76.4			
	Far post	29.3	70.1	5.23	0.02	0.07
Shooting area	Near post	19.9	80.1			
	Far post	33.5	66.5	26.32	<0.001	0.15
Offensive organization	Static	21.6	78.4			
	Dynamic	35.1	64.9	23.14	<0.001	0.14
Match status	Winning	29.8	70.2			
	Drawing	24.6	75.4	2.45	0.29	---
	Losing	25.8	74.2			

The following variables were significantly associated with a shot produced from a corner: position of corner (χ^2=7.49; p=0.006), laterality of corner (χ^2=9.35; p=0.002), delivery of ball (χ^2=12.28; p<0.001), path of ball (χ^2=10.86; p<0.001), number of intervening attackers (χ^2=97.82; p<0.001), zone to which kick is sent (χ^2=5.23; p=0.02), shooting area (χ^2=26.32; p<0.001), and offensive organization (χ^2=23.14; p<0.001). Based on the contingency coefficient, number of intervening attackers and delivery of ball were the two variables most strongly associated with shot (*C*=0.284 and *C*=0.106, respectively). Corner kicks resulted more frequently in a shot when they were taken from the right-hand side of the pitch (29.4%), kicked with the same foot as the side from which the corner was taken (30.1%), sent indirectly to the shooting area (35.9%), passed along the ground (40.6%), involved three or four attackers (62.5%), and when the ball was delivered to or shot in the shooting area (29.3% and 33.5%, respectively), or the attack was organized dynamically (35.1%).

Table 7 summarizes the results for SHOT ON GOAL. Significant associations were detected for time (χ^2=6.20; p=0.045), delivery of ball (χ^2=4.54; p=0.03), path of ball (χ^2=6.39; p=0.01), number of intervening attackers (χ^2=77.35; p<0.001, shooting area (χ^2=15.47; p<0.001), and offensive organization (χ^2=20.13; p<0.001). Corners resulting in a shot on goal were more common in the first (12%) and last (11.2%) 30 minutes of the match, when the ball was sent to the shooting area indirectly (14.1%), when it was kicked along the ground (17.7%), when there were three or four intervening attackers (32%), when the shot was taken in the area of the far post (13.8%), and when the offensive organization was dynamic (15.7%).

Table 7. Corner kick success analyzed by shot on goal

VARIABLES		CRITERION 2:SHOT ON GOAL % Yes	% No	χ^2	Sig.	Contingency Coefficient
Time	0' - 30'	12	88			
	31'- 60'	6.8	93.2	6.20	0.045	0.07
	61'-90'	11.2	88.8			
Position of corner	Right	10.4	89.6			
	Left	9.1	90.9	0.41	0.52	---
Laterality of corner	Same	11.2	88.8			
	Opposite	8.4	91.6	2.25	0.13	---
No. of attackers	2-3	17.6	82.4			
	4-5	9.4	90.6	1.49	0.47	---
	6 or more	10.6	89.4			
No. of defenders	4-5	10.7	89.3			
	6 or more	9.8	90.2	0.01	0.93	---
Interaction context	Numerical inferiority	9.8	90.2			
	Numerical equality	11.1	88.9	0.001	0.97	---
Delivery of ball	Direct	8.9	91.1			
	Indirect	14.1	85.9	4.54	0.03	0.067
Path of ball	Ground	17.7	82.3			
	Air	9.1	90.9	6.39	0.01	0.08
Type of marking	Man-to-man	8.8	91.2			
	Zone	9.3	90.7	0.25	0.88	---
	Combined	10.1	89.9			
Defenders on the posts	None	10.5	89.5			
	1	9.4	90.6	0.20	0.87	---
	2	10	90			
No. of intervening attackers	1-2	7	93			
	3-4	32	68	77.35	<0.001	0.256
Zone to which kick is sent	Near post	8.7	91.3			
	Far post	11.7	88.3	2.5	0.11	---
Shooting area	Near post	6.6	93.4			
	Far post	13.8	86.2	15.47	<0.001	0.12
Offensive organization	Static	7	93			
	Dynamic	15.7	84.3	20.13	<0.001	0.13
Type of shot	Header	38.6	61.4			
	Kick	36	64	0.09	0.76	---
Match status	Winning	12.6	87.4			
	Drawing	9.6	90.4	3.19	0.20	---
	Losing	8	92			

Table 8. Corner kick success analyzed by goal

VARIABLES		CRITERION 3:GOAL				
		% Yes	% No	χ^2	Sig.	Contingency Coefficient
Time	0' - 30'	1.8	98.2			
	31'- 60'	1.1	98.9	6.15	0.046	0.074
	61'-90'	3.6	96.4			
Position of corner kick	Right	2.3	97.7	0.01	0.99	---
	Left	2.1	97.9			
Laterality of corner	Same	2.1	97.9	0.1	0.99	---
	Opposite	2.3	97.6			
No. of attackers	2-3	11.8	88.2			
	4-5	2.1	97.9	9.78	0.15	---
	6 or more	1.9	98.1			
No. of defenders	4-5	3.6	96.4	0.79	0.37	---
	6 or more	2.1	97.9			
Interaction context	Numerical inferiority	2.3	97.7	1.05	0.30	---
	Numerical equality	0	100			
Delivery of ball	Direct	2.3	97.7	0.01	0.99	---
	Indirect	1.9	98.1			
Path of ball	Ground	3.1	96.9	0.008	0.77	---
	Air	2.1	97.9			
Type of marking	Man-to-man	0	100			
	Zone	1.2	98.8	4.1	0.12	---
	Combined	2.8	97.2			
Defenders on the posts	None	2.8	97.2			---
	1	1.9	98.1	0.83	0.66	
	2	2.3	97.7			
No. of intervening attackers	1-2	1.5	98.5	18.35	<0.001	0.135
	3-4	7.8	92.2			
Zone to which kick is sent	Near post	1.8	98.2	0.66	0.42	---
	Far post	2.8	97.2			
Shooting area	Near post	1.9	98.1	0.31	0.58	---
	Far post	2.6	97.4			
Offensive organization	Static	1.4	98.6	5.39	0.02	0.075
	Dynamic	3.8	96.2			
Type of shot	Header	6.6	93.4	1.86	0.17	---
	Kick	12	88			
Match status	Winning	2.5	97.5			
	Drawing	2	98	0.26	0.88	---
	Losing	2.3	97.7			

Finally, Table 8 shows the results for the criterion GOAL. The following variables were significantly associated with a corner kick resulting in a goal: time (χ^2=6.15; p=0.04), number of intervening attackers (χ^2=18.35; p<0.001), and offensive organization (χ^2=5.39; p=0.02).

Goals resulting from a corner kick were more common in the last 30 minutes of the match (3.6%), when three or four attackers interacted with the ball (7.8%), and when the attack was set up dynamically (3.8%).

3.3. Multivariate Analysis

Results from the bivariate analysis were used to build binomial logistic regression models to predict the likelihood of success for corner kicks taken in elite football.

The explained variables used were shot, shot on goal, and goal (all dichotomous). All variables significantly associated with these three variables in the bivariate analysis were included as predictors.

The models were built by stepwise regression with the Wald statistic. The theoretical models tested in each case are shown below:

SHOT $f_{(x)} = \alpha + \beta_1$ (position of corner) + β_2 (laterality of corner) + β_3 (delivery of ball) +β_4 (path of ball) + β_5 (number of intervening attackers) + β_6 (zone to which kick is sent) + β_7 (shooting area) + β_8 (offensive organization) + ε (1)

SHOT ON GOAL $f_{(x)} = \alpha + \beta_1$ (Time) + β_2 (delivery of ball) + β_3 (path of ball) + β_4 (number of intervening attackers) + β_5 (shooting area) + β_6 (offensive organization) + ε (2)

GOAL $f_{(x)} = \alpha + \beta_1$ (Time) + β_3 (number of intervening attackers) + β_3 (offensive organization) + ε (3)

The models were statistically significant for shot (χ^2=122.50; p<0.001), shot on goal (χ^2=82.22; p<0.001), and goal (χ^2=12.25; p<0.001), although their predictive power was moderate: R^2=15% for shot and shot on goal and R^2=7% for goal (Table 9). The omnibus test showed that all predictors contributed to the model (p<0.001) and the Hosmer-Lemeshow test was not significant for any of the models (>0.05 in all cases), indicating goodness of fit.

Table 9. Logistic regression results

CRITERION: SHOT					
VARIABLES	**B**	**S.E***	**Wald**	**Sig.**	**Exp (B) [CI**]**
No. of intervening attackers	1.62	0.20	62.82	<0.001	5.05 [3.38-7.53]
Shooting area	0.61	0.14	17.88	<0.001	1.84 [1.38-2.44]
Offensive organization	0.45	0.15	8.91	<0.01	1.56 [1.16-2.10]
Laterality of corner	-0.42	0.14	8.61	<0.01	0.65 [0.49-0.87]
Constant	-3.78	0.41	84.75	<0.001	0.023

χ^2 (sig)	**Nagelkerke R^2**	**Hosmer-Lemeshow**	**% correctly classified actions**
122.50 (p<0.001)	0.15	6.96 (p=0.32)	76.8%

CRITERION: SHOT ON GOAL					
VARIABLES	**B**	**S.E**	**Wald**	**Sig.**	**Exp (B) [CI]**
No. of intervening attackers	2.08	0.31	46.09	<0.001	8.01 [4.39-14.61]
Shooting area	0.65	0.21	9.12	<0.01	1.92 [1.26-2.93]
Offensive organization	0.63	0.22	8.39	<0.01	1.87 [1.22-2.87]
Delivery of ball	-0.78	0.33	5.66	<0.05	0.46 [0.24-0.87]
Constant	-5.63	0.53	112.87	<0.001	0.004

χ^2 (sig)	**Nagelkerke R^2**	**Hosmer-Lemeshow**	**% correctly classified actions**
82.22 (p<0.001)	0.15	2.34 (p=0.80)	89.9%

CRITERION: GOAL					
VARIABLES	**B**	**S.E**	**Wald**	**Sig.**	**Exp (B) [CI]**
No. of intervening attackers	1.74	0.42	17.11	<0.001	5.68 [2.49-12.95]
Constant	-5.91	0.62	91.99	<0.001	0.003

χ^2 (sig)	**Nagelkerke R^2**	**Hosmer-Lemeshow**	**% correctly classified actions**
12.25 (p<0.001)	0.07	----	97.7%

Notes: *Standard Error; **Confidence Interval (95%)

The following variables were included in the equation for SHOT: number of intervening attackers, shooting area, offensive organization, and laterality of corner. The other variables were not included, as their regression coefficients were not significant.

The sign on the coefficient for number of intervening attackers was positive (B=1.62), indicating that the likelihood of a shot following a corner kick increases with the number of attackers. The corresponding odds ratio (OR) of 5.05 indicates that the odds of a corner resulting in a shot is increased 5-fold when three or four players participate in the kick compared with just one or two.

The positive sign on the coefficient for shooting area (B=0.61) and the OR of 1.84 shows that corner kicks are twice as likely to end in a shot when the kick reaches the far post.

The sign on the coefficient for offensive organization was also positive (B=0.45), and the odds of success are 1.56 times higher in the case of a dynamic rather than a static attack (OR=1.56).

The coefficient for the foot used to kick the corner had a negative sign (B=-0.42) and the OR was 0.65, indicating that the odds of a shot being taken is 0.65 higher when the ball is kicked with same foot as the side of the pitch from which the corner is taken.

Once estimated, the values for the different parameters, expressed as logit units, were included in the predictive equation as follows:

Logit (p) = -3.78 + 1.62 (3-4 attackers.) + 0.61 (shooting area, far post) + 0.45 (dynamic offensive organization) –0.42 (same laterality of corner) = 75.9% (4)

Accordingly, the likelihood of a shot resulting from a corner kick is 75.9% if each of the above criteria is fulfilled.

The above model has low sensitivity for predicting shots produced by corner kicks (25.67%) and a specificity of 94.78% for predicting kicks that do not result in a shot. It correctly classified 76.8% of all kicks analyzed, and had a false-positive rate of 36.66% and a false-negative rate of 21.59%.

The following variables were included in the equation for SHOT ON GOAL: number of intervening attackers, shooting area, offensive organization, and delivery of ball. The positive sign on the regression coefficient for number of attackers (B=2.08) indicates that the chances of a corner kick producing a shot on goal increase as the number of intervening attackers increases. The OR of 8.01 indicates that the odds of a shot on goal are 8 times higher when three or four players rather than one or two players interact with the ball.

The positive sign on the coefficient for shooting area (B=0.65) shows that corner kicks completed at the far post are more successful, with an OR of 1.92.

The regression coefficient for offensive organization was also positive (B=0.63) and the odds ratio was 1.87, indicating that the odds of a successful outcome are almost doubled when the attack is organized dynamically.

Finally, the results show that the odds of a shot on goal are approximately 0.5 times higher when the corner kick is sent indirectly to the shooting area (B=-0.78; OR=0.46).

The equation for the above model expressed in logit units is expressed as follows:

Logit (p) = -5.63 + 2.08 (3-4 attackers.) + 0.65 (far post)+ 0.63 (dynamic attack) – 0.78 (indirect delivery) = 57.6% (5)

The model has low sensitivity (3.6%) and high specificity (99%), and correctly classified 89.9% of the corner kicks analyzed. It was associated with a false-positive rate of 55.5% and a false-negative rate of 9.7%.

Finally, the only variable included in the equation for GOAL was number of attackers, with a positive coefficient (B=1.74) and an OR of 5.68, indicating that the odds of a goal are significantly higher when three or four players are involved in the action.

The equation in terms of logit units is as follows:

Logit (p) = -5.91 + 1.74 (3-4 attackers.) = 8% (6)

The model has a specificity of 100% and classified 97.7% of the corner kicks analyzed correctly.

4. Discussion

The findings of the present study confirm that corner kicks are relatively uncommon, with an average of 10.24 kicks taken per match. This figure is similar to figures reported by Castelo (1986), Alonso (1995), Pérez & Vicente (1996), Olsen & Larsen (1997), Ensum et al. (2000), Hill & Hughes (2001), Yamanaka et al. (2002), Bangsbo & Peitersen (2003), Borrás & Sainz de Baranda (2005), Carling et al. (2005), Taylor, James, & Mellalieu (2005), Acar et al. (2009), Silva (2011), Pulling, Robins, & Rixon (2013), Sainz de Baranda, & López Riquelme (2012), Sánchez-Flores et al. (2012) and Siegle & Lames (2012). Only 26% of corner kicks taken during the matches analyzed resulted in a shot, coinciding with findings by Borrás & Sainz de Baranda (2005), Silva (2011), Mara, Weeler, & Lyons (2012) and Sainz de Baranda & López Riquelme (2012), and only 9.8% of these shots were between the posts, also coinciding with figures reported by Sainz de Baranda & López-Riquelme (2012). Even more important, however, is that just 2.2% of corner kicks ended in a goal, confirming reports by Grehaigne (2001), Taylor, James, & Mellalieu (2005) and Sainz de Baranda & López-Riquelme (2012) that corner kicks are largely ineffective. Nevertheless, although corner kicks are both uncommon and largely ineffective, they have a decisive role in the outcome of matches between teams of a similar level (Mombaerts, 2000; Castelo, 2009; and Ardá et al., 2014). In our series, goals scored from corner situations meant a draw or a victory in 76% of cases

Our study also revealed that shots between the posts resulting from corner kicks are more common in the first and last 30 minutes of the match, and that goals are more common in the last 30 minutes, confirming previous reports of Jinshan et al. (1993), Abt, Dickson, & Mummery (2002), Armatas, Yiannakos, & Sileloglou (2007), Saraiva (2007) and Acar et al. (2009). We believe that this higher frequency of shots during the early part of the match may be due to the "surprise factor", i.e. the defending team is still unfamiliar with the attacking team's corner kick tactics. The fact that shots resulting from corner situations are more common in the later part of the game might be due to the greater physical and mental fatigue experienced by the defenders and/or to the fact that attacking teams tend to take more initiative and risks towards the end of a game, particularly if they are losing. Teams in such situations may employ what could be termed "desperate" strategies that depart from normal practice, such as overloading the goal area with attackers and sometimes even pushing up the goalkeeper to participate in the kick.

Like Sainz de Baranda, López-Riquelme, & Ortega (2011), we saw that corner kicks are more likely to lead to a shot when they are taken with the same foot as the side of the pitch from which they are taken or when the ball is delivered to the far post, as reported

by Taylor et al. (2005), Saraiva (2007), Silva (2011) and Sánchez-Flores et al. (2012). In the first case, the receiver may be able to inject more power into the shot because of the greater speed with which the ball is delivered, and in the second case, players who receive the ball further away from the goalkeeper have more time and space to act and therefore the chances of the ball being intercepted are reduced. Nevertheless, data on these aspects are limited, and even conflicting, with Carling et al. (2005), for example, reporting that corner kicks taken with the opposite foot to the side of the pitch lead to more goals.

Coinciding with reports from Teodorescu (1984), Ali (1988), Bate (1988), Castelo (1999), Mombaerts (2000), Grehaigne (2001), Sainz de Baranda, López-Riquelme, & Ortega (2011), Silva (2011) and Sánchez-Flores (2012), our study revealed that corner kicks delivered along the ground, with the intervention of three or four players, and with a dynamic offensive set-up, are, contrary to what might be expected, more effective than kicks delivered directly. This is possibly because of the greater uncertainty created among the defenders, which would be compounded by the need to keep an eye on both the ball (zone defense) and the attackers (man-to-man defense), thereby giving their rivals more opportunities to create space and take a shot on goal.

Finally, our multivariate analysis showed that corner kicks delivered indirectly to the far post, with the intervention of three to four players performing feinting movements, are 57.6% more likely to result in a shot between the posts. Unfortunately we are unable to compare our results with those of other studies due to the lack of multivariate analyses of corner kick performance. We believe that our findings may be of considerable value in helping to improve corner kick performance in elite football.

5. Conclusions

The main conclusions that can be drawn from our study are 1) corner kicks are uncommon and largely ineffective, but are often decisive in the outcome of a match; 2) more elaborate corner kicks—sent to the far post, following a short initial kick and the intervention of three or four players in a dynamic set-up—are more effective; and 3) corner kicks taken under these circumstances have a 57.6% chance of resulting in a shot between the posts.

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