

**Position-specific performance indicators that discriminate between successful and unsuccessful teams in elite women's indoor field hockey: Implications for coaching**

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## **Abstract**

The aim of this investigation was to establish median performance profiles for the six playing positions in elite women's indoor hockey and then identify whether these position-specific profiles could discriminate between qualifying (top four), mid-table and relegated teams in the 2011-12 England Hockey premier league. Successful passing in relegated teams was significantly lower ( $p < 0.008$ ) than in mid-table and qualifying teams in four of the five outfield positions. Furthermore, the right backs of qualifying teams demonstrated significantly fewer ( $p < 0.008$ ) unsuccessful passes ( $\bar{x} = 15.5 \pm \text{CLs } 15.0 \text{ and } 10.0$  respectively) and interceptions ( $\bar{x} = 4.0 \pm \text{CLs } 4.0 \text{ and } 3.0$  respectively) than relegated teams ( $\bar{x} = 19.5 \pm \text{CLs } 21.0 \text{ and } 17.0$ ;  $\bar{x} = 7.5 \pm \text{CLs } 8.0 \text{ and } 6.0$  respectively). Finally, the right forwards of relegated teams demonstrated significantly fewer ( $p < 0.008$ ) successful interceptions ( $\bar{x} = 4.0 \pm \text{CLs } 5.0 \text{ and } 4.0$  respectively) than qualifying teams ( $\bar{x} = 5.0 \pm \text{CLs } 6.0 \text{ and } 3.0$  respectively) and significantly more ( $p < 0.008$ ) unsuccessful interceptions ( $\bar{x} = 5.5 \pm \text{CLs } 6.0 \text{ and } 4.0$  respectively) than mid-table teams ( $\bar{x} = 3.0 \pm \text{CLs } 3.0 \text{ and } 2.0$  respectively). Based on these findings, coaches should adapt tactical strategies and personnel deployment accordingly to enhance the likelihood of preparing a qualifying team. Research should build from these data to examine dribbling, pressing and patterns of play when outletting.

## **Introduction**

Performance profiling provides insight into the physiological, technical and tactical requirements of modern day sport (O'Donoghue, 2013) and as a result sporting actions are often analysed to inform the coaching process and to assist in identifying which are the most important performance variables that discriminate between successful and unsuccessful teams (Sampaio & Leite, 2013). Despite research concerning performance indicators developing considerably over the last 30 years (Sampaio, McGarry, & O'Donoghue, 2013) and despite there being a relative plethora of research published about outdoor field hockey (Boot-Handford, Braddock, & Peters, 2006; Boran, 2012; Gabbett, 2010; Holmes, Peters, & Robinson, 2008; Holmes, Robinson, & Peters, 2006; Holmes, Robinson, & Peters, 2007; Jennings, Cormack, Coutts, & Aughey, 2012; Lythe & Kilding, 2011, 2013; Macutkiewicz & Sunderland, 2011; Mosquera, Molinuevo, & Roman, 2007; Podgórski & Pawlak, 2011; Sunderland, Bussell, Atkinson, Alltree, & Kates, 2006; Tromp & Holmes, 2011; White & MacFarlane, 2013) performance analysis remains a relatively sparse discipline of investigation in indoor hockey.

Of the two published studies focussing on indoor hockey, one focussed on the heart rate demands relative to outdoor field hockey (Konarski and Strzelczyk 2009) and the other focussed solely on trying to identify potential predictors of successful penalty corners within the elite women's game (Vinson et al. 2013). Vinson et al. (2013) found 22.6% of penalty corner executions resulted in a goal, 1.6% were upgraded to a penalty stroke and 4.4% were re-awarded as another penalty corner; the remaining 71.5% were unsuccessful. However, Vinson et al. (2013) did not explore the differences between successful and unsuccessful teams. To date, no

research has sought to identify performance profiles in indoor hockey with a view to identifying what discriminates between successful and unsuccessful teams; a significant consideration in this venture being the way in which teams are classified as ‘successful’ or ‘unsuccessful’.

Previous recent research in other sports that has attempted to discriminate between successful and unsuccessful teams has commonly differentiated between winners and losers (Lago-Peñas, Lago-Ballesteros, Dellal, & Gómez, 2010; Vaz, Mouchet, Carreras, & Morente, 2011; Vaz, Van Rooyen, & Sampaio, 2010). However, in round-robin phases of competitions, teams can lose a number of games but still qualify for the next round and compete for the title. Similarly, teams can win a number of games but still be relegated. Indeed, within such qualification stages, there are tactical decisions to be made that may mean that ‘winning’ a game is not the prioritised outcome e.g. where a team only needs a draw, or indeed where it makes no difference to the final competition standings if a team loses, in which case many first choice players may be rested for the next stage. Therefore, when investigating such round-robin tournaments, the most appropriate differentiation of ‘relative success’ would appear to be via final tournament ranking (Oberstone, 2011; Reid, McMurtrie, & Crespo, 2010; Ziv, Lidor, & Arnon, 2010) and this would also account for the non-individual game-based outcome tactics.

The aim of this study therefore was to first establish median profiles and confidence limits for each of the six playing positions (goalkeeper, left back, right back, centre, left forward, right forward) in elite women’s indoor hockey thus producing position specific performance profiles, and second to identify if any of these position specific

profiles would discriminate between qualifying, mid-table and relegated teams in the round-robin stages of a season.

## **Methods**

### *Sample*

All 36 matches of the England Hockey Women's Premier League 2011-2012 round-robin phase were analysed. The league comprised the top nine indoor teams in England who played each other once at a single neutral venue over a series of weekends during the outdoor season's winter break. The University Ethics Committee approved the project and permission to collect the data was also granted by the England Hockey Board.

### *Development of the system*

According to stage one of James et al. (2005), a list of potential technical actions for indoor hockey players was devised by the lead author in conjunction with a panel of experienced performance analysts and indoor hockey coaches with over 30 years of performance analysis experience and 35 years of playing and coaching indoor hockey. The agreed list of technical actions was then presented to an external, experienced, indoor hockey coach for further content validation; some minor alterations were made to the definitions but the overall framework was retained. The final list of technical actions comprised:

- Pass (successful/unsuccessful), operationally defined as an attempt to project the ball which is subsequently controlled by a player on the same team.
- Interception (successful/unsuccessful), operationally defined as an attempt by a player from the opposing team to gain possession by controlling the ball in transit from the passer to receiver.
- Shot (successful/unsuccessful), operationally defined as an attempt to project the ball into the goal.
- Tackle (successful/unsuccessful), operationally defined as an attempt to dispossess an opponent.
- Dribble, operationally defined as any substantive lower-body movement, including turning, whilst in possession of the ball which is not inherently part of a passing action.
- Loss of control, a player outside the playing reach of an opponent and not attempting a pass, loses possession of the ball.
- Bully, operationally defined as being one of the two players to contest for the ball at a re-start of play by tapping the ground and then the opponent's stick before attempting to play the ball.
- (penalty corner) stop, successfully controlling the ball on the left side of the body with the stick held horizontally immediately outside the 'D'.
- Foul, any offence which is penalised by the umpire as a free-hit, penalty corner or penalty stroke.

The notion of a 'successful' dribble could not be agreed by the panel that highlighted that such actions which retain possession may actually enhance the pressure on the ball carrier and so the category was left without a diagnostic label.

Bespoke categories for the goalkeeper were added and comprised save and clearance (successful/unsuccessful). The panel also agreed to assign positional tags to each technical action as goalkeeper, left defender, right defender, centre, left forward and right forward, with each positional tag representing the position taken by each player at the previous match re-start (see Figure 1).

\*\*\*\* Figure 1 near here \*\*\*\*

Each match was video recorded (Sony, DCR-SR32, Tokyo) from a first floor balcony with an unobstructed view of the whole pitch. The data were collated through a tagging panel created in Dartfish TeamPro version 7 with both teams analysed in each match.

### ***Reliability of the system***

Intra-operator reliability was established from reanalysis of four randomly selected matches within four weeks of the first analysis. Agreement across all variables for both technical elements and positional tags was 98% with  $\kappa > 0.94$  and 94% with  $\kappa > 0.90$  respectively. Inter-operator reliability was established from nine matches analysed by another trained research assistant. For technical elements, agreement was above 95% ( $\kappa > 0.92$ ) for all behaviours, whilst positional tagging agreement was above 90% ( $\kappa > 0.85$ ). All values were considered well above the acceptable threshold to demonstrate a reliable system (O'Donoghue, 2015).

### *Development of positional profiles*

According to James et al. (2005) medians were calculated by assessing the 50<sup>th</sup> percentile of the technical action categories for each position. Confidence limits (95%) were calculated by assessing the binomial distribution. Bland (2000) proposed the following formulae for identifying the appropriate value in the distribution:

$$\text{Lower bound: } j = nq - 1.96\sqrt{(nq(1-q))}$$

$$\text{Upper bound: } k = nq + 1.96\sqrt{(nq(1-q))}$$

Where  $n$  is the number of observations and  $q$  is the required percentile. Both  $j$  and  $k$  should be rounded up to the next integer (Bland, 2000). For the purposes of this investigation  $q = 0.5$  and  $n = 32, 24$  and  $16$  for the qualifiers, mid-table and relegated teams, thus  $j = 10, 7, 6$  and  $k = 22, 17, 10$  and respectively.

### *Data analysis*

Following development of medians and confidence limits, data were transformed to  $z$  scores. The majority of the data demonstrated univariate and multivariate normal distribution as determined by Shapiro-Wilk tests with the exception of the shooting-related variables and goalkeeper fouls. Positional differences were assessed by MANOVA. Homogeneity of covariance matrices could not be demonstrated with both rank and position-related independent variables and so each playing position

was tested via a separate MANOVA with Bonferroni adjustment of  $\alpha$  to 0.008 due to the six comparisons which were conducted. No outliers were identified through examination of Mahalanobis distance and no problems with linearity or multicollinearity were evident. *Post-hoc* analysis of variables identified as significant within the MANOVAs was conducted using ANOVA with Tukey *post-hoc* tests;  $\alpha = 0.008$ . Whilst MANOVA and ANOVA compare means, results are presented in their unstandardized form as medians for ease of comprehension by coaches and to follow James et al.'s (2005) procedure for performance profiling.

Successful shots, unsuccessful shots and goalkeeper fouls were assessed by Kruskal-Wallis H Tests with  $\alpha = 0.008$ . Loss of control, stop and bully were not included in the differences or discriminant analysis due to their near-zero median value across the playing positions. Despite the low frequency of the successful shot variable it was retained in the difference analysis due to the importance of the behaviour within the game.

Discriminant analysis was then used to attempt to predict whether a team would qualify (top four teams), finish in mid-table (three teams) or be relegated (bottom two teams) based on the list of identified technical variables. According to Burns and Burns (2008) the interpretation of the discriminant functions were based on the structure coefficients reporting an absolute value  $>0.30$ . All data were analysed using SPSS version 22.

## Results

31,138 technical actions were identified across the 36 matches with 241 goals scored at an average of 6.69 goals per game. Only four matches ended in a draw. Table 1 reveals the most frequent action across each of the groups of teams in the two defensive positions was successful passing followed by either unsuccessful passes or dribbles. The interception-related variables reveal more successful than unsuccessful actions whilst the converse is true of tackling; these patterns are evident across all positions and ranking groups.

There was a statistically significant difference between qualifiers, mid-table and relegated teams in terms of the performance profiles of the right back position on the combined dependent variables ( $F(16,126) = 5.09, p < 0.001$ ; Pillai's Trace 0.79; partial eta squared 0.39). Examining the between-subjects effects revealed successful pass ( $F(2,69) = 18.66, p < 0.001, \eta^2 = 0.35$ ), unsuccessful pass ( $F(2,69) = 9.49, p < 0.001, \eta^2 = 0.22$ ) and unsuccessful interceptions ( $F(2,69) = 10.03, p < 0.001, \eta^2 = 0.23$ ) as potential discriminating variables and demonstrated significant differences via ANOVA with a large effect (Cohen, 1988). *Post-hoc* tests revealed the right back position of qualifiers ( $\bar{x} = 57.0 \pm$  CLs of 63.0 and 48.0 respectively) and mid-table teams ( $\bar{x} = 60.0 \pm$  CLs of 71.0 and 52.0 respectively) completed significantly more successful passes than relegated teams ( $\bar{x} = 38.0 \pm$  CLs of 41.0 and 32.0 respectively). Additionally, right backs of qualifiers completed significantly fewer unsuccessful passes ( $\bar{x} = 13.5 \pm$  CLs of 15.0 and 10.0 respectively) and unsuccessful interceptions ( $\bar{x} = 4.0 \pm$  CLs of 4.0 and 3.0

respectively) than right backs of relegated teams ( $\tilde{x} = 19.5 \pm$  CLs of 21.0 and 17.0;  $\tilde{x} = 7.5 \pm$  CLs of 8.0 and 6.0 respectively).

\*\*\*\* Table 1 near here \*\*\*\*

Table 2 reveals the most frequent action across each of the groups of teams in the centre position was successful passing followed by dribbles; this pattern was reversed in both of the two forward positions. Within the centre ( $F(16,126) = 2.49$ ,  $p = 0.003$ ; Pillai's Trace 0.48; partial eta squared 0.24) and left forward positions ( $F(16,126) = 2.35$ ,  $p = 0.004$ ; Pillai's Trace 0.46; partial eta squared 0.23) both demonstrated significant differences between qualifiers, mid-table and relegated teams when considering the combined dependent variables. Consideration of the between-subject effects revealed that the only significant differences related to the successful pass category ( $F(2,69) = 8.13$ ,  $p = 0.001$ , eta squared = 0.19; ( $F(2,69) = 7.92$ ,  $p = 0.001$ , eta squared = 0.19 respectively) with both revealing a large effect. In both cases, *post-hoc* tests revealed the qualifiers and mid-table team performers were significantly different from the relegated teams but not from each other.

\*\*\*\* Table 2 near here \*\*\*\*

The MANOVA relating to the right forward position revealed significant differences when considering the combined dependent variables ( $F(16,126) = 3.29$ ,  $p < 0.001$ ; Pillai's Trace 0.59; partial eta squared 0.30). Examining the between-subjects effects revealed successful pass ( $F(2,69) = 11.24$ ,  $p < 0.001$ , eta squared = 0.25), successful interception ( $F(2,69) = 6.56$ ,  $p = 0.002$ , eta squared = 0.16) and

unsuccessful interception ( $F(2,69) = 7.01, p < 0.002, \eta^2 = 0.17$ ) as potential discriminating variables and demonstrated significant differences via ANOVA, all with relatively large effects. *Post-hoc* tests revealed the right forward of qualifiers ( $\bar{x} = 15.0 \pm \text{CLs of } 18.0 \text{ and } 12.0$  respectively) and mid-table teams ( $\bar{x} = 12.5 \pm \text{CLs of } 16.0 \text{ and } 11.0$  respectively) completed significantly more successful passes than relegated teams ( $\bar{x} = 8.5 \pm \text{CLs of } 9.0 \text{ and } 6.0$  respectively). Table 2 also reveals the only variable which demonstrated a significant difference between qualifiers and mid-table teams. *Post-hoc* tests revealed the right forwards of qualifiers ( $\bar{x} = 5.0 \pm \text{CLs of } 6.0 \text{ and } 3.0$  respectively) completed significantly more successful interceptions than mid-table teams ( $\bar{x} = 3.5 \pm \text{CLs of } 4.0 \text{ and } 1.0$  respectively). Finally, right forwards of mid-table teams ( $\bar{x} = 3.0 \pm \text{CLs of } 3.0 \text{ and } 2.0$  respectively) were shown to make significantly fewer unsuccessful interceptions than those of relegated teams ( $\bar{x} = 5.5 \pm \text{CLs of } 6.0 \text{ and } 4.0$  respectively). Table 3 shows the performance profile for goalkeepers. Goalkeepers' predominant action was 'save' with the occasional successful clearance. No unsuccessful clearances were recorded in the competition. Although the combined dependent variables suggested a potential significant difference between qualifiers, mid-table and relegated teams relating to the goalkeepers' actions ( $F(4,138) = 3.76, p = 0.006; \text{ Pillai's Trace } 0.20; \text{ partial } \eta^2 = 0.10$ ), consideration of the individual dependent variables was not able to identify any significant differences.

\*\*\*\* Table 3 near here \*\*\*\*

Table 4 reveals the structure coefficients from the discriminant analyses for the five outfield positions across the three ranking groups. Each of the analyses revealed two

discriminant functions. In combination these discriminant functions significantly differentiated the ranking groups for the right back ( $\Lambda = 0.33$ ,  $\chi^2(16) = 72.17$ ,  $p < 0.001$ ), centre ( $\Lambda = 0.57$ ,  $\chi^2(16) = 36.93$ ,  $p = 0.002$ ), left forward ( $\Lambda = 0.59$ ,  $\chi^2(16) = 34.50$ ,  $p = 0.005$ ) and right forward ( $\Lambda = 0.50$ ,  $\chi^2(16) = 46.06$ ,  $p < 0.001$ ). Removing the first functions from the four significant analyses revealed that none of the second functions significantly differentiated the ranking groups.

\*\*\*\* Table 4 near here \*\*\*\*

In each case, the structure coefficient of greatest absolute value was successful passing (left back  $r = 0.75$ , right back  $r = -0.53$ , centre  $r = 0.68$ , left forward  $r = 0.76$ , right forward  $r = -0.68$ ). Other important variables for the right back were unsuccessful pass ( $r = 0.42$ ), unsuccessful interception ( $r = 0.45$ ) and dribble ( $r = -0.31$ ). Unsuccessful passing loaded highly on the first function for the centre ( $r = -0.50$ ) and left forward ( $r = 0.32$ ), whilst dribbling was important for the right forward ( $r = -0.42$ ) and centre ( $r = 0.30$ ). Both interception categories were important for the right forward (successful  $r = 0.30$ ; unsuccessful  $r = 0.62$ ), whilst unsuccessful interceptions also loaded highly on the first function for the left forward ( $r = -0.38$ ).

Discriminant analysis of the goalkeeper-related variables also revealed two discriminant functions. The first explained 87.8% of the variance, canonical  $R^2 = 0.17$ , Eigenvalue = 0.20, whereas the second explained only 12.2%, canonical  $R^2 = 0.03$ , Eigenvalue = 0.03. In combination these discriminant functions significantly differentiated the ranking groups,  $\Lambda = 0.81$ ,  $\chi^2(4) = 14.613$ ,  $p = 0.006$ , but removing the first function revealed the second function did not significantly differentiate the

ranking groups. The correlations between outcomes revealed both successful save and successful clearance loaded more highly on the first function ( $r = 0.78$ ,  $r = 0.76$  respectively) than the second ( $r = -0.62$ ,  $r = 0.65$  respectively). Figure 2 shows the combined-groups centroid plot and reveals that function one, concerning the goalkeeper and two defensive positions. This plot underlines the capability of the performance of the right back to discriminate between qualifying, mid-table and relegated teams to a much greater extent than the goalkeeper or left back.

\*\*\*\* Figure 2 near here \*\*\*\*

Figure 3 reveals discriminant function one of the centre, left forward and right forward was able to discriminate between the relegated teams and the other two groups. Furthermore, the performance of the right forward is a potential discriminator between qualifiers and the other two groups as indicated by the vertical distance between the centroids.

\*\*\*\* Figure 3 near here \*\*\*\*

## **Discussion**

These results identify the technical actions that discriminate between successful and unsuccessful teams in elite women's indoor hockey. Most prominently, the analysis has indicated the capacity to discriminate between relegated teams and the other two categories by considering the performances of almost all the playing positions with the exception of the left back. The highly significant discriminating first functions of the right back, centre, left forward and right forward, coupled with the moderate to

strong degree of variance explained by these functions and the significant MANOVA results suggest that examining the performance of individual playing positions can provide real insight into the likely success of a team. The discriminant analyses suggest that the success of the team can be explained through examination of a combination of functions in each playing position. Nevertheless, despite the significant discriminant analysis, the relative lack of univariate differences indicate the relationship between team success and positional performance profiles is more complex than it may at first appear.

Our findings support previous literature in identifying hockey as a sport where the location of play on the field matters a great deal (Mosquera et al., 2007; Tromp & Holmes, 2011). Within the outdoor discipline, Tromp and Holmes (2011), in investigating the impact of the self-pass rule introduced by the FIH in 2009, reported that the substantial difference between right-sided and left-sided 'D' penetrations prior to the implementation of the new rule was no longer evident. Sunderland et al. (2006) also reported a difference between sides of the pitch when investigating how goals were scored in international women's hockey. Sunderland et al. (2006) found that right-hand-side attacks were more likely to yield a goal than penetrations from the left and these findings are furthered here. For example, in the present study, team success can be discriminated by the performance of the right back, but not by the left. A greater variance of success is explained by examination of the right forward (canonical  $R^2 = 0.34$ ) than the left forward (canonical  $R^2 = 0.28$ ). Furthermore, a greater number of univariate differences were apparent between qualifiers, mid-table and relegated teams within the profile of the right forward than the left forward. The discriminatory power of the right-sided positions suggests that coaches should consider the personnel and strategy-related decisions concerning

these roles particularly carefully. Whilst the sports are innately similar, the extent to which the body of work in the outdoor game can impact upon coaching of the indoor small-sided game is as yet unclear.

Whilst Vinson et al. (2013) established that the decision of the goalkeeper in indoor hockey to charge down shots or stay on the goal-line during penalty corners affected the attacking team's ability to score, this investigation has found that the performance of the goalkeeper does not discriminate between qualifying, mid-table and relegated teams. Vinson et al. (2013) also established that the tactical decision to prepare positionally for a shooting opportunity was a more important predictor of success than the execution of the shooting routine itself. The importance of the preparatory actions above shooting execution is supported here insofar as it is the passing and interception-related actions which loaded more highly across the discriminant functions and which demonstrated the most univariate differences as opposed to the shooting-related actions. Successful passing in particular is evidently a crucial action within elite women's indoor hockey and the principal component in discriminating between the relegated teams and the other two groups. 'Successful pass' represented the highest loading structure coefficient in all five outfield positions. Qualifiers and mid-table teams completed significantly more successful passes in all five outfield positions than relegated teams, although there were many fewer differences in the number of unsuccessful passes suggesting that it is not only the accuracy, but also the frequency of pass that is important.

The performance profiles in Table 1 reveal it is the two defensive roles which complete the majority of passes suggesting the coaches of poorly performing teams should seek ways to increase the number of successful passes completed by players in these positions which may help to disrupt their opponents' press. This

investigation has not been able to examine other potential explaining variables such as the receiver of the pass, time in possession of the ball or whether the sideboards were used in the attempted pass; all of these elements should be investigated further in future research by examining the patterns of play when outletting the ball from defensive hit-outs. Furthermore, this investigation has not been able to advance the commonly utilised conception of a 'successful' pass. By simply considering whether the ball is received by a teammate, this investigation has not been able to evaluate whether any strategic advantage was gained by transferring the ball from one player to another. The location of the receiver on the pitch, the proximity of opponents and the movement of the opponent's press should all be considered within future research to add greater insight into the diagnostic labels attributed to such actions as passing.

Discriminating between qualifying teams and both other categories is, perhaps, best examined through the actions of the right forward. Along with successful pass, unsuccessful interception loaded most highly within the first discriminant function for the right forward ( $r = 0.62$ ). Furthermore, the only univariate significant difference between qualifiers and mid-table teams was identified as successful interception. The importance of these interception-related variables suggests that a coach's construction of a team's pressing strategy is crucially important in determining success; in particular, the 'first line' of the press, occupied by the forwards, appears most able to discriminate between those teams that qualify for the next phase of the competition and those that do not. Pressing strategies have not yet been investigated in field hockey research and this represents a crucial area of the game for future performance analysts to investigate. The proximity of the forwards to the ball carrier when play commences alongside examination of the tactical

pressing structures implemented by teams could all help explain a greater degree of variance of success than has been possible in this investigation.

## **Conclusion**

The aim of this investigation was to create position-specific performance profiles for the six positions in elite women's indoor hockey. It is evident that whilst some actions are common across all players, the positional actions are quite different in frequency and importance. Therefore, coaches should ensure that preparation for competition is, to some degree, differentiated by playing position. Furthermore, the investigation sought to identify the components of positional profiles which are able to discriminate between successful and unsuccessful teams. This investigation has enabled coaches to garner a better understanding of the requirements of the different positional roles and has emphasised the importance of passing and intercepting. Coaches working with teams seeking to avoid relegation should ensure a high number of successful passes are completed by their defensive players. Coaches working with teams targeting for qualification should also ensure a high frequency of passing but should also focus on establishing an effective attacking press, prioritising interceptions by the right forward. Coaches should consider deploying their most influential players to the right-hand-side roles within the team.

Of course, this study is not without its limitations. Indoor hockey features a great deal of temporary positional rotation by players (for example, the usual right defender may be caught high up the field in a particular phase of play and could

temporarily switch positional role with a team mate), the roles themselves remain stable and were identified at each match re-start from either centre pass or defensive hit-out. Due to the dynamic nature of the game, it was occasionally difficult to establish whether players had adopted a different role for a particular phase of play; in such cases players were considered to have maintained their role from the previous phase. Players were also considered to maintain the same positional role during periods of play when their team had suffered a temporary suspension or had switched the goalkeeper for a kicking back. For these reasons, it is not possible to know how many different players contributed to each positional performance statistics for each game. Neither did we monitor the length of time of these relative contributions, the tactical instructions of the coaches or the order in which the matches were played. All of these factors potentially impact the extent to which each position-specific performance is related to any other. Whilst our analysis shows no cause for concern regarding the independence of our data and the techniques we have used are widely applied in performance analysis research, this pragmatic approach to such matters is, perhaps, less statistically 'pure' than some might like. Furthermore, the sample is only one national league and may not be representative of other national leagues.

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Table 1: Median ( $\bar{x}$ ) profiles and 95% confidence limits for the two defensive positions

|                                | Left back  |     |     |           |     |     |           |     |     | Right back        |     |     |                   |     |     |           |     |     |
|--------------------------------|------------|-----|-----|-----------|-----|-----|-----------|-----|-----|-------------------|-----|-----|-------------------|-----|-----|-----------|-----|-----|
|                                | Qualifiers |     |     | Mid-table |     |     | Relegated |     |     | Qualifiers        |     |     | Mid-table         |     |     | Relegated |     |     |
|                                | $\bar{x}$  | +CL | -CL | $\bar{x}$ | +CL | -CL | $\bar{x}$ | +CL | -CL | $\bar{x}$         | +CL | -CL | $\bar{x}$         | +CL | -CL | $\bar{x}$ | +CL | -CL |
| Successful pass                | 63.5       | 76  | 53  | 65.5      | 74  | 55  | 45.5      | 48  | 42  | 57.0 <sup>a</sup> | 63  | 48  | 60.0 <sup>b</sup> | 71  | 52  | 38.0      | 41  | 32  |
| Unsuccessful pass              | 16.0       | 18  | 14  | 17.5      | 21  | 14  | 19.5      | 20  | 14  | 13.5 <sup>a</sup> | 15  | 10  | 15.0              | 19  | 13  | 19.5      | 21  | 17  |
| Successful interception        | 8.5        | 10  | 6   | 8.0       | 10  | 7   | 8.0       | 9   | 7   | 10.0              | 11  | 6   | 9.0               | 11  | 8   | 9.5       | 10  | 6   |
| Unsuccessful interception      | 5.0        | 4   | 3   | 5.0       | 6   | 4   | 5.0       | 5   | 4   | 4.0 <sup>a</sup>  | 4   | 3   | 5.0               | 6   | 4   | 7.5       | 8   | 6   |
| Dribble                        | 14.0       | 18  | 12  | 16.0      | 21  | 13  | 15.5      | 16  | 13  | 15.0              | 18  | 13  | 16.0              | 17  | 13  | 13.0      | 14  | 10  |
| Successful shot <sup>†</sup>   | 0.0        | 0   | 0   | 0.0       | 1   | 0   | 0.0       | 0   | 0   | 0.0               | 1   | 0   | 0.0               | 0   | 0   | 0.0       | 0   | 0   |
| Unsuccessful shot <sup>†</sup> | 0.0        | 1   | 0   | 2.0       | 3   | 0   | 0.0       | 1   | 0   | 2.0               | 3   | 1   | 1.0               | 2   | 0   | 1.0       | 1   | 0   |
| Successful tackle              | 4.0        | 5   | 3   | 4.0       | 5   | 3   | 5.5       | 6   | 4   | 3.0               | 4   | 2   | 4.0               | 5   | 2   | 3.0       | 4   | 2   |
| Unsuccessful tackle            | 6.0        | 7   | 5   | 6.5       | 8   | 4   | 6.5       | 7   | 5   | 4.0               | 5   | 3   | 5.0               | 8   | 4   | 5.0       | 7   | 4   |
| Loss of control                | 0.0        | 1   | 0   | 0.5       | 1   | 0   | 0.5       | 1   | 0   | 0.0               | 1   | 0   | 0.0               | 0   | 0   | 0.0       | 0   | 0   |
| Stop                           | 1.0        | 2   | 1   | 0.0       | 0   | 0   | 0.0       | 0   | 0   | 0.0               | 1   | 0   | 0.0               | 0   | 0   | 0.0       | 0   | 0   |
| Bully                          | 0.0        | 0   | 0   | 0.0       | 0   | 0   | 0.0       | 0   | 0   | 0.0               | 0   | 0   | 0.0               | 0   | 0   | 0.0       | 0   | 0   |
| Foul                           | 4.0        | 5   | 3   | 5.0       | 6   | 3   | 4.0       | 5   | 3   | 3.5               | 4   | 2   | 5.0               | 7   | 3   | 4.5       | 5   | 4   |

<sup>†</sup> Differences tested via Kruskal Wallis H; <sup>a</sup> Significant difference between qualifiers and relegated teams ( $p < 0.008$ ); <sup>b</sup> Significant difference between mid-table and relegated teams ( $p < 0.008$ )

Table 2: Median ( $\tilde{x}$ ) profiles and 95% confidence limits for centre and two forward positions

|                                | Centre            |     |     |                   |     |     |             |     |     | Left forward      |     |     |                   |     |     |             |     |     | Right forward     |     |     |                   |     |     |             |     |     |
|--------------------------------|-------------------|-----|-----|-------------------|-----|-----|-------------|-----|-----|-------------------|-----|-----|-------------------|-----|-----|-------------|-----|-----|-------------------|-----|-----|-------------------|-----|-----|-------------|-----|-----|
|                                | Qualifiers        |     |     | Mid-table         |     |     | Relegated   |     |     | Qualifiers        |     |     | Mid-table         |     |     | Relegated   |     |     | Qualifiers        |     |     | Mid-table         |     |     | Relegated   |     |     |
|                                | $\tilde{x}$       | +CL | -CL | $\tilde{x}$       | +CL | -CL | $\tilde{x}$ | +CL | -CL | $\tilde{x}$       | +CL | -CL | $\tilde{x}$       | +CL | -CL | $\tilde{x}$ | +CL | -CL | $\tilde{x}$       | +CL | -CL | $\tilde{x}$       | +CL | -CL | $\tilde{x}$ | +CL | -CL |
| Successful pass                | 24.0 <sup>a</sup> | 28  | 21  | 24.0 <sup>b</sup> | 31  | 21  | 17.0        | 18  | 14  | 13.0 <sup>b</sup> | 16  | 11  | 11.5 <sup>b</sup> | 16  | 10  | 8.0         | 9   | 6   | 15.0 <sup>a</sup> | 18  | 12  | 12.5 <sup>b</sup> | 16  | 11  | 8.5         | 9   | 6   |
| Unsuccessful pass              | 9.0               | 9   | 7   | 8.0               | 9   | 6   | 10.5        | 11  | 8   | 6.0               | 7   | 6   | 5.0               | 7   | 4   | 4.0         | 4   | 4   | 6.0               | 7   | 4   | 5.0               | 7   | 4   | 6.0         | 6   | 5   |
| Successful interception        | 5.0               | 7   | 4   | 5.5               | 7   | 4   | 6.0         | 7   | 5   | 4.0               | 5   | 2   | 3.0               | 4   | 2   | 4.0         | 4   | 3   | 5.0 <sup>c</sup>  | 6   | 3   | 3.5               | 4   | 1   | 4.0         | 5   | 4   |
| Unsuccessful interception      | 4.0               | 7   | 3   | 3.0               | 6   | 2   | 5.0         | 6   | 3   | 4.5               | 6   | 3   | 4.0               | 5   | 3   | 6.0         | 6   | 5   | 3.0               | 4   | 3   | 3.0 <sup>b</sup>  | 3   | 2   | 5.5         | 6   | 4   |
| Dribble                        | 16.5              | 20  | 11  | 19.5              | 23  | 15  | 15.0        | 16  | 13  | 15.5              | 19  | 13  | 13.5              | 17  | 11  | 15.0        | 16  | 13  | 17.0              | 19  | 14  | 16.0              | 19  | 14  | 13.0        | 13  | 12  |
| Successful shot <sup>†</sup>   | 1.0               | 1   | 0   | 0.0               | 1   | 0   | 0.0         | 0   | 0   | 1.0               | 2   | 1   | 1.0               | 1   | 0   | 0.5         | 1   | 0   | 0.0               | 1   | 0   | 1.5               | 2   | 0   | 0.0         | 1   | 0   |
| Unsuccessful shot <sup>†</sup> | 3.0               | 3   | 3   | 4.0               | 5   | 3   | 2.5         | 3   | 2   | 5.0               | 7   | 3   | 5.0               | 6   | 4   | 4.0         | 5   | 3   | 4.0               | 5   | 2   | 4.0               | 5   | 2   | 2.5         | 3   | 2   |
| Successful tackle              | 3.0               | 3   | 2   | 3.0               | 5   | 2   | 2.5         | 3   | 2   | 1.0               | 2   | 1   | 1.0               | 3   | 1   | 1.5         | 2   | 1   | 1.0               | 3   | 1   | 2.0               | 3   | 1   | 2.5         | 3   | 1   |
| Unsuccessful tackle            | 5.0               | 8   | 5   | 5.5               | 7   | 3   | 2.0         | 4   | 2   | 5.0               | 6   | 4   | 4.5               | 5   | 3   | 4.0         | 5   | 4   | 5.0               | 6   | 3   | 3.5               | 4   | 2   | 3.5         | 5   | 3   |
| Loss of control                | 1.0               | 1   | 0   | 1.0               | 1   | 0   | 1.0         | 1   | 0   | 1.0               | 1   | 0   | 1.0               | 1   | 0   | 0.0         | 1   | 0   | 1.0               | 1   | 0   | 1.0               | 1   | 0   | 1.0         | 1   | 1   |
| Stop                           | 0.0               | 0   | 0   | 2.5               | 4   | 1   | 0.0         | 0   | 0   | 0.0               | 0   | 0   | 0.0               | 0   | 0   | 0.0         | 0   | 0   | 0.0               | 0   | 0   | 0.0               | 0   | 0   | 0.0         | 0   | 0   |
| Bully                          | 0.0               | 0   | 0   | 0.0               | 0   | 0   | 0.0         | 0   | 0   | 0.0               | 0   | 0   | 0.0               | 0   | 0   | 0.0         | 0   | 0   | 0.0               | 0   | 0   | 0.0               | 0   | 0   | 0.0         | 0   | 0   |
| Foul                           | 4.0               | 6   | 3   | 5.0               | 7   | 3   | 4.0         | 4   | 3   | 7.0               | 8   | 6   | 5.0               | 6   | 3   | 6.0         | 6   | 5   | 6.0               | 7   | 4   | 6.5               | 8   | 5   | 6.5         | 8   | 5   |

<sup>†</sup> Differences tested via Kruskal Wallis H; <sup>a</sup> Significant difference between qualifiers and relegated teams ( $p < 0.008$ ); <sup>b</sup> Significant difference between mid-table and relegated teams ( $p < 0.008$ ); <sup>c</sup> Significant difference between qualifiers and mid-table teams ( $p < 0.008$ )

Table 3: Median ( $\tilde{x}$ ) profiles and 95% confidence limits for the goalkeeper

|                      | Qualifiers  |     |     | Mid-table   |     |     | Relegated   |     |     |
|----------------------|-------------|-----|-----|-------------|-----|-----|-------------|-----|-----|
|                      | $\tilde{x}$ | +CL | -CL | $\tilde{x}$ | +CL | -CL | $\tilde{x}$ | +CL | -CL |
| Save                 | 9.0         | 11  | 8   | 9.0         | 10  | 7   | 9.0         | 12  | 10  |
| Successful clearance | 1.0         | 2   | 0   | 1.5         | 2   | 1   | 2.0         | 2   | 2   |
| Fouls                | 0.0         | 0   | 0   | 0.0         | 0   | 0   | 0.0         | 1   | 0   |

Table 4: Discriminant function structure coefficients

|                               | Left back          |         | Right back          |         | Centre             |         | Left forward       |         | Right forward       |         |
|-------------------------------|--------------------|---------|---------------------|---------|--------------------|---------|--------------------|---------|---------------------|---------|
|                               | Func. 1            | Func. 2 | Func. 1             | Func. 2 | Func. 1            | Func. 2 | Func. 1            | Func. 2 | Func. 1             | Func. 2 |
| Successful pass               | 0.75               | -0.33   | -0.53               | 0.77    | 0.68               | 0.33    | 0.76               | -0.05   | -0.68               | 0.51    |
| Unsuccessful pass             | -0.06              | 0.51    | 0.42                | 0.36    | -0.50              | 0.38    | 0.32               | 0.51    | 0.08                | -0.01   |
| Successful interception       | 0.08               | 0.50    | -0.04               | 0.24    | -0.02              | -0.33   | -0.19              | 0.25    | 0.30                | 0.66    |
| Unsuccessful interception     | -0.02              | 0.23    | 0.45                | 0.20    | -0.04              | 0.67    | -0.38              | 0.17    | 0.62                | 0.06    |
| Dribble                       | 0.19               | 0.31    | -0.31               | 0.11    | 0.30               | -0.42   | 0.25               | 0.12    | -0.42               | 0.26    |
| Successful tackle             | -0.31              | 0.15    | -0.08               | 0.32    | 0.12               | -0.33   | 0.20               | -0.14   | 0.02                | -0.01   |
| Unsuccessful tackle           | -0.18              | -0.16   | 0.09                | 0.34    | 0.29               | 0.61    | 0.16               | 0.05    | 0.00                | 0.34    |
| Foul                          | 0.11               | 0.55    | 0.08                | 0.24    | 0.12               | -0.61   | -0.01              | 0.71    | 0.50                | 0.21    |
| Wilks' Lambda                 | 0.65 <sup>†</sup>  | 0.95    | 0.33 <sup>†</sup>   | 0.80    | 0.57 <sup>†</sup>  | 0.85    | 0.59 <sup>†</sup>  | 0.83    | 0.50 <sup>†</sup>   | 0.75    |
| Chi-Square                    | 28.60 <sup>†</sup> | 3.19    | 72.17 <sup>†</sup>  | 14.66   | 36.93 <sup>†</sup> | 10.54   | 34.50 <sup>†</sup> | 12.59   | 46.06 <sup>†</sup>  | 18.48   |
| p                             | 0.027 <sup>†</sup> | 0.866   | <0.001 <sup>†</sup> | 0.041   | 0.002 <sup>†</sup> | 0.160   | 0.005 <sup>†</sup> | 0.083   | <0.001 <sup>†</sup> | 0.010   |
| Eigenvalue                    | 0.47               | 0.05    | 1.41                | 0.25    | 0.50               | 0.18    | 0.40               | 0.21    | 0.52                | 0.33    |
| Relative percentage           | 90.5               | 9.5     | 84.9                | 15.1    | 74.0               | 26.0    | 65.2               | 34.8    | 61.6                | 38.4    |
| Squared canonical correlation | 0.32               | 0.05    | 0.58                | 0.20    | 0.33               | 0.15    | 0.28               | 0.17    | 0.34                | 0.25    |

<sup>†</sup>Relates to the combination of both functions, i.e. 'functions 1 through 2'

Figure 1: Example positional tags at a defensive hit-out for team 2 (ball at RB2)

Figure 2: Combined-groups centroid plot for goalkeeper, left defender and right defender

Figure 3: Combined-groups centroid plot for centre, left forward and right forward