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The influence of opponents' offensive play on the performance of professional rink hockey goalkeepers

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ABSTRACT

The purpose of this study was to analyse the performance of professional rink hockey goalkeepers and ascertain whether this is influenced by the opposition's offensive play. A sample of 40 matches, including 1713 shots on goal from the Portuguese First Division (2016/2017) was analysed using Chi-square and logistic regression analysis. The results suggest that goalkeepers are more effective in the first half versus the second half (odds ratio [OR] = 1.39; 95% CI: 1.06–1.82; p = 0.017) of matches. Goalkeeping performance was also lower in the direct free-hits (OR = 0.22; 95% CI: 0.13–0.38; $p < 0.001$) and penalties (OR = 0.12; 95% CI: 0.06–0.22; $p < 0.001$), when compared with indirect free-hits. The technique most used by rink hockey goalkeepers to save shots at goal is the "knee on the floor". Observations demonstrate that when attacks commence in the oppositions defensive area, teams are 55% more likely to score and shots at the upper zones of the goal have a higher probability of being successful. These findings could assist coaches and researchers in understanding current goalkeeping performance in relation to offensive patterns of play in rink hockey.

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KEYWORDS
Roller hockey; match analysis; patterns of play; notational analysis; goalkeeper techniques

1. Introduction

Rink hockey (otherwise known as roller or hardball hockey) is a physiologically demanding, intermittent team sport that requires balance, speed, coordination, and explosive strength (Yagüe, Del Valle, Egocheaga, Linnamo, & Fernández, 2013). The sport has seen an exponential increase in published scientific literature over the past 25 years. These studies have included, among others, ball possession (Mendo & Argilaga, 2002; Vaz, 2011), types of attack (Vaz et al., 2016), finishing actions (Vaz, 2011), specific characteristics according to players functional field positions (Kingman & Dyson, 1997a, 1997b), age group (Oliveira, Clemente, & Martins, 2015), situational variables (Kingman & Dyson, 1997b), phase of competition (Bastos, 2005), and match result (Kingman &

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Dyson, 1997b). However, these investigations have focused mainly on outfield players with a notable lack of attention afforded to the performance of rink hockey goalkeepers.

The goalkeeper is typically the last line of defence for rink hockey teams with a role focused on reducing goals conceded. This specialised position requires quick reactions, mobility, endurance and strength, whilst restricted by protective gear and the crouched position they are required to adopt (Sousa, Sarmento, Harper, Valente-dos-Santos, & Vaz, 2018). To date, studies have investigated the movements of rink hockey goalkeepers in relation to the position of shots at the goal using match footage from teams in the English national Premier League (Kingman & Dyson, 2001). However, it should be considered that this study analysed a small number of matches (6) and a sizeable change to the rule set in 2009 was employed, which may potentially limit the applicability of the aforementioned research. Therefore, further research is warranted using larger sample samples with novel perspectives on the unique demands (i.e. movement and skilled/technical actions) of this bespoke position.

Rink hockey is anecdotally renowned for being predominantly offensive in nature as it is purported that players perform 408–422 displacements during a match (Tantiña, Vidal, & López, 2014) being that most of the offensive actions are performed in short periods of time, which leads to a high number of ball possessions per game (range: 55.6 to 105.5) (Brázio, 2006; Duque, 2004; Rosa, 2006; Vaz, 2011). Almost half of these offensive actions result in an attempt at goal, yet only 3% of these ensue in goals scored (Ferreira, 2003). Rink hockey, like futsal (Agras, Ferragut, & Abraldes, 2016) is a sport of finishing actions. However, the extent to which opponents' offensive play influences the effectiveness of the performance of rink hockey goalkeepers is somewhat unknown. Accordingly, it may be important to consider goalkeeping actions in relation to the opponents attacking play. Furthermore, a validated observational instrument has been developed for analysing the activity of rink hockey goalkeepers (Sousa et al., 2018). Therefore, the aim of this study was twofold: 1) to investigate the activity and performance of rink hockey goalkeepers; 2) to assess whether the oppositions attacking play has any relationship with goalkeeping performance.

2. Methods

A total of 40 games, including 1713 shoots at goal from the 2016/2017 season in the Portuguese Rink Hockey First Division were analysed. The sample included matches from 13 out of 14 teams that participated in the Portuguese League (one was excluded from the competition by the Portuguese Roller Sports Federation). Of the 13 teams analysed, we obtained footage for ~6 games from each team.

2.1. Data coding system

Data were analysed using a specific notational analysis system developed and validated by Sousa et al. (2018). The variables were divided into four categories: (1) context of attacking play; (2) beginning of attacking play; (3) development of attacking play, and; (4) end of attacking play (Table 1). For the characterisation of attacking play, a validated rink hockey field was utilised Gayo (2000). The field is divided into 18 areas, which comprised of 3 corridors and 6 sectors (Figure 1) (Vaz et al., 2016).

Table 1. Descriptions of variables and definitions of the categories used in the team match performance analysis (context of attacking play).

Variables and categories
Context of attacking play
Half
1st Half – 00:01–25:00 minutes.
2nd Half – 25:01–50:00 minutes.
Start of the offensive process
After break in play:
Break in play – attacking play begins after a break in play.
Goal from the opposing team – attacking play starts after a goal is conceded.
Direct free hit – attacking play starts with a direct free hit.
Penalty – attacking play restarts with a penalty.
Dynamic movement:
Interception – attacking play is started after an interception of a pass or shot, is made without interruption of the game.
Disarm – attacking play commences after a disarming of an opponent without interruption of the game.
Goalkeeper action – attacking play begins after recovery of the ball or after a save from the goalkeeper.
Ball recovery – the attacking play starts when the opponent makes a misplaced pass to a zone of the field where there is no element of his team or after a poorly directed shot.
Development of the offensive process
Area whereby attacking play commences – area of the field where teams regained ball possession.
Area of the last pass – area of the field where players made the last interaction (pass).
Shooting area – area of the field where teams finished their offensive action with a shot at goal.
Zone of the field – the rink hockey field is divided into 3 corridors (left, centre and right), 6 areas (1, 2, 3, 4, 5, and 6), and 18 zones, the defensive area corresponding to areas 1 and 2, areas 3 and 4 are the intermediate areas of the field and 5 and 6 are considered definition areas (**Error! Reference source not found.**).
End of attacking play
Zones of the goal – zones of the goal where the shots are directed.
Techniques – rink hockey goalkeepers' technique used to save an attempt at goal.

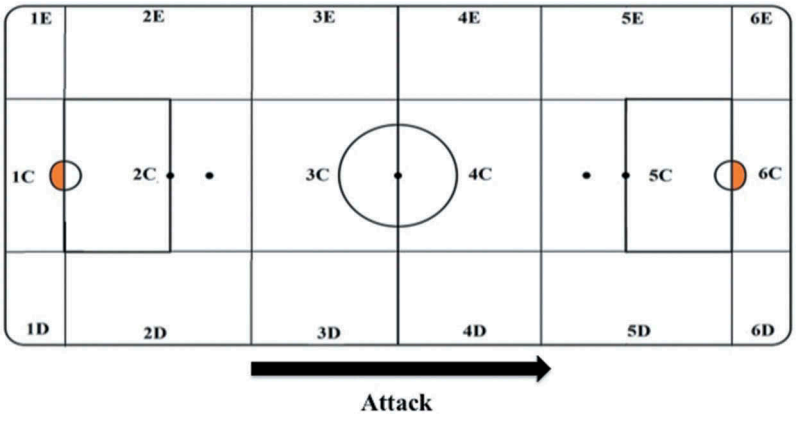

Figure 1. Rink hockey field playing zones. Defensive areas: zones 1 and 2; intermediate areas: zones 3 and 4; offensive areas: zones 5 and 6.

For intra-observer reliability, the lead investigator compared the same observations of two games (which included 96 actions), on two separate occasions, i.e., 2 weeks apart from one another (Tabachnick & Fidell, 2007). Concerning inter-observer reliability, an additional experienced researcher in this field was trained to use this specific observational instrument tool. After this process, he independently observed the same two

Table 2. Kappa values for intra-observer and inter-observer reliability.

	Intra-observer		Inter-observer	
Variable	Kappa	CI (95%)	Kappa	CI (95%)
Start of the offensive process	0.96	0.95–0.97	0.88	0.85–0.92
Development of the offensive process	0.87	0.85–0.88	0.93	0.92–0.93
End of the offensive process	0.92	0.89–0.97	0.89	0.83–0.93

games. Cohen's *kappa* index (Robinson & O'Donoghue, 2007) was calculated to analyse the results. This instrument revealed high intra-observer and inter-observer reliability, since values obtained for all categories were higher than 0.70 (Table 2).

2.2. Statistical analysis

All analyses were conducted using the software IBM SPSS, version 22.0. A Chi-square test was performed to determine whether each independent variable (i.e. Half; Match Status; Final result; Start of attacking play; Development of attacking play; Zones of the goal and Techniques) was associated with the final action (i.e. save or goal). A logistic regression analysis, using stepwise backward selection (Kleinbaum & Klein, 2010), was performed to examine the relationship between goalkeeper's effectiveness, and "Half", "Match Status" and "Final result". This statistical test was also employed to assess the relationship between goalkeeper's effectiveness, and the different aspects of attacking play. Alpha was set at <0.05 prior to analyses.

3. Results

Differences in variables such as "Half", "Match Status" and "Final result" were found to have an effect on the goalkeepers' effectiveness according to opponents attacking play (Table 3).

Table 3. Differences in goalkeepers' effectiveness according to the context of the offensive process.

Variable	Number of goalkeeper saves (%)	Number of goals scored (%)	Odds ratio	CI (95%) odds ratio	*p*
Half					
1st half	698 (87.3)	102 (12.8)	1.388	1.059–1.820	0.017*
2nd half	759 (83.1)	154 (16.9)	1.00 (ref.)		
Match Status					
G2	257 (80.3)	63 (19.7)	0.551	0.374–0.811	0.003**
G1	186 (84.5)	34 (15.5)	0.739	0.468–1.165	0.192
P1	274 (85.9)	45 (14.1)	0.822	0.542–1.247	0.356
P2	303 (84.6)	55 (15.4)	0.744	0.501–1.105	0.142
G0	437 (88.1)	59 (11.9)	1.00 (ref.)		
Final result					
Draw	470 (86.2)	75 (13.8)	1.620	1.182–2.219	0.003**
Lose	515 (89.7)	59 (10.3)	2.256	1.614–3.154	<0.001**
Win	472 (79.5)	122 (20.5)	1.00 (ref.)		

Note. Half: 1st Half – 00:01–25:00 minutes; 2nd Half – 25:01–50:00 minutes. Match Status: A win by more than one goal (G2); A win by a goal (G1); A tie (G0); Lose by a goal (P1); Loses by more than one goal (P2). Final result: Win – the observed team won the game; Draw – the observed teams draw the game; Lose – the observed team lost the game. ** ($p < 0.01$); * ($p < 0.05$).

Goalkeepers tend to be more successful (i.e. more likely to save shots) in the first half rather than in the second half 1.39 (OR) (95% confidence interval [CI]: 1.06–1.82; $p = 0.017$). On the other hand, when the observed team had at least two or more goals scored than their opponent, the effectiveness of the opposition goalkeeper dropped by 45% when compared with when the match is tied (odds ratio [OR] = 0.55; 95% CI: 0.37–0.81; $p = 0.003$). When a team loses, the probability of the opponent goalkeeper making a save is 2.26 times higher than when the team wins the match (95% CI: 1.61–3.15; $p < 0.001$). Additionally, when the two teams draw, the probability of the goalkeeper saving a shot is 1.62 times higher than when one of the teams wins the contest (95% CI: 1.18–2.22; $p = 0.003$).

As outlined in Table 4, the effectiveness of the opponents' goalkeeper is 43% lower after an interruption, when compared with situations of dynamic movement (e.g. interception, disarm, goalkeeper actionand ball recovery; OR = 0.57; 95% CI: 0.43–0.75; $p < 0.001$). Goalkeeper effectiveness is lower when the opponents have a direct free-hit (OR = 0.22; 95% CI: 0.13–0.38; $p < 0.001$) and a penalty (OR = 0.12; 95% CI: 0.06–0.22; $p < 0.001$) when compared with an indirect free-hit. When the offensive sequence begins after an intervention from the goalkeeper, the probability the opponents' goalkeeper saving the shot is 98.5% higher (OR = 1.99; 95% CI: 1.10–3.59; $p = 0.023$) versus situations where the offensive process starts after a misplaced pass or a poorly directed shot.

Table 4. Differences in goalkeepers' performance according to the beginning and development of the offensive process.

Variable	Number of goalkeeper saves (%)	Number of goals scored (%)	Odds ratio	CI (95%) odds ratio	*p*
Start of the offensive process					
After break in play	405 (79.7)	103 (20.3)	0.572	0.434–0753	<0.001**
lj	8 (72.7)	3 (27.3)	0.300	0.075–1.193	0.087
lpga	36 (90.0)	4 (10.0)	1.012	0.336–3.045	0.984
LD	72 (66.1)	37 (33.0)	0.219	0.126–0.380	<0.001**
P	31 (50.8)	30 (49.2)	0.116	0.062–0.219	<0.001**
lpera	258 (89.9)	29 (10.1)	1.00 (ref.)		
Dynamic movement	1052 (87.3)	153 (12.7)	1.00 (ref.)		
lpi	174 (85.7)	29 (14.3)	0.916	0.580–1.446	0.707
lpd	159 (85.0)	28 (15.0)	0.867	0.545–1.379	0.547
lpgr	182 (92.9)	14 (7.1)	1.985	1.099–3.585	0.023*
lpRB	537 (86.8)	82 (13.2)	1.00 (ref.)		
Area of beginning of the offensive process:					
Opposition defensive area	458 (79.0)	122 (21.0)	0.459	0.340–0.620	<0.001**
Intermediate area	304 (86.1)	49 (13.9)	0.759	0.521–1.106	0.151
Defensive area	695 (89.1)	85 (10.9)	1.00 (ref.)		
Area of the last pass:					
Opposition defensive area	433 (84.2)	81 (15.8)	1.657	1.201–2.287	0.002**
Intermediate area	579 (90.0)	64 (10.0)	2.804	2.000–3.931	<0.001**
Defensive area	103 (95.4)	5 (4.6)	6.385	2.535–16.079	<0.001**
Without interaction	342 (76.3)	106 (23.7)	1.00 (ref.)		
Shooting area:					
Opposition defensive area	1123 (82.9)	232 (17.1)	0.349	0.225–0.540	<0.001**
Intermediate area	333 (93.3)	24 (6.7)	1.00 (ref.)		

Note. After break in play: Start of the game (lj); Regulatory disruption of the game in favour (lpera); Goal from the opposing team (lpga); Direct free hit (LD); Penalty (P).

Dynamic movement: Interception (lpi); Disarm (lpd); Goalkeeper action (lpgr); Ball recovery (lpRB).

Zone of the field – the rink hockey field is divided into 3 corridors (left, centre and right), 6 areas (1, 2, 3, 4, 5 and 6), and 18 zones, the defensive area corresponding to areas 1 and 2, areas 3 and 4 are the intermediate areas of the field and 5 and 6 are considered opposition defensive area. ** ($p < 0.01$); * ($p < 0.05$).

When teams initiate the offensive process in the opposition's defensive area, they are 55% more likely to score a goal (OR = 0.46; 95% CI: 0.34–0.62; $p < 0.001$) than when the offensive action starts in their own defensive area. Moreover, if the last pass is performed in the defensive area of the team in possession of the ball, the opposition goalkeeper had a 6.39 (OR) higher chance of being effective (95% CI: 2.54–16.08; $p < 0.001$). When the last pass was performed in the intermediate areas, the odds of the opposition goalkeeper performing a save were lower (OR = 2.80; 95% CI: 2.00–3.93; $p < 0.001$) than when the final pass was completed in the defensive area (OR = 6.39; 95% CI: 2.54–16.08; $p < 0.001$). However, the odds were higher than when performed in the opposition defensive area (OR = 1.66; 95% CI: 1.20–2.29; $p = 0.002$). When a shot at goal was performed in the opposition defensive area, goalkeepers were 66% less likely to save the shot (OR = 0.35; 95% CI: 0.23–0.54; $p < 0.001$) in comparison with shots performed in the intermediate area.

When an offensive action ends with a shot at the upper zones of the goal (upper right – OR = 0.18; 95% CI: 0.08–0.38; $p < 0.001$; upper centre – OR = 0.26; 95% CI: 0.12–0.56; $p < 0.001$; upper left – OR = 0.10; 95% CI: 0.05–0.21; $p < 0.001$) there was a higher chance of it being successful, when compared to shots in the centre of the goal (Table 5). The odds ratios presented in Table 5 indicate that a shot placed at the upper left of the goal has a 90% higher likelihood of being successful (OR = 0.10; 95% CI: 0.05–0.21; $p < 0.001$). Shots are 83% likely to result in a goal when placed in the upper right region of the goal (OR = 0.18; 95% CI: 0.08–0.38; $p < 0.001$) and have a 74% chance of scoring when directed in the upper centre section of the goal (OR = 0.26; 95% CI: 0.12–0.56; $p < 0.001$). When placed middle right (OR = 0.32; 95% CI: 0.15–0.69; $p = 0.004$) and middle left (OR = 0.41; 95% CI: 0.20–0.85; $p = 0.017$) of the goal, shots displayed lower values than in the upper zones of the goal. A shot to the medium left of the goal has a 59% probability of being successful, while a shot to the medium right area of the goal has a 68% chance of resulting in a successful outcome. Furthermore, a shot to the lower centre of the goal has a 55% probability of being successful, while a shot to the lower right and lower left zones of the goal are 59% and 74% likely to result with a goal scored, respectively.

When pertaining to goalkeeper technique, the "fleck" (OR = 0.30; 95% CI: 0.21–0.43; $p < 0.001$), "spatula" (OR = 0.33; 95% CI: 0.23–0.48; $p < 0.001$), and "side fall" (OR = 0.21; 95% CI: 0.14–0.32; $p < 0.001$) had a lower effectiveness in comparison with the "knee on the floor".

4. Discussion

The aim of this study was to analyse goalkeepers' performance and ascertain whether this was influenced by the opponents' offensive patterns, actions and proficiency. To the best of our knowledge, this is the first study that has analysed within-match performance of goalkeepers in relation to the opponents attacking play over a full season. Our results demonstrate that the opponents attacking play impacts goalkeepers' performance. These findings provide data that may assist coaches, practitioners and researchers with a clearer understanding of the demands of rink hockey goalkeepers and the patterns of offensive play, with the view to ultimately improving performance.

As observed in this study, goalkeepers were more effective in the first half compared to the second half. This may be related to the fact that there is an inherent reduction in the physical capacity of players and goalkeepers, which in turn leads to a lower intensity during

Table 5. Differences in goalkeepers' effectiveness according to opposition shot placement and goalkeeping technique.

Variable	With effectiveness from the goalkeeper (save), *n* (%)	Without effectiveness from the goalkeeper (goal), *n* (%)	Odds ratio	CI (95%) odds ratio	*p*
Zones of the goal					
Upper left	70 (64.2)	39 (35.8)	0.100	0.047–0.212	<0.001**
Lower left	197 (82.8)	41 (17.2)	0.268	0.131–0.552	<0.001**
Middle left	242 (88.0)	33 (12.0)	0.410	0.197–0.853	0.017*
Upper right	82 (75.9)	26 (24.1)	0.176	0.081–0.382	<0.001**
Lower right	244 (88.1)	33 (11.9)	0.413	0.198–0.860	0.018*
Middle right	144 (85.2)	25 (14.8)	0.322	0.150–0.692	0.004**
Upper centre	137 (82.5)	29 (17.5)	0.264	0.124–0.560	<0.001**
Lower centre	162 (89.0)	20 (11.0)	0.453	0.206–0.995	0.049*
Middle centre	179 (94.7)	10 (5.3)	1.00 (ref.)		
Technique					
Fleck	248 (77.3)	73 (22.7)	0.301	0.211–0.428	<0.001**
Spatula	208 (78.8)	56 (21.2)	0.329	0.225–0.480	<0.001**
Side fall	105 (70.5)	44 (29.5)	0.211	0.138–0.323	<0.001**
Others (Squatting; V position; Seated)	60 (87.0)	9 (13.0)	0.590	0.282–1.237	0.162
Knee on the floor	836 (91.9)	74 (8.1)	1.00 (ref.)		

Note. ** ($p < 0.01$); * ($p < 0.05$).

the second half (Kingman & Dyson, 1997a). Similarly, a decline in physical performance in the second half of matches has been observed in other team sports such as soccer (Pratas, Volossovitch, & Ferreira, 2012; Sarmento et al., 2017, 2014) and rugby (Duthie, Thornton, Delaney, McMahon, & Benton, 2017). Indeed, a considerable change was made to the rules of the game in 2009, which involved a technical sanction (i.e. concede a direct free-hit) each time a team accumulates 10 fouls or five additional team fouls (World Skate, 2018). The application of this rule has resulted in more direct free-hits in the second half of matches, potentially as a result of physical and mental fatigue-related fouling. Furthermore, we established that goalkeepers are less effective when having to deal with direct free-hits and penalties (set pieces) in comparison with situations of indirect free-hit. The combination of the rule change, reduction in physical capacity and the reduced effectiveness of goalkeepers at saving direct-free hits may explain the reason why goalkeepers are less effective during the second half.

In accordance with our data, when the observed team had at least two or more goals scored than the opponent team, the effectiveness of the opponent goalkeepers is reduced by 45% versus a match that is tied. This may be related to the fact that when teams are losing, they tend to take more risks and as a consequence are exposed defensively to counter-attacks. By assuming a more offensive approach and becoming more exposed to dynamic counter-attacking play, teams will often encounter situations of numerical disadvantage. Additionally, in sports such as soccer (Sarmento et al., 2018) teams that adopt a counter-attacking style of play tend to be more effective. This premise may apply to rink hockey, and thus, it is important that coaches prepare teams (including goalkeepers) to be able to deal with this overload from a tactical and technical standpoint to limit opposition space and delay attacks.

According to our findings, the effectiveness of the rink hockey goalkeeper is reduced when a given offensive action starts following a break in play. However, there are situations where an attack can commence with an interception following a misplaced

pass or shot, a disarm or recovery of the ball. In line with our data, it can be deduced that when possession was regained nearer to the opposition goal, the opponents' goalkeeper was less likely to save the subsequent shot. Although from a different sport, our results are similar to those of (Gamble, Bradley, McCarren, & Moyna, 2019) as they investigated the influence of tactical and situational variables on offensive sequences during elite football matches. They concluded that when teams regain ball possession in more offensive areas, they are more likely to score during a given attacking phase of play. In rink hockey, the defensive and intermediate areas of the rink (zones 1, 2, 3 and 4; see Figure 1) are the desirable areas in which to start offensive actions (Clérigo, 2006; Duque, 2004; Ferreira, 2005, 2003; Rosa, 2006). This information could assist coaches when work on developing strategies that develop the goalkeepers' ability to distribute the ball effectively into the desired zones.

Our results suggest that where an interaction (pass) between players occurred, the likelihood of scoring a goal was reduced. However, it is acknowledged that this information may be influenced by direct free-hits and penalty data. It can also be deduced that the effectiveness of the goalkeeper is reduced when the last interaction is performed in the zones nearer the opposition defensive area. It may be plausible to suggest that the goalkeeper has less time to react and adopt favourable positioning in relation to the completion of opponents quick manoeuvring of the ball. These observations reveal important information about the areas and actions that make it difficult for goalkeepers to prevent a goal. Conversely, goalkeeping coaches and/or individuals regarded as being involved in the tactical preparations of goalkeepers may utilise these data to their advantage.

As outlined in this study, goalkeepers tend to be less effective when shots are placed in the upper zones and more effective in the middle of the goal. Our data is similar to Kingman and Dyson (2001), which analysed the performance of six English national Premier League rink hockey matches. They found that 38.2% of the shots placed in top right of the goal were successful (in our study we concluded that 35.8% of the goals are scored in the upper left of the goal), whereas only 5.9% of the shots directed towards the centre of the goal resulted in a goal scored. In a study performed by Almeida, Volossovitch, and Duarte (2016), the authors analysed a total of 536 penalties from 2010–2011 to 2014–2015 from the UEFA Champions and Europa league (football) and also concluded that players should direct the shots to the upper corners of the goal, because those were the zones of the goal where the probability of ending in a goal was higher.

Furthermore, the most frequent technique used was the "knee on the floor" with goalkeepers utilising this technique to attempt to save 53.1% of the shots on goal. From all the techniques considered, the "knee to floor" was the most successful method of shot stopping. Moreover, we found the "fleck" technique was ineffective in our study. In a study performed by Sousa et al. (2018) coaches considered "fleck" as an "optimum position" to save a shot at goal (defined as a posture adopted by the goalkeeper that allows to carry out a save with efficiency and economy of effort). Comparing the two techniques, there is 70% more chance of conceding a goal using the "fleck" technique than the "knee on the floor". This technique (fleck) requires a great deal of motor coordination and strength in the support arm and may be an explanation as to why this complex technique is less effective.

5. Conclusion

These contemporary data provide a better understanding of the performance of professional hockey goalkeepers in relation to the attacking play of rink opposition hockey teams. The results of this investigation could be useful for coaches and researchers to understand the profile of the offensive process in rink hockey and also the effectiveness of goalkeepers. In this sense, new training strategies can be implemented so as to help improve goalkeepers' performance in relation to the opposition teams attacking play. These may include, working on saving set pieces, distributing the ball into opposition areas and performing effective techniques, such as the "knee on the floor". Conversely, these findings may assist attacking teams in exploiting goalkeepers by manipulating the goalkeeper positioning through quick movements and passes, and placing the ball in the upper section of the goal in both open play and set pieces.

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References

Haydée Agras, Carmen Ferragut & J. Arturo Abraldes (2016) Match analysis in futsal: a systematic review, *International Journal of Performance Analysis in Sport*, 16:2, 652–686, doi:10.1080/24748668.2016.11868915.

Almeida, C. H., Volossovitch, A., & Duarte, R. (2016). Penalty kick outcomes in UEFA club competitions (2010–2015): The roles of situational, individual and performance factors. *International Journal of Performance Analysis in Sport*, *16*(2), 508–522.

Bastos, D. (2005). Análise do 1 x 1 no processo ofensivo no Hóquei em Patins: estudo realizado com a Selecção Portuguesa no Campeonato do Mundo 2003 (Dissertação deLicenciatura), Faculdade de Ciências do Desporto e Educação Física - Universidade de Coimbra, Portugal.

Brázio, P. (2006). *Estudo do Processo Ofensivo no Hóquei em Patins da Selecção de Portugal do Escalão Júnior*. (Dissertação de Mestrado). Faculdade de Desporto da Universidade do Porto. Portugal.

Clérigo, L. F. C. (2006). *Estrutura Interna do jogo de Hóquei em Patins: Estudo Exploratório sobre as Posses de Bola no Escalão de Juniores Masculinos em Portugal* (Dissertação de Licenciatura). Faculdade de Ciências do Desporto e Educação Física - Universidade de Coimbra, Portugal.

Duque, G. (2004). *Estrutura interna do jogo de hóquei em patins: Estudo exploratório das posses de bola no escalão de juvenis masculinos* (Dissertação de Licenciatura). Faculdade de Ciências do Desporto e Educação Física - Universidade de Coimbra, Portugal

Duthie, G. M., Thornton, H. R., Delaney, J. A., McMahon, J. T., & Benton, D. T. (2017). Relationship between physical performance testing results and peak running intensity during professional rugby league match play. *Journal of Strength and Conditioning Research*. doi:10.1519/JSC.0000000000002273

Ferreira, J. (2005). *Análise do jogo e do rendimento desportivo no hóquei em patins* (Dissertação deLicenciatura). Faculdade de Ciências do Desporto e Educação Física - Universidade de Coimbra, Portugal

Ferreira, L. (2003). *Estrutura interna do jogo de hóquei em patins: Estudo exploratório das posses de bola no escalão de séniores masculinos* (Dissertação de Licenciatura). Faculdade de Ciências do Desporto e Educação Física - Universidade de Coimbra, Portugal

Gamble, D., Bradley, J., McCarren, A., & Moyna, N. M. (2019). Team performance indicators which differentiate between winning and losing in elite Gaelic football. *International Journal of Performance Analysis in Sport*, *19*(4), 478–490.

Gayo, A. (2000). *El hockey sobre patines como deporte de equipo. Análisis y optimización de los sistemas de juego a través de indicadores tácticos* (Dissertação de Doutoramento). Universidad de A Coruña, España.

Kingman, J., & Dyson, R. (1997a). Player position, match half and score effects on the time and motion characteristics of roller hockey match play. *Journal of Human Movements Studies*, *33*(1), 15–30.

Kingman, J., & Dyson, R. (2001). Video analysis of shot distribution and goalkeeper movement during roller hockey match play. *ISBS-Conference Proceedings Archive* (Vol. 1).University of San Francisco

Kingman, J., & Dyson, R. J. (1997b). Analysis of roller hockey match play. *Journal of Human Movement Studies*, *32*(6), 235–251.

Kleinbaum, D. G., & Klein, M. (2010). *Logistic regression (statistics for biology and health)* (3rd ed.). New York, NY: Springer-Verlag New York Inc, Ed.

Mendo, A. H., & Argilaga, M. T. A. (2002). Behavioral structure in sociomotor sports: Roller-Hockey. *Quality and Quantity*, *36*(4), 347–378.

Oliveira, P., Clemente, F. M., & Martins, F. M. L. (2015). Who is the prominent tactical position in rink-hockey? A network approach based on centrality metrics. *Journal of Physical Education and Sport*, *15*(4), 657–662.

Pratas, J., Volossovitch, A., & Ferreira, A. P. (2012). The effect of situational variables on teams' performance in offensive sequences ending in a shot on goal. A case study. *The Open Sports Sciences Journal*, *5*(1), 193–199.

Robinson, G., & O'Donoghue, P. (2007). A weighted kappa statistic for reliability testing in performance analysis of sport. *International Journal of Performance Analysis in Sport*, *7*(1), 12–19.

Rosa, C. (2006). *Estrutura Interna do Jogo de Hóquei em Patins: Estudo Exploratório das Posses de Bola no Escalão de Juvenis Nacionais* (Dissertação de Bacharelato). Faculdade de Ciências do Desporto e Educação Física - Universidade de Coimbra, Portugal.

Sarmento, H., Clemente, F. M., Araújo, D., Davids, K., McRobert, A., & Figueiredo, A. (2017). What performance analysts need to know about research trends in association football (2012–2016): A systematic review. *Sports Medicine*. doi:10.1007/s40279-017-0836-6

Sarmento, H., Figueiredo, A., Lago-Peñas, C., Milanovic, Z., Barbosa, A., Tadeu, P., & Bradley, P. S. (2018). Influence of tactical and situational variables on offensive sequences during elite football matches. *The Journal of Strength & Conditioning Research*, *32*(8), 2331–2339. Retrieved from: http://journals.lww.com/nsca-jscr/Fulltext/publishahead/The_Influence_of_Tactical_and_Situational.95849.aspx

Sarmento, H., Marcelino, R., Anguera, M. T., Campaniço, J., Matos, N., & Leitão, J. C. (2014). Match analysis in football: A systematic review. *Journal of Sports Sciences*, *32*(20), 1831–1843.

Sousa, T., Sarmento, H., Harper, L. D., Valente-dos-Santos, J., & Vaz, V. (2018). Development and validation of an observational instrument tool for analysing the activity of rink hockey goalkeepers. *Journal of Sport Pedagogy and Research*, *4*(3), 16–26.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (Vol. 5). Boston, MA: Pearson.

Tantiña, J. M., Vidal, E. B., & López, J. P. (2014). Análisis de la actividad competitiva en jugadores profesionales de hockey sobre patines. *Revista Kronos*, *13*(2), 35–44.

Vaz, V. (2011). *Especialização desportiva em jovens hoquistas masculinos. estudo do jovem atleta, do processo de selecção e da estrutura do rendimento* (Dissertação de Doutoramento). Faculdade de Ciências do Desporto e Educação Física - Universidade de Coimbra, Portugal.

Vaz, V., Dias, G., Gama, J., Couceiro, M., Valente-dos-Santos, J., Rafael, J., & Gayo, J. A. A. (2016). Network of interpersonal interactions in Roller Hockey. *International Journal of Sports Science*, *6*(1A), 1–7.

World Skate, technical comission. (2018). *Rules of the game & technical regulation*. Lausanne Switzerland: World Skate.

Yagüe, P., Del Valle, M. E., Egocheaga, J., Linnamo, V., & Fernández, A. (2013). The competitive demands of elite male rink hockey. *Biology of Sport*, *30*(3), 195–199.