




Multivariable analysis of key performance indicators in rink hockey

Jordi Arboix-Alió¹ , Guillem Trabal² , Bernat Buscà¹ , Joan Aguilera-Castells¹ , Azahara Fort-Vanmeerhaeghe¹ , Maria José Sánchez-López³ and Javier Peña² 

¹Department of Sports Sciences, Ramon Llull University, FPCEE Blanquerna, Barcelona (Spain).

²Centre for Studies in Sport and Physical Activity (CEEAF), University of Vic - Central University of Catalonia, Vic (Spain).

³Sagrat Cor University Hospital, Barcelona (Spain).



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Abstract

This study aimed to analyse the influence of various game variables on the final result of rink hockey matches. The influence of the game location, scoring the first goal of the match, winning at halftime and winning at halftime were analysed. A total of 480 matches of the Spanish first division (OK Liga) played during the 2017-2018 and 2018-2019 seasons were analysed. The logistic regression analysis showed that the variable with a stronger association with victory was leading at half time by more than one goal (OR 4.47). In addition, the variables winning at half time (OR 3.35), scoring first (OR 2.05) and game location (OR 1.83) were also factors showing association with the final result of the match. The factors identified could help rink hockey coaches and players better tailor their training strategies and objectives before each competition, establishing a better knowledge and understanding of the game.

Keywords: game variables, performance analysis, performance factors, roller hockey, situational variables, team sports.

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*Corresponding author:

Guillem Trabal*
guillem_tt@hotmail.com

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Introduction

Sports science has recently focused on the quantitative analysis of technical and tactical actions in various sporting specialities with the aim of establishing correlations related to sporting success. Performance analysis, defined as the study of behaviour in competitive sports, seems to be widely accepted by coaches, sports science researchers and players, as well as being a suitable procedure to analyse and improve performance (Drust, 2010; Liu et al., 2016). In this sense, a performance indicator is defined as a selection or combination of variables that aim to define some or all of the aspects that can improve that sporting performance (Hughes and Bartlett, 2002). Therefore, it seems necessary and useful to identify and quantify which performance indicators are relevant to each sport, mainly for team sports. In recent years these have been widely studied in basketball, handball and football (Diana et al., 2017; García-Rubio et al., 2015b; Lago-Peñas, et al., 2016a; Prieto et al., 2015). Many of these contributions have identified influential variables such as the time in possession of the ball (Gómez et al., 2015), the sending off of players (Gómez et al., 2018; Lago-Peñas et al., 2016b), the location of the match (Pollard et al., 2017), the effect of substitutions (Gómez et al., 2016; Gómez et al., 2017), and the time a goal is scored (Baert and Amez, 2018).

One of the game variables that has been shown to have a great influence on the performance of the teams is the home advantage (HA), the advantage of playing at the team's own ground (Prieto et al., 2013). HA is defined as the advantage that teams have when playing on their own pitch as opposed to their opponent's, relating the percentage of points that teams win when they play at home to the total points scored in the competition (Pollard, 1986). This metric provides information on the effect of competing as the home team or as the visitor on the result of sporting competitions. Some studies have identified the factors that could explain this phenomenon, such as, for example, the adverse effects of travel fatigue, familiarity with the pitch, refereeing bias, territoriality and the effect of the local spectators (Courneya and Carron, 1992). In this sense, the HA phenomenon has been demonstrated in individual sports such as tennis (Koning, 2011), judo (Brito et al., 2017; Ferreira Julio et al., 2012), speed skating (Koning, 2005) and golf (Nevill et al., 1997), as well as in collective sports such as football (Gómez and Pollard, 2014; Pollard, 2006), basketball (Pollard and Gómez, 2013; Ribeiro et al., 2016), rugby (McGuckin et al., 2015; Thomas et al., 2008), handball (Prieto and Gómez, 2012) and water polo

(Prieto et al., 2013). Although the value of HA can vary between different sports, regions or levels of competition, in general terms its effect on team sports is quantified at around 60% (Jamieson, 2010). To our knowledge, only two studies have previously analysed the phenomenon of HA in rink hockey, which has also quantified it with an approximate value of 60% (Arboix-Alió et al., 2020; Arboix-Alió and Aguilera-Castells, 2019).

Another variable that can influence the performance of the teams is the time at which goals are scored, a situation that leads to a change in the score (Leite, 2013). According to the psychological momentum theory (Gayton et al., 1993; Iso-Ahola and Mobily, 1980), scoring the first goal in a match can provide an added advantage. This happening, which comes about when an initial successful event occurs in a sporting context, produces a psychological momentum in the sports-person that leads to later success. Some football research has established that the team that scores first significantly increases its chances of winning (Courneya, 1990; Jones, 2009; Lago-Peñas, et al., 2016c; Leite, 2013; Sampedro and Prieto, 2012). Another significant factor related to the time of scoring is that the teams that are winning at the end of the first half of the game are more likely to win (Cooper et al., 1992; Martínez, 2014). In rink hockey, scoring the first goal of the match has also been shown to be a significant indicator for competitive performance (Arboix-Alió and Aguilera-Castells, 2018). Similarly, the effect and interaction of various situational variables on the final result have been analysed in order to identify the critical moments in the game (García-Rubio et al., 2015a; Lago-Peñas and Dellal, 2010; Lago et al., 2010), and a significant correlation has been shown between winning the match and scoring first for teams playing at home.

Although it has been studied in other sports, no research has been found that has focused on the establishment of a predictive model for rink hockey that uses multivariable regression analysis to examine the contribution of the main performance indicators to the final result of the matches. Therefore, this study aimed to study the effects that the following game variables may have: match location, scoring first, winning at half-time and winning at half-time by more than one goal to the final result of the rink hockey matches in top level Spanish competition. As a secondary aim, it was suggested that the various predictive variables be compared to understand which are the most influential factors in the final result.

Methodology

Sample

To carry out this study, 480 rink hockey matches were analysed. All the matches were from the 2017-2018 and 2018-2019 seasons of the Spanish first division of men's rink hockey (OK Liga). Many of the players playing in this league have played in international competitions, both at club level and with the national team, with Spain being the most successful team in these competitions, with a total of 17 world cups and 17 European championships.

The Spanish rink hockey league (OK Liga) is based on a regular home and away league system, in which the same number of games are played at home and away from home. In the OK Liga, a winning team receives three points, a drawing one receives one point, and no points for a loss. The data collection procedure was carried out using the information available for each match on the official website of the Spanish Skating Federation (www.fep.es).

Variables

The result of the match was established as the dependent variable for the study, expressed as the goal difference between the two teams. Four independent variables were examined to identify their influence on the match result: a) winning at half time (WH), 0 = not winning at half time, 1 = winning at half time; b) Game Location (GL), 0 = away, 1 = home; c) scoring first (SF), 0 = scoring first, 1 = not scoring first; d) winning at half time by more than one goal (WHG), 0 = not winning at half time by more than one goal, 1 = winning by two or more goals.

Statistical analysis

The main variable for the study was the result of the match (not winning, winning). A univariate analysis was performed for each of the variables related to the match result, using the χ^2 test with Yates' correction for categorical variables. Statistical significance was established at $p < .05$. The variables were subjected to a multivariable analysis using a logistic regression (Hidalgo and Goodman, 2013). A predictive model based on four variables was established. In the final model, the match result was coded as no victory = 0, victory = 1, considered, as we have mentioned previously, as the dependent variable.

Logistic regression was used to predict the categorical results based on the predictor variables for the matches (Pic and Castellano, 2016, 2017). Four independent variables were included in the model: WH, SF, GL, WHG. The dependent variable used in this model was Y [0.1]. The value of the dependent variable was one for winning the match and zero for not winning the match. The final equation for the model was established as follows:

$$P(Y) = \frac{1}{(1 + e^{-(\beta_0 + \beta_1 \cdot WH + \beta_2 \cdot SF + \beta_3 \cdot GL + \beta_4 \cdot WHG + \beta_5)})}$$

The odds ratio (OR) and 95% confidence intervals were calculated from beta coefficients and the standard error. The ORs showed the change in the probabilities, which means that if the value was greater than one the probability of winning increased. Likewise, if the value was less than one the probability decreased. The hypothesis that the logistic model fits the data adequately was tested using the χ^2 goodness-of-fit test (Hosmer and Lemeshow, 1980). Statistical analysis was performed using the SPSS program (version 20 for Windows; SPSS Inc., Chicago, IL, USA).

Ethical considerations

As the study was carried out in the setting of an official competition for public broadcast, the informed consent of the athletes was not required, in accordance with the ethical requirements established by the American Psychological Association (2002).

Results

Table 1 shows the descriptive and percentage statistics of all the games played in the OK Liga during the 2017-2018 and 2018-2019 seasons. The teams that were ahead at half time won 76.21% of the matches, while, when they were drawing or losing, this percentage decreased to 11.35% and at 12.43%, respectively. In addition, home teams that were ahead at half time ended up winning 83.5% of the matches. By contrast, visiting teams won 68.54% of matches when they were ahead at half time.

All the performance indicators analysed showed significant differences between wins (winning) and draws or losses (not winning) (Table 2). The presence of any of the performance indicators studied was linked to a higher number and percentage of wins. In general, the WHG

Table 1
Percentage of wins, draws and losses as a function of the result at half time.

Result at half time	Result full Time	Win			Draw			Loss		
		Home	Visitor	Total	Home	Visitor	Total	Home	Visitor	Total
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Result at half time	Win	162 (83.5)	120 (68.54)	282 (76.21)	16 (8.25)	26 (14.16)	42 (11.35)	16 (8.25)	30 (16.85)	46 (12.43)
	Draw	40 (36.36)	36 (32.72)	76 (34.54)	34 (30.9)	34 (30.9)	68 (30.9)	36 (32.72)	40 (36.36)	76 (34.54)
	Loss	30 (16.85)	16 (8.25)	46 (12.43)	26 (14.16)	16 (8.25)	42 (11.35)	120 (68.54)	162 (83.5)	282 (76.21)

variable resulted in 93.3% of winning and a 6.7% of not winning ($p < .001$); WH resulted in a 76.2% of winning and a 23.8% of not winning ($p < .001$); SF in 62.5% of winning and a 37.5% of not winning ($p < .001$), and GL in 49.2% of winning and a 50.8% of not winning ($p = .004$).

After multivariable analysis, the results showed that all the variables analysed had a positive effect on the end result of the match (Table 3). WHG was the most powerful

predictor variable, with an OR value of 4.695. The second variable was WH with an OR of 3.348, followed by SF (OR = 2.058) and GL (OR = 1.828).

In the model, establishing a cut-off point of 0.420 to predict a win resulted in a sensitivity of 0.6692, a specificity of 0.8301, a positive predictive value of 73.61%, a negative predictive value of 77.98% and a total correct classification of 76.73%.

Table 2
Descriptive statistics and percentage of game variables on the result of the game.

	Match result		p
	Win	Not a win	
	n (%)	n (%)	
Leading at half time	282 (76.2)	8 (23.8)	.000**
Scoring first	289 (60.6)	188 (39.4)	.000**
Location of the match	235 (49.2)	243 (50.8)	.001**
Leading at half time by more than one goal	154 (87)	23 (13)	.000**

Note. ** Significant differences between the game variables and the final result; $p < .01$

Table 3
Results of the multivariable analysis. Effects of leading at half time, scoring first, location of the match and leading at half time by more than one goal.

	Model coefficients	Significance value	Odds ratio	Confidence interval of the odds ratio (95.0%)	
				Lower	Upper
Winning at halftime	1.208	.000	3.348	2.234	5.018
Scoring first	.722	.002	2.058	1.433	2.955
Game location	.605	.000	1.828	1.354	2.469
Winning at half time by more than one goal	1.546	.000	4.695	2.757	7.993
Constant	-1.795	.000	.166		

Note. Goodness of fit $\chi^2 = 7.218$; df = 6; $p = .301$. Area under the ROC curve = 0.81; sensitivity = 0.6692; specificity = 0.8301; PPV = 0.7361; NPV = 0.7798.

In Figure 1, the ROC curve is shown for the multiple logistic regression model based on the variables of the match result, indicator of the representation of the ratio or proportion of true positives (RVP) versus the ratio or proportion of false positives. (RFP).

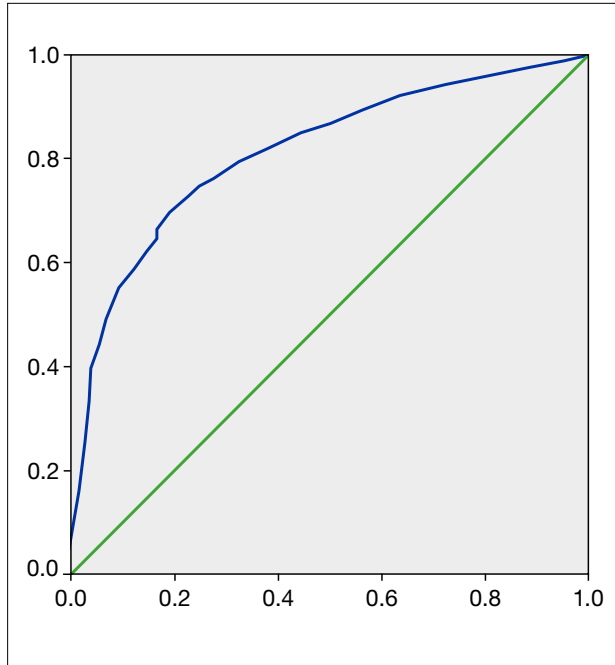


Figure 1
ROC curve for the multiple logistic regression model based on the match result variables. Area under the ROC curve = 0.81.

Discussion

The main objective of this study was to identify the variables related to the final result of matches in the Spanish men's first division of rink hockey and their specific importance by means of a multivariable analysis. The results obtained showed that the variables game location (GL), scoring first (SF), winning at half time (WH) and winning at half time by more than one goal (WHG) have an independent predictive effect related to the final result of the match. The strongest predictor variable was WHG (OR = 4.695), followed by WH (OR = 3.348), SF (OR = 2.058) and GL (OR = 1.828). These findings confirmed that the evolution of the score clearly influenced the results of rink hockey matches. No previous studies have been found in this sport that allow us to compare our results. However, they coincide with those reported for other team sports such as football, where teams also get better results when they are winning at half time (Martínez, 2014).

Winning at half time

The study results showed that 76.2% of the victories corresponded to teams that were winning at half time. The logistic regression showed that the WH variable provided a positive effect quantified with an OR of 3.348. However, the most powerful predictor in our study was the WHG variable, which produced an OR of 4.695. There may be several reasons for these findings. One of them would be that the fact of being ahead in the game creates a state of comfort that allows players to adopt strategies to maintain possession of the ball during the second half, which translates into a less direct style of play and therefore a greater control of the game (Lago et al., 2010). In this sense, it has been shown that, in sports with a formal structure similar to rink hockey, such as football, teams play differently depending on whether they are losing, winning or drawing (Lago and Martín, 2007).

Scoring the first goal

Another performance indicator predictor of victory was the variable SF, with an OR of 2.058. The results showed that the teams won 60.6% of matches when they scored first. According to previous studies, such as that of Arboix-Alió and Aguilera-Castells (2018), which quantified the advantage of scoring first in Spanish men's professional hockey at 64.14%, or like others on team sports, scoring first is relevant because a team that is level or behind reduces attempts to score a goal (García-Rubio et al., 2015a; Taylor et al., 2008). In football, García-Rubio et al. (2015a) found an OR of 3.36 for teams that score the first goal in a match. The lower OR value found in this study could be explained by rink hockey being a sport with a higher number of goals per game than football, with an average of 7.13 goals in the Spanish league (Arboix-Alió and Aguilera-Castells, 2019) as against only 2.65 in Spanish futsal (Sampedro and Prieto, 2012) or 3.61 and 3.55 in the football world cups and the UEFA European championships played in the 2010s. Contrary to what happens in football, the data indicate a greater difficulty for rink hockey teams to maintain a favourable result when they score first. However, the advantage of scoring first could be explained for the same reasons as in other team sports.

Scoring the first goal of the match also has a positive impact on the home crowd, increasing their enthusiasm and participation. This effect is based on the theory of psychological momentum (Gayton, et al., 1993;

Iso-Ahola and Mobily, 1980), known to be the added advantage obtained when a successful initial event occurs in a sporting context, providing a psychological momentum to the sports-person that leads to improvements in performance and increases their chances of success. This phenomenon is also thought to explain the ups and downs in the performance of teams and players (Roane et al., 2004) in various situational sports such as football, baseball or beach football (Courneya, 1990; Lago-Peñas et al., 2016c; Leite, 2016).

Game location

Finally, the predictor that least affected the final result, although it was also statistically significant, was the variable GL, with an OR of 1.828. The effect of HA in rink hockey has been confirmed in recent studies, and has been estimated to be around 60% (Arboix-Alió et al., 2020; Arboix-Alió and Aguilera-Castells, 2019). Playing at home can have a psychological effect on players who experience a response in their behaviour to protect their own territory (Pollard and Gómez, 2009). According to the theory of territoriality and social facilitation, local teams show more aggressive behaviour to intimidate and dissuade their rival, thus conditioning the visitor's performance (Prieto and Gómez, 2012). Other extrinsic factors that can influence HA are the size of the crowd, the conditions of the trip, the refereeing or familiarity with the pitch (Courneya and Carron, 1992; Pollard and Pollard, 2005).

The differences found between the four predictive variables in this study can be explained by the intrinsic characteristics of rink hockey. In the Spanish rink hockey league there are an average of 7.13 goals per game (Arboix-Alió and Aguilera-Castells, 2019), which means that scoring first is not as decisive as in other team sports in which the number of goals is considerably lower (García-Rubio et al., 2015a). However, leading at the end of the first half and leading by more than one goal seem to be the two most determining factors for victory. Logically, the sum or combination of these four variables further increases the chances of predicting victory in a match, for example, scoring first, along with playing at home and being ahead at the end of the half.

This study also has some limitations that should be addressed in future research. On one hand, the possible effects of some factors such as refereeing bias (Sors et al., 2020), the influence of travel and competitive balance have not been considered (Arboix-Alió et al., 2019; Arboix-Alió, et al., 2021) or crowd behaviour (Pollard,

2008). On the other hand, future research should confirm our results in other competitive rink hockey contexts, such as, for example, in the women's league, in the main national leagues (for example, the Italian league or the Portuguese league) or in competition at a lower level (grassroots sports or regional leagues). Similarly, it would be interesting to analyse whether these game variables change according to the relevance of the competition (European and world championships and the Euroleague) or to study the effect on specific actions in the game, such as set-piece actions (Fernández-Hermógenes et al., 2017, 2021) or the intervention of the goalkeeper (Trabal, 2016; Trabal et al., 2020).

Conclusions

This study has identified, in decreasing order, the following predictive values for victory in the matches of the Spanish rink hockey league: winning at half time by more than one goal, winning at half time, scoring first and playing at home. These results show the importance of dominating the score at the end of the first half. Further, initial sporting events such as scoring first also appear to affect the outcome and play in rink hockey matches. As practical applications of this research, the analysis of the influence of the game variables can provide valuable information to coaches and practitioners in this sport in aspects such as team selection according to the needs of the team itself, the characteristics of the opponent, the point in the match and the match location. Therefore, coaches should design training to reinforce the pressure in attack at the beginning of the game, forestalling the opposing team to achieve a lead at half time and not to concede any goals.

Playing at such a high rhythm to maintain competitive advantage also implies proper management of the team's physical preparation, requiring a physical condition that allows optimal technical and tactical performance under high demands, coping with accumulated fatigue (Fernández et al., 2020). Furthermore, these findings could help technical team members to design specific training sessions based on specific game situations and also to simulate various game scenarios where there is a scoring advantage or disadvantage. These hypothetical situations could be useful to analyse the individual responses of the players in these situations and to improve their performance in pressure situations. For this reason, it is advisable to apply psychological alternatives that allow optimizing sports performance in times of pressure inherent in competitive sports.

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