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Multivariate analysis of indirect free kick in the FIFA World Cup 2014

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Título: Análisis multivariante del tiro libre indirecto en la Copa del Mundo de la FIFA 2014.

Resumen: Los tiros libres indirectos son situaciones que se producen con regularidad durante los partidos de fútbol, siendo acciones potencialmente trascendentales en el resultado final de los partidos. Los objetivos de este estudio fueron determinar la efectividad de estas acciones, identificar las variables asociadas con el éxito y proponer un modelo de tiro libre indirecto exitoso.

Fueron codificados y analizados 506 tiros libres indirectos registrados en los 64 partidos de la FIFA World Cup Brasil 2014, se llevaron a cabo análisis univariados, bivariados (Ji-Cuadrado) y multivariados (regresión logística binaria), los resultados indican una baja eficacia en el remate, remate entre los tres palos y el gol en este tipo de acciones. En cambio, el 89% de los goles con procedencia en un tiro libre indirecto han contribuido a sumar puntos en el resultado final de los partidos. La organización ofensiva, basada en maniobras de creación y ocupación de espacios, y la intervención de hasta 4 jugadores, son variables que se han revelado como moduladoras de la eficacia. Sin duda, estos enunciados podrían suponer un punto de partida para dotar a entrenadores de nuevas herramientas tácticas con el fin de dotar de un perfil más eficaz en este tipo de acciones.

Palabras clave: Regresión logística; metodología observacional; fútbol; saque de esquina.

Abstract: Indirect free kicks are relatively common in soccer and have the potential to change the outcome of a match. The aim of this study was to determine the effectiveness of these kicks, to identify variables associated with success, and propose a model for optimal execution.

We analyzed and coded 506 indirect free kicks taken in 64 matches during the FIFA 2014 World Cup in Brazil and conducted univariate, bivariate (chi-square), and multivariate (binary logistic regression) analyses. Our results show very low success rates in terms of shots, shots between the posts, and goals. Nevertheless, 89% of goals scored from indirect free kicks led to the teams gaining valuable points. Determinants of success included a dynamic attack based on the creation and occupation of spaces and the intervention of up to four attackers. Our findings offer an interesting starting point for trainers to build on tactical strategies designed to improve free-kick performance.

Key words: Logistic Regression; observational methodology; soccer; corner.

Introduction

The search for success factors, i.e., factors directly associated with winning, forms a key part of research in soccer and indeed sport in general. The identification thus of possible routes to victory, supported by solid evidence, should be a priority for sports researchers within their ultimate search for an explanation of *everything*. The subsequent dissemination of findings in a format that is accessible to trainers and players alike could have a direct impact on the overall performance of individuals and teams.

The expression "less talk and more evidence" would appear to be particularly pertinent in soccer, where everyone has opinions and theories about what actually happens on the pitch. This speculative approach, however, is a far cry from the scientific rigor required to answer the numerous questions that arise in this intricate sport científico (Harris y Reilly, 1988). It is here where researchers' strive for rigor becomes relevant, as a systematic, rigorous analysis can help to find order in the seeming chaos of a soccer match through the identification of patterns and the assignment of meaning to the complex interactions that occur.

Within this strive for a greater understanding of the intricacies of soccer and a reduction of the element of chance, the scientific community has produced extensive research on the two main components of play: dynamic or open play situations, which account for 60% to 70% of all actions in a match (McGarry, Anderson, Wallace, Hughes y Franks, 2002), and static or dead ball situations, which account for the remaining 30% to 40% (Maneiro, 2014; Yiannakos y Armatas, 2006).

Of the many performance indicators that have been analyzed in situations of open play (Mackenzie & Cushion, 2012), ball possession is perhaps one of the most widely studied. Several retrospective studies have found a direct link between possession and winning (Bloomfield, Polman, & O´Donoghue, 2005; Hughes & Franks, 2005 and Jones, James, & Mellalieu, 2004).

Studies of static play have analyzed how goal scoring and match outcomes are influenced by performance in set plays or dead-ball situations. According to empirical work by Yiannakos and Armatas (2006) and Armatas and Yiannakos (2010), approximately one-third of all goals scored in the FIFA World Cup and the UEFA European Championship are, directly or indirectly, a result of set plays. This is pertinent, as the number of goals scored per match has reached an all-time low and has shown no signs of increasing in recent years (see Figure 1). This stagnation can largely be explained by greater defensive organization and intensity and more rigorous implementation of tactical planning. Soccer is in general a low-scoring sport, unlike basketball or handball, for example, and the lack of goals could potentially detract

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from the game. It is not easy to score in soccer and therefore any information that could help to increase goal-scoring opportunities will benefit both teams and followers.

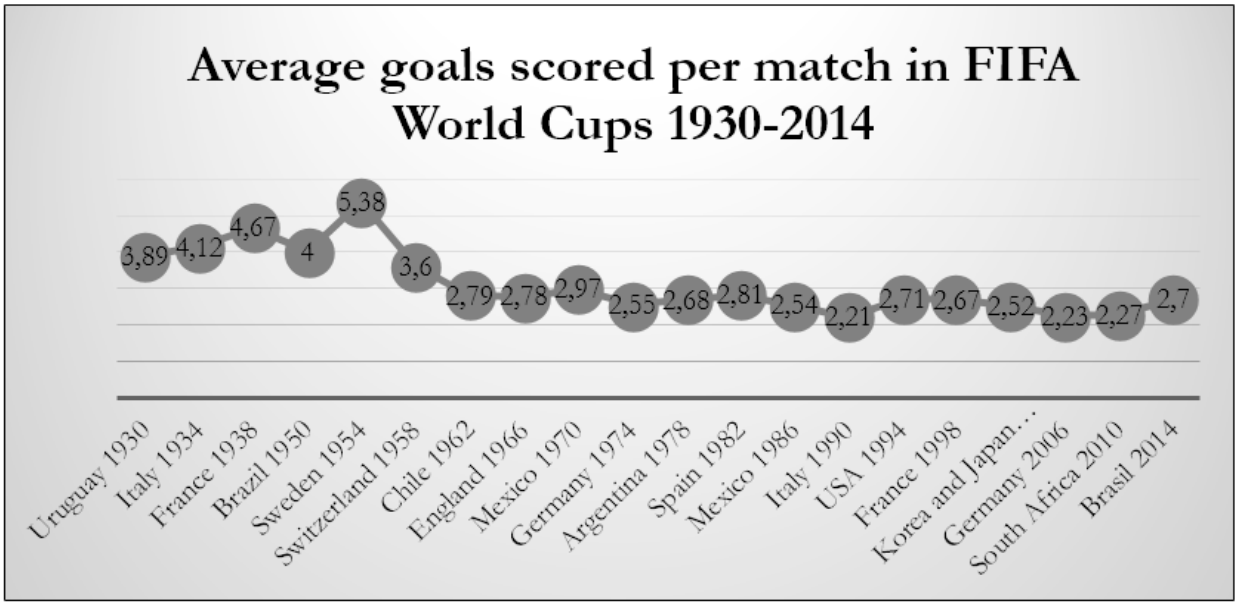

Figure 1. Average number of goals scored in FIFA World Cups from the 1930 World Cup in Uruguay to the 2014 World Cup in Brazil. *Source*: Modified from Castellano, Perea, and Hernández-Mendo (2008).

Based on our review of the literature, the most effective set plays in terms of goal scoring are penalty kicks (Armatas, Yiannakos, Papadopoulou, & Galazoulas, 2007), followed by indirect free kicks and corner kicks, although goals resulting from direct free kicks appear to be on the rise (Njororai, 2013). Throw-ins, goal kicks, and kickoffs, by contrast, are associated with low scoring rates.

An estimated 70% to 85% of penalty kicks taken by professional soccer players result in a goal (Jordet, Hartman, Visscher, & Lemmink, 2007; McGarry & Franks, 2000). Palacios-Huerta (2003), on analyzing 1417 penalty kicks, concluded that to be a highly effective penalty taker, players need to learn to shoot into different areas of the goal. In a later study, Bar-Eli and Azar (2009), found that penalty kicks were more likely to be successful (100% so) if they were aimed at the upper two corners of the goal.

Penalty shoot-outs have also been analyzed. In a large study of 269 penalty shoot-outs consisting of 2820 penalty kicks, Apesteguia and Palacios-Huerta (2010) found that outcome was influenced by kicking order (determined by a coin toss), with teams who took the first kick having a 60% chance of winning the shoot-out.

More recent empirical studies have provided interesting insights into corner kick performance. Although corner kicks are associated with a very low goal rate (around 2% according to Schmicker, 2013), the goals they produce can decide the outcome of the match in 76% of cases (Casal, Maneiro, Ardá, Losada & Rial, 2015). With respect to tactics, two recent studies (Casal, Losada, Maneiro, & Ardá, *in press*; Sainz de Baranda & López-Riquelme, 2012) have shown that the score of the match at the moment of a corner kick can influence the outcome and suggested that the fastest way to a create a scoring opportunity is to put the ball immediately into play and reach the shooting area using simple, straightforward attacking tactics.

The most effective direct free kicks appear to be kicks taken from central areas of the pitch, kicks taken with the opposite foot to the side of the pitch (Carling, Williams, & Reilly, 2005), and kicks aimed at the upper corners of the goal (Alcock, 2010). Although there is a lack of consensus on the success rates of direct free kicks, in general, they appear to be surprisingly ineffective, with just 8%, in the best of cases, resulting in a goal (Silva, 2011). Interestingly, Savelsbergh, Cañal-Bruland, and van der Kamp (2012) designed training protocols aimed at improving free-kick performance in soccer and found that an error-reduction protocol with increasing task difficulty resulted in a lasting improvement in results.

Finally, from our review of the literature, it would seem that very few empirical studies have analyzed indirect free kicks. One of the first studies to analyze these kicks, conducted by Van Meerbeek, Van Gool, and Bollens (1988), analyzed free kicks taken at the 1986 World Cup in Mexico. They described an average of 9.6 indirect free kicks per match and reported that the majority had come from offside situations. Indirect free kicks are relatively ineffective, with just 14% resulting in a shot (Mara, Weeler, & Lyons, 2012) and 3% resulting in a goal. In a recent study by our group, we found that an offensive set-up in which the ball was passed along the ground between three or four players be-

fore the shot was taken increased the chances of a goal 15-fold (Casal, Maneiro, Ardá, Losada, & Rial, 2014).

Findings such as the above highlight the importance of analyzing dead-ball situations within the context of play. The overall aim of this empirical study was to analyze the effectiveness of indirect free kicks in elite soccer within the context of different factors of play. We had three specific objectives: to objectively analyze the effectiveness of these kicks, to identify potential determinants of success, and to create explanatory models to guide the work of trainers and players.

Method

Sample

We studied 506 indirect free kicks taken during the 64 matches of the FIFA World Cup in Brazil 2014. We chose this competition in order to control for the main situational variables found to influence tactical/strategic behavior in soccer (Jones, James, & Mellalieu, 2004; Lago & Martín, 2007; O´Donoghue & Tenga, 2001; Sasaki, Nevill, & Reilly, 1999; Shaw & O´Donoghue, 2004; Tucker, Mellalieu, James, & Taylor, 2005), namely, venue (all the matches were played on a neutral pitch), level of the teams (matches played by top national teams), and match status (e.g., winning, drawing, or losing) at the time of the kick. We only included free kicks that involved four or fewer passes before a shot was taken (Bate, 1988).

Instruments

We used a previously described ad hoc observation instrument comprising a combination of field formats and category systems (Table 1). The full definitions of the categories can be consulted in the study describing the design of the instrument (Casal et al. 2014).

Table 1. Criteria and categories in the ad hoc observation instrument.

Criterion	Categories
Time (T)	0' - 30'
	31'- 60'
	61'-90'
Position of free kick (LS)	Far right
	Far left
	Near right
	Near left
	Area in front of penalty box
Laterality of kick (LG)	Natural
	Switched
No. of attackers (JA)	2-3
	4-5
	6 or more
No. of defenders (JD)	1-4
	5-6
	7 or more
Interaction context (COI)	Numerical inferiority
	Numerical equality
	Numerical superiority
Delivery of ball (EDF)	Direct
	Indirect
Path of ball (TB)	Ground
	Air
Type of marking (MAR)	Man-to-man
	Zone
	Combined
No. of intervening attackers (NJ)	1-2
	3-4
Zone to which pass is made	Near post
	Far post
Shooting area (ZF)	Near post
	Far post
Offensive organization (OF)	Static
	Dynamic
Match status (R)	Winning
	Drawing
	Losing

To facilitate coding of the position of the free kicks, we divided the attacking half of the pitch into different zones following the model used by Casal et al. (2014), shown in Figure 2.

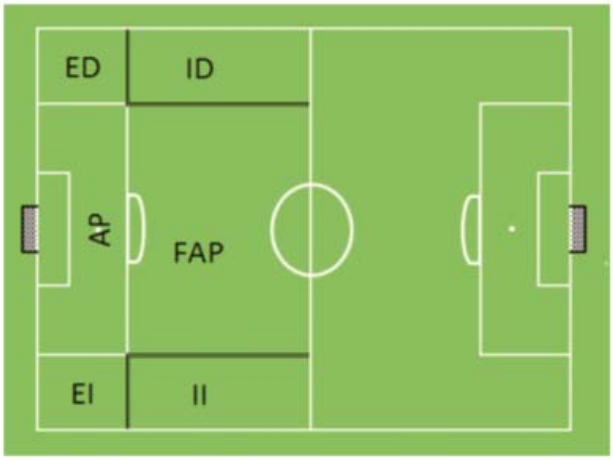

Figure 2. Division of pitch into areas where an indirect free kick can be taken.

The binary logistic regression module in IBM SPSS Statistics 23 was used for data analysis.

Procedure

The study design falls into quadrant IV (follow-up/nomothetic/multidimensional) of the observational methodology models described by Anguera, Blanco, and Losada (2001).

Once all the relevant sequences of play had been extracted from public video footage of the matches, four observers applied the observation instrument to code all events and

behaviors. The observers are all Doctors in Physical Activity and Sports Sciences, experts in observational methodology, and national soccer trainers. In addition, they were specifically trained for the purpose of the study during eight sessions using the consensus agreement method described by Anguera (1990), in which events and behaviors are coded only when there is agreement between the observers. The data were recorded and coded in the LINCE software program (Gabin, Camerino, Anguera, & Castañer, 2012).

The reliability of the resulting datasets was assessed by calculating interobserver agreement using Cohen's kappa statistic for each of the criteria in the observation instrument. Overall agreement was 0.94, which, according to the scale of Fleiss, Levin, and Paik (2003), can be considered very good.

We performed three types of analysis—a descriptive or univariate analysis, a comparative or bivariate analysis, and an explanatory or multivariate analysis. The descriptive analysis provided information on the number of indirect free kicks taken, on how these kicks were taken, and on how successful they were. In our bivariate analysis, we created different contingency tables (with chi-square tests and association measures) to identify variables potentially associated with successful outcomes. Finally, we used multivariate logistic regression to identify significant predictors of successful free kicks. Success was defined as an indirect free kick that resulted in one of the following: a shot (outside the posts), a shot between the posts, or a goal.

Three success criteria have been taken into account: if a shot is produced, regardless of whether it is aimed at goal or not; if the shot is directed between the goal posts; and if the shot gets a goal.

Results

A total of 1893 direct and indirect free kicks were taken in the 64 matches played at the FIFA 2014 World Cup in Brazil. This corresponds to a mean of 29.57 kicks per match. Of these 1893 kicks, 506 met the inclusion criteria for the study. Almost three-quarters (73.3%) of the free kicks were direct kicks, while the remaining 26.7% were indirect kicks or direct kicks taken as if they were indirect kicks. This corresponded to an average of 7.9 indirect free kicks per match. Although these kicks produced eight specific goal-scoring opportunities per match, they were overall very ineffective (Figure 3), as only 1.8% ended in a goal, 10% ended in a shot between the posts, and 22.1% ended in a shot. This lack of effectiveness is even more patent if we consider that each team failed to take advantage of four specific opportunities to score and change the result of each match.

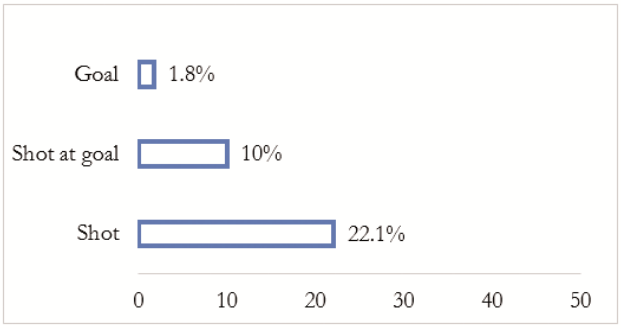

Figure 3. Percentage of indirect free kicks ending in a goal, a shot at goal, or a shot.

Empirically, our results show that almost five indirect free kicks taken with the purpose of scoring a goal are needed to produce a shot, while 10 are needed to produce a shot between the posts, and 56 are needed to actually score a goal.

Despite their overall ineffectiveness, however, goals resulting from indirect free kicks had a decisive impact on the final outcome of matches, as eight (89%) of the nine goals scored helped the teams to gain valuable points (Figure 4).

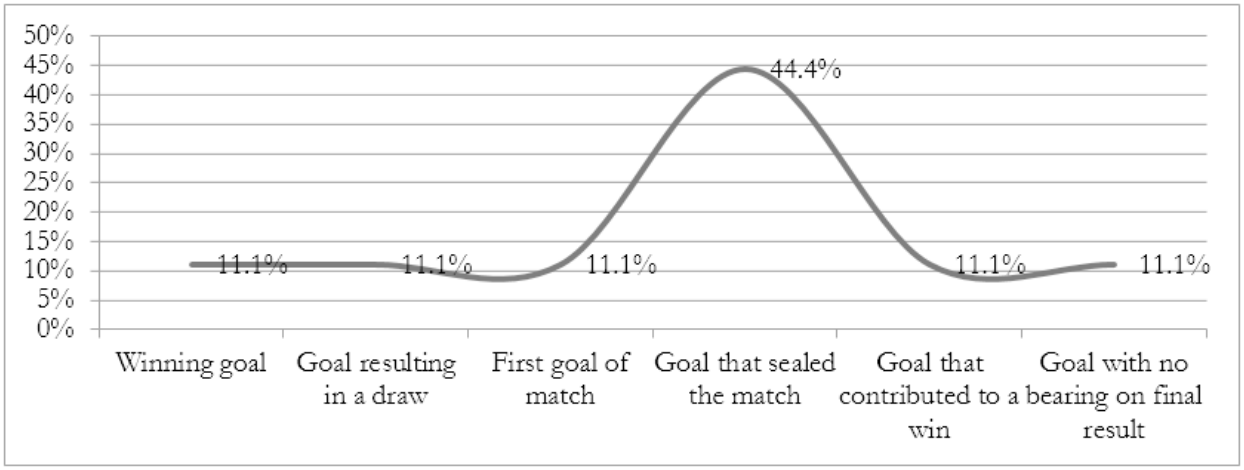

Figure 4. Importance of indirect free kicks in the final result.

Bivariate analysis

To identify factors potentially associated with the effectiveness of indirect free kicks, we created contingency tables and tested associations using the chi-square test, with calculation of the corresponding contingency coefficients. Table 2 shows the five variables that were significantly associated with shot.

These were Number *of defenders* ($\chi^2 = 7.63$, $p = .02$), *Delivery of ball* ($\chi^2 = 14.24$, $p < .001$), *Path of ball* ($\chi^2 = 56.68$, $p < .001$), *Number of intervening attackers* ($\chi^2 = 157.45$, $p < .001$), and *Offensive organization* ($\chi^2 = 38.73$, $p < .001$).

Table 2. Bivariate analysis results for shot criterion.

Variables		CRITERION 1: SHOT		
		χ^2	Sig.	Contingency coefficient
Time	0' - 30' 31'- 60' 61'-90'	1.79	0.40	---
Position of free kick	Far right Far left Near right Near left In front of penalty box	2.86	0.58	---
Laterality of kick	Natural Switched	2.27	0.13	---
No. of attackers	1-3 4-5 6 or more	3.37	0.18	---
No. of defenders	1-4 5-6 7 or more	7.63	0.02	0.12
Interaction context	Numerical inferiority Numerical equality	0.034	0.85	---
Delivery of ball	Direct Indirect	14.24	<0.001	0.17
Path of ball	Ground Air	56.68	<0.001	0.34
Type of defense	Man-to-man Zone Combined	3.15	0.20	---
No. of intervening attackers	1-2 3-4	157.45	<0.001	0.56
Zone to which pass is made	Near post Far post	0.29	0.58	---
Shooting area	Near post Far post	0.01	0.91	---
Offensive organization	Static Dynamic	38.73	<0.001	0.28
Match status	Winning Drawing Losing	0.08	0.95	---

Table 3 shows the results for the second criterion: shot between the posts. Again, five variables were significantly associated with this criterion: *Position of free kick (*$\chi^2 = 13.25$, $p < .01$), *Delivery of ball* ($\chi^2 = 17.07$, $p < .001$), *Path of ball* ($\chi^2 = 31.30$, $p < .001$), *Number of intervening attackers* ($\chi^2 = 65.10$, $p < .001$), and *Offensive organization* ($\chi^2 = 21.53$, $p < .001$).

Table 3. Bivariate analysis results for shot between the posts criterion.

Variables		CRITERION 2: SHOT BETWEEN THE POSTS		
		χ^2	Sig.	Contingency coefficient
Time	0' - 30' 31'- 60' 61'-90'	0.29	0.86	---
Position of free kick	Far right Far left Near right Near left In front of penalty box	13.25	0.01	0.16
Laterality of kick	Natural Switched	0.22	0.63	---
No. of attackers	1-3 4-5 6 or more	1.48	0.47	---
No. of defenders	1-4 5-6 7 or more	1.37	0.50	---
Interaction context	Numerical inferiority Numerical equality	0.59	0.43	---
Delivery of ball	Direct Indirect	17.07	<0.001	0.19
Path of ball	Ground Air	31.30	<0.001	0.25
Type of defense	Man-to-man Zone Combined	3.28	0.19	---
No. of intervening attackers	1-2 3-4	65.1	<0.001	0.36
Zone to which pass is made	Near post Far post	<0.001	1	---
Shooting area	Near post Far post	0.10	0.74	---
Offensive organization	Static Dynamic	21.53	<0.001	0.21
Match status	Winning Drawing Losing	1.88	0.39	---

Finally, Table 4 shows the variables statistically associated with goal. These were *Position of free kick (*$\chi^2 = 29{,}76$, $p < 0.01$), *Type of marking* ($\chi^2 = 8{,}39$; $p \leq 0.01$), *Number of intervening attackers* ($\chi^2 = 8{,}79$; $p \leq 0.003$), and *Offensive organization* ($\chi^2 = 4{,}42$; $p = 0.03$).

Table 4. Bivariate analysis results for goal criterion.

Variables		CRITERION 3: GOAL		
		χ^2	Sig.	Contingency coefficient
Time	0' - 30' 31'- 60' 61'-90'	2.40	0.30	---
Position of free kick	Far right Far left Near right Near left In front of penalty box	29.76	<0.001	0.24
Laterality of kick	Natural Switched	<0.001	1	---
No. of attackers	1-3 4-5 6 or more	2.49	0.28	---
No. of defenders	1-4 5-6 7 or more	3.47	0.17	---
Interaction context	Numerical inferiority Numerical equality	1.65	0.19	---
Delivery of ball	Direct Indirect	0.60	0.43	---
Path of ball	Ground Air	0.04	0.83	---
Type of defense	Man-to-man Zone Combined	8.39	0.01	0.12
No. of intervening attackers	1-2 3-4	8.79	0.003	0.14
Zone to which kick is sent	Near post Far post	0.10	0.74	---
Shooting area	Near post Far post	<0.001	1	---
Offensive organization	Static Dynamic	4.42	0.03	0.10
Match status	Winning Drawing Losing	1.08	0.58	---

The contingency tables for both the criteria and categories in the observation instrument also showed strong interrelations between indirect free kick success and two variables in particular: number of intervening attackers and offensive organization.

Multivariate analysis

For the third objective of the study, we performed several multivariate logistic regression analyses to identify models that would help to explain or predict the effectiveness of indirect free kicks in elite soccer. The dependent variables, all dichotomous, were shot, shot between the posts, and goal, while the explanatory variables, or predictors, were variables significantly associated with the three dichotomous variables in the bivariate analysis (five variables for shot and shot between the posts and four variables for goal). The models were built using stepwise selection based on the Wald test.

For the criterion shot (Table 5), the probability of a successful outcome was 10.055 higher when the indirect free kick was defended by between one and four players rather than seven or more. A similar four-fold increase was observed when five or six defenders were used. In the case of ball delivery, the likelihood of a shot resulting from an indirect free kick was reduced by a factor of 0.514 when the ball was delivered to the shooting area using several players rather than directly. Similarly, a shot was 0.111 times less likely when the ball was delivered along than ground rather than through the air, and 0.003 times less likely when the number of attackers intervening in the kick was one or two rather than three or four. Finally, a static attack was 0.334 times less likely than a dynamic attack to result in a shot from an indirect free kick.

The Hosmer-Lemeshow and Nagelkerke R^2 tests both showed a good fit for the model, with respective scores of 0.797 and 0.650.

$$SHOT\ f_{(x)} = \alpha + \beta_1\,(\text{no. of defenders}) + \beta_2\,(\text{delivery of ball}) + \beta_3\,(\text{path of ball}) + \beta_4\,(\text{no. of intervening attackers}) + \beta_5\,(\text{finish zone}) + \varepsilon_6\,(\text{offensive organization}) + \varepsilon$$

Table 5. Logistic regression results for shot criterion.

		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for EXP(B) Lower	Upper
Step 1	defenders			19.158	2	0,000			
	defense(1)	2.308	0.551	17.526	1	0.000	10.055	3.413	29.624
	defense(2)	1.386	0.403	11.813	1	0.001	4.000	1.814	8.819
	delivery(1)	-1.761	0.422	17.414	1	0.000	0.172	0.075	0.393
	path(1)	2.197	0.451	23.767	1	0.000	9.002	3.721	21.777
	intervention(1)	-5.775	0.773	55.750	1	0.000	0.003	0.001	0.014
	organization(1)	-1.110	0.330	11.323	1	0.001	0.330	0.173	0.629
	Constant	4.653	0.855	29.593	1	0.000	104.947		

χ^2 (sig)	Nagelkerke R^2	Hosmer & Lemeshow	% correctly classified actions
4.624	0.650	0.797	87.4

In the second model, the probability of a shot between the posts was reduced by a factor of 0.091 when the free kick was taken from the far left of the field rather than in front of the penalty box. It was increased, however, by a

factor of 2.686 when the ball was delivered through the air rather than along the ground. Finally, static attacks were 0.250 times less likely to result in a shot between the posts than dynamic attacks.

The goodness of fit of the model is shown by a Hosmer-Lemeshow score of 0.963 and a Nagelkerke R^2 of 0.445 (table 6).

SHOT BETWEEN THE POSTS $f_{(x)} = \alpha + \beta_1$ (position of free kick) + β_2 (path of ball) + β_3 (delivery of ball) + β_4 (no. of intervening attackers) + β_5 (offensive organization) + ε

Table 6. Logistic regression results for shot between the posts criterion.

								95% CI for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	position			12.713	4	0.013			
	position(1)	-0.757	0.820	0.852	1	0.356	0.469	0.094	2.341
	position(2)	-2.396	0.797	9.032	1	0.003	0.091	0.019	0.435
	position(3)	0.408	0.489	0.696	1	0.404	1.503	0.577	3.918
	position(4)	0.480	0.549	0.767	1	0.381	1.617	0.552	4.738
	path(1)	0.988	0.444	4.940	1	0.026	2.686	1.124	6.417
	delivery(1)	-0.282	0.449	0.396	1	0.529	0.754	0.313	1.817
	intervention(1)	-19.840	2283.444	0.000	1	0.993	0.000	0.000	.
	organization(1)	-1.385	0.407	11.574	1	0.001	0.250	0.113	0.556
	Constant	21.545	2283.444	0.000	1	0.992	2274737274.18		

χ^2 (sig)	Nagelkerke R^2	Hosmer & Lemeshow	% correctly classified actions
2.462	0.445	0.963	90.7

The explanatory variables for goal were position of free kick, interaction context, type of marking, number of intervening attackers, and offensive organization. Compared with a free kick taken from in front of the penalty area, a goal was 0.029 times less likely when the kick was taken from the far right of the pitch and 0.006 times less likely when it was taken from the far left. Finally, goals were 0.047 times less likely when the defense played a mixture of man-to-man and zone defense compared with zone defense only.

The goodness of fit assessment showed a Hosmer-Lemeshow score of 0.999 and a Nagelkerke R^2 of 0.554 (table 7).

GOAL $f_{(x)} = \alpha + \beta_1$ (position of free kick) + β_2 (type of marking) + β_3 (offensive organization) + β_4 (no. of intervening attackers) + β_5 (interaction context) +ε

Table 7. Logistic regression results for goal criterion.

								95% CI for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	position			10.889	4	0.028			
	position(1)	-3.538	1.643	4.636	1	0.031	0.029	0.001	0.728
	position(2)	-5.160	1.572	10.780	1	0.001	0.006	0.000	0.125
	position(3)	15.873	3087.044	0.000	1	0.996	7828611.22	0.000	.
	position(4)	-1.069	1.082	0.976	1	0.323	0.343	0.041	2.864
	marking			4.858	2	0.088			
	marking(1)	-2.849	1.538	3.430	1	0.064	0.058	0.003	1.181
	marking(2)	-3.057	1.496	4.174	1	0.041	0.047	0.003	0.883
	organization(1)	-1.948	1.295	2.265	1	0.132	0.143	0.011	1.802
	intervention(1)	-18.810	1902.236	0.000	1	0.992	0.000	0.000	.
	context(1)	0.766	1.578	0.235	1	0.627	2.150	0.098	47.378
	Constant	25.660	1902.238	0.000	1	0.989	1.394E+11		

χ^2 (sig)	Nagelkerke R^2	Hosmer & Lemeshow	% correctly classified actions
0.547	.554	.999	98.6

Once the values for the different variables had been estimated, we expressed the predictor equations using logit units to estimate the probability, under optimal conditions, of an indirect free kick ending in a shot, a shot between the posts, or a goal under optimal conditions.

As indicated by the equation below, the probability of a shot resulting from an indirect free kick was 33.86% when between three and four attackers, using a dynamic attack, participated in the kick and sent the ball through the air directly to the shooting area while being defended by between one and four players.

$$\text{Logit}\quad (p\,|\,\text{Shot}) = \frac{e^{4{,}691 + 1{,}921(\mathbf{1}) - 665(\mathbf{1}) - 1{,}379(1)}}{1 + e^{-0{,}158 + \mathbf{1}{,}441(\mathbf{1}) + 2{,}327\,(\mathbf{1}) - 1{,}379(1)}} =$$

0.3386 (i.e., probability of 33.86%)

We also detected a 95.48% probability of an indirect free kick ending in a shot between the posts when the kick was delivered the air from in front of the penalty box in a dynamic offensive set-up.

$$\text{Logit}(p\,|\,\text{Shot between the posts}) = \frac{e^{(21{,}545+0{,}988-1{,}385)}}{1 + e^{(21{,}545+0{,}988-1{,}385)}} =$$

0.9548 (i.e., probability of 95.48%)

Finally, the likelihood of a free kick resulting in a goal was 95.93% when the kick was taken from in front of the penalty area with the opposing team playing a zone defense.

$$\text{Logit}(p\,|\,\text{Goal}) = \frac{e^{(25{,}660+1-3{,}057)}}{1 + e^{(25{,}660+1-3{,}057)}} = 0.9593 \text{ (i.e., 95.93\%)}$$

Discussion

This study had three separate yet complementary objectives. The first was to provide empirical evidence on the effectiveness of indirect free kicks in elite soccer, using data from the 2014 World Cup in Brazil. The second objective was to identify variables or tactical elements with a possible influence on free-kick performance, and the third objective was to develop multivariate models to explain and/or predict the effectiveness of indirect free kicks.

We registered 1893 direct and indirect free kicks in the 64 matches analyzed. This corresponds to a mean of 29.6 kicks per match, which is similar to figures reported by Siegle and Lames (2012) and Wallace and Norton (2014). Just over a quarter of these kicks (n=506) were regular indirect kicks or direct kicks taken as if they were indirect kicks. Again, this proportion is similar to rates reported by Van Meerbeek, Van Gool, and Bollens (1988) and by Casal et al. (2014).

The average number of indirect free kicks taken per match—eight—is similar to that reported by Silva (2011) and Casal et al. (2014), but considerably lower than that reported by Carling et al. (2005) (12 kicks per match).

One of the first observations to emerge from our data is that despite their relative frequency, indirect free kicks are largely ineffective. Just 1.8% of the 506 kicks led to a goal, and only 22.1% resulted in a shot. This last rate is higher than that reported by Mara, Weeler, and Lyons (2012) and similar to that reported by Maneiro (2014).

The overall ineffectiveness of indirect free kicks, however, contrasts sharply with the impact that goals resulting from these kicks have on the final outcome of matches. Our data show that practically nine of every ten goals scored from an indirect free kick lead to a win or a draw. As found in a previous study by our group (Casal et al., 2014) goals scored from free kicks are few are far between but they can be decisive.

Like Maneiro (2014), we believe that the multiple, complex factors underlying free-kick situations are partly responsible for this overall lack of effectiveness, but we also believe that that insufficient practise and planning have a role. It is not uncommon to see free kicks taken with what appears to be little foresight or consideration of the immediate context. Our results suggest that free kicks should form part of weekly training programmes designed to build tactics that offer an alternative to on-the-spot decisions taken during match situations.

Our bivariate investigation of variables potentially associated with free kick success recurring variables: the number of attackers that intervene in the sequence leading up a shot following an indirect free kick and the organization of the attack.

With just one exception—number of defenders—all the variables significantly associated with either a shot or a shot between the posts were related to offensive play (delivery and path of the ball, number of attackers, and offensive organization). This observation supports previous findings by our team (Casal et al., 2015), and adds strength to the idea that indirect free kicks should be practised in order to reduce the element of chance and uncertainty by building patterns and skills designed to achieve optimal execution.

The variables found to be associated with goals scored from indirect free kicks again show that the key to success would appear to lie in simplicity and tactical refinement, which is quite the opposite to what is typically seen in free-kick situations. Like Maneiro (2014), however, we also found that the position of the free kick influences the likelihood of scoring.

Although statistically, the results of our multiple logistic regression analysis are modest in their predictive ability, at an applied level, they are very interesting, as they could help to increase the overall effectiveness of indirect free kicks.

We found that the likelihood of an indirect free kick ending in a shot increased significantly when the ball was sent directly to the shooting area, with a pass through the air, within a dynamically organized attack involving three to four attackers and four defenders at the most. Again, our results support previous findings by our group that indirect free kicks are more effective when the attackers move around the shooting area and when several players intervene in the sequence leading up to the shot (Casal et al., 2014). A novel finding of the present study, however, is that it is important to send the ball to the shooting area rapidly and through the air at some point. These differences can probably be explained by the fact that while dynamic play does not vary significantly from one World Cup to another (Castellano, Perea, & Hernández Mendo, 2008; Castellano, Perea y Blanco-Villaseñor, 2007), set play does, as it is more likely to be influenced by predefined strategies and positional tactics

aimed at minimizing interaction with the defense. These actions, however, can be easily studied and their effects neutralized, highlighting the importance of constant innovation and renewal in set-play situations.

We also found that the probability of an indirect free kick ending in a shot between the posts was significantly increased by organizing the attack dynamically and passing the ball through the air. This observation indicates that it is not enough to simply deliver the ball to the shooting area, but to ensure that the awaiting attackers vary their positions, by moving around, feinting, and pulling/pushing to create space (Ardá, Maneiro, Rial, Losada, & Casal, 2014).

Finally, we observed that indirect free kicks resulted in more goals when the defending team was playing zone defense, suggesting that in these situations the attacking team should position more players in the immediate defensive area to create uncertainty.

The results of this empirical study are consistent with previous findings by Casal et al. (2014) and Maneiro (2014) and highlight again the importance of elaborate moves, prior practice, and targeted rather than random delivery of the ball to the shooting area. The fact that teams study each other's strategies also suggests that these actions should be as creative and as unpredictable as possible.

Conclusions

The main conclusions that can be drawn from our study are

1) Indirect free kicks are relatively common in elite soccer.
2) Overall, they are very ineffective, as four free kicks are needed to produce a shot, 12 to produce a shot between the posts, and 56 to produce a goal.
3) The way of taking indirect free kicks has evolved from the 2010 World Cup to the 2014 World Cup.
4) An indirect free kick is more likely to result in a shot or a shot between the posts when the attacking side organizes itself dynamically and when three or four players are involved in the sequence leading up to the shot.

Practical applications

Our study has several practical applications as our findings could help trainers and players to improve both the efficiency and effectiveness of indirect free kicks by providing them with new tools and strategies with immediate application. Considering the relative frequency of these set plays in elite soccer, improved free-kick performance is likely to increase scoring opportunities and make the game more attractive.

By being familiar with factors that can help to convert an indirect free kick into a clear scoring opportunity, trainers will be able to propose alternatives to traditional, yet ineffective, tactics based on direct airborne passes from the taker of the free kick. And logically, they will be able to incorporate these new models into regular training sessions.

Finally, the fact that we analyzed interactions between variables will also help trainers to build a richer repertoire of strategies designed to improve their team's performance both in terms of indirect free kicks and overall.

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