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Research article

Performance Indicators Related to Points Scoring and Winning in International Rugby Sevens

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Abstract
Identification of performance indicators related to scoring points and winning is needed to inform tactical approaches to international rugby sevens competition. The aim of this study was to characterize team performance indicators in international rugby sevens and quantify their relationship with a team's points scored and probability of winning. Performance indicators of each team during 196 matches of the 2011/2012 International Rugby Board Sevens World Series were modeled for their linear relationships with points scored and likelihood of winning within (changes in team values from match to match) and between (differences between team values averaged over all matches) teams. Relationships were evaluated as the change and difference in points and probability of winning associated with a two within- and between-team standard deviations increase in performance indicator values. Inferences about relationships were assessed using a smallest meaningful difference of one point and a 10% probability of a team changing the outcome of a close match. All indicators exhibited high within-team match-to-match variability (intraclass correlation coefficients ranged from 0.00 to 0.23). Excluding indicators representing points-scoring actions or events occurring on average less than once per match, 13 of 17 indicators had substantial clear within-team relationships with points scored and/or likelihood of victory. Relationships between teams were generally similar in magnitude but unclear. Tactics that increase points scoring and likelihood of winning should be based on greater ball possession, fewer rucks, mauls, turnovers, penalties and free kicks, and limited passing.

Key words: Match analysis, modeling, notational analysis, performance analysis, rugby union, statistics.

Introduction

Rugby sevens is a complex team sport requiring a combination of fitness and physical ability (Higham et al., 2012; 2013), execution of technical skills (Meir, 2012), and tactical and strategic considerations (Hughes and Jones, 2005) for success at the international level. The dynamic match environment can make it difficult for coaches and support staff to identify which elements of physical, technical, and tactical development to target to enhance the probability of successful performance. Match analysis is often used to provide an objective and unbiased record of team activity to assess and monitor performance. However, it is unclear which performance indicators should be monitored to evaluate team performance in rugby sevens.

A performance indicator is a variable that characterizes some aspect of performance (Hughes and Bartlett, 2002). To be meaningful and useful, performance indicators should be related to a successful performance outcome. Research is required to characterize the technical and tactical aspects of team play related to successful performance in rugby sevens. In team sports such as rugby sevens, the primary criterion for assessing a team's performance is the match outcome, determined by the points scored by each team. The final point difference, that is, the margin of victory or loss, provides important contextual information relating to how well matched the competing teams are and the relative success of the tactics and strategies employed. Team performance indicators should therefore be considered in relation not only to winning (Jones et al., 2004; Ortega et al., 2009), but also points scored in close matches (Vaz et al., 2011; Vaz et al., 2010).

Team performance indicators describing individual or collective skills or match events may fluctuate as a function of situational variables such as, environmental conditions, officiating style, and each team's technical strengths and weaknesses (Taylor et al., 2008). Analyses of limited data sets, such as those of a single tournament or team, may be heavily influenced by these variables and not truly representative of international-level competition. By analyzing a large sample of matches from different national teams, played under varying conditions, issues related to match volatility are minimized and performance indicators commonly associated with successful performances can be identified.

Identifying performance indicators related to scoring points and winning in rugby sevens is useful to develop reference values for international matches. These values can be used by coaches and support staff to inform practical guidelines for technical and tactical development. Reference values can assist in understanding the variability of team performance, and aid coaches in establishing quantifiable objectives for training and competition performance, as well as aid in evaluating the efficacy of training interventions and tactical changes. Knowledge of performance indicators can also be used to create performance profiles to predict team behaviors and performance outcomes. The purpose of this study was to characterize common team performance indicators in international rugby sevens matches and calculate the typical within-team variability and between-team differences in these values. The effect of changes or differences in per-

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formance indicators on points scoring and probability of winning within and between teams was then quantified.

Methods

Sample

Match statistics from 196 men's international matches played over four tournaments of the 2011/2012 International Rugby Board (IRB) Sevens World Series were analyzed. Match data were retrieved from the official IRB tournament website (http://www.irbsevens.com). Team performance indicators representing totals of a given event for each team in each match were divided into four categories: match development, scoring, set-piece play, and phase play (Table 1). Match development indicators described the time with the ball and number of law infringements for a given team. Scoring indicators described the number of points scored or conceded and the way and frequency in which points were scored. Set-piece play indicators described the frequency and outcome of line-outs thrown, scrums fed and restarts kicked by the team. Phase play indicators described how the team used the ball when in possession. The performance indicators were analyzed as absolute values and as values standardized per min of possession time or per try scored.

Table 1. Rugby sevens team performance indicators.

Classification	Team Performance Indicator
Match development	Possession time, penalties and free kicks conceded, yellow cards
Scoring	Points scored, points conceded, tries scored, tries conceded, tries scored per min of possession, conversions
Set-piece play	Line-outs, line-out possessions retained, scrums, scrum possessions retained, restarts, restarts regained
Phase play	Passes, passes per min of possession, passes per try scored, rucks, rucks per try scored, rucks retained, mauls, rucks and mauls per min of possession, ruck and maul retention, kicks, kicks per min of possession, turnovers conceded, turnovers conceded per min of possession

Statistical analysis

Data were imported into the Statistical Analysis System (version 9.3, SAS Institute, Cary, NC) for analysis. Mean values and true between-team and within-team standard deviation (SD) for common team performance indicators were calculated using a mixed-model reliability analysis with a random effect for team. Mean values were estimated as the intercept of the model with the between-team standard deviation calculated from the random effect, and the within-team standard deviation calculated from the residual variance. A standard deviation representing observed between-team match-to-match typical differences was calculated as the square root of the sum of the true between-team and within-team variances. Intraclass correlation coefficients representing match-to-match reliability of performance indicators were calculated as the true between-team variance divided by the observed between-team variance.

Performance indicators representing events occurring on average more than once per match, and not directly representing points-scoring actions, were further analyzed for their relationship with points scored by a team and the probability of winning. A mixed model with the performance indicator as a linear fixed effect, a random effect for team, and an interaction effect for performance indicator and team, was employed to characterize the relationship between the performance indicator and points scored within each team. This model allowed for the possibility of individual team differences in the relationship between the performance indicator and points scored. An additional interaction effect for team and the tournament at which matches were played, allowing for individual team differences in the relationship at different tournaments, was removed from the model because it explained no additional variance in points scored. A linear relationship between performance indicators and points scored was deemed appropriate after assessment of a quadratic trend yielded no additional meaningful information. A linear model was also favored for its simpler interpretation. The effect of a change within a team in performance indicator value on points scored was assessed by multiplying the slope of the relationship by two within-team standard deviations (Hopkins et al., 2009). Two standard deviations represents the change within a team from a typically low performance indicator value (-1 SD) to a typically high value (+1 SD).

A between-team effect of the selected indicators was assessed by averaging the values of the performance indicator and points scored for each of the 26 teams. The effect of the performance indicator was derived by multiplying the slope of the linear relationship between the means by twice the standard deviation of the teams' mean values of the performance indicator.

Generalized linear modeling was used to estimate the effect of an increase in performance indicator value on a team's probability of winning. Cumulative logistic regression was employed to model categorical match outcomes of a win or loss, allowing for the inclusion of drawn matches. The addition of a random effect for team allowed for individual team differences. The logarithm of the odds ratio of winning was calculated and the effect of a two within- and between-team means standard deviation increase in the performance indicator value expressed as a percent change or difference in the likelihood of a team winning a close match (probability of winning centered on 50%).

Possible confounding effects of two important performance indicators (passes per min of possession and rucks and mauls per min of possession) were analyzed by assessing the effects of a two standard deviation increase in the performance indicator after adjusting for the second indicator by adding it to the model as a covariate. The results of these analyses did not change the inferences about the effect on points and probability of winning and are therefore not shown.

Inferences about effects of performance indicators were assessed using the smallest meaningful difference in points scored during close matches. In this context, close matches were defined as those with a final points score

difference of ≤7, corresponding to match outcomes decided by a converted try or less (41% of observed matches, n = 80). The smallest meaningful difference is given by 0.3 of the typical variation between competitions of an athlete's or team's performance (Hopkins et al., 1999). This difference was calculated as the standard deviation of the points difference in close matches (4.5) multiplied by 0.3/√2, equal to approximately one point. The formula was divided by the square root of two to account for the combined random variation in the performance of the two teams contesting a match. The smallest meaningful difference represents the difference in a team's points score required to change the match outcome in ~10% of close matches. Similarly, 10% was defined as the smallest meaningful difference in the analyses of a team's probability of changing a match outcome. A 10% difference represents one extra win or loss in 10 evenly-balanced matches. An inference about the true value of an effect was based on the uncertainty of its magnitude. When the 90% confidence interval crossed the threshold for both negative and positive values of the smallest meaningful difference, the effect was deemed unclear (Hopkins et al., 2009).

Results

Values for match development, scoring, set-piece play and phase play indicators in a typical match summarized by the mean and observed standard deviation are presented in Table 2. The observed standard deviation consists of contributions from the between-team standard deviation, representing the stable typical differences between teams, and the within-team standard deviation, representing the typical variability a team shows between matches. All performance indicators exhibited higher variability in changes within teams than differences between teams. The intraclass reliability correlation coefficients ranged from 0.00 to 0.23 (Table 2).

Of the 17 performance indicators analyzed, 13 had a clear substantial relationship with points scored within teams (Figure 1A). The only unclear within-team relationships with points scored were for line-out possessions retained and kicks per min of possession. Of the indicators demonstrating clear relationships, scrums and scrum possessions retained had trivial effects (within the positive and negative thresholds for the smallest meaningful difference). In contrast, the only clear between-team relationships with points scored were for rucks and mauls per min of possession, penalties and free kicks conceded, passes per min of possession, scrum possessions retained, possession time, and percentage of ruck and maul retention (Figure 1A). Rucks and mauls per min of possession had the strongest relationship with points scored. Figure 2 shows the differences in mean rucks and mauls per min of possession between teams and substantial negative between- and within-team relationships with points scored in a match.

Table 2. Rugby sevens team performance indicator values per team per match (n = 392 observations, 196 international matches).

		Mean; ±90% CL	Observed SD*	Between-team SD†	Within-team SD*	ICC
Match development	Possession time (s)	213; ±7	52	14	50	.08
	Penalties and free kicks conceded	3.26; ±.20	1.86	.33	1.83	.03
	Yellow cards	.15; ±.03	.37	.00	.37	.00
Scoring	Points scored	15.6; ±1.6	10.5	3.8	9.7	.14
	Tries scored	2.5; ±.3	1.6	.6	1.5	.14
	Tries scored per min of possession	.72; ±.07	.46	.15	.44	.11
	Conversions	1.5; ±.2	1.3	.4	1.3	.09
Set-piece play	Line-outs	1.06; ±.13	1.08	.23	1.06	.05
	Line-out possessions retained	.79; ±.12	.93	.25	.89	.07
	Scrums	1.90; ±.13	1.27	.16	1.26	.02
	Scrum possessions retained	1.78; ±.12	1.26	.14	1.25	.01
	Restarts	3.06; ±.19	1.40	.44	1.33	.10
	Restart regained	.76; ±.13	.94	.27	.90	.08
Phase Play	Passes	33.7; ±1.4	11.7	2.8	11.3	.06
	Passes per min of possession	9.36; ±.26	1.93	.56	1.85	.08
	Passes per try scored	16.6; ±1.4	11.6	2.5	11.3	.05
	Rucks	8.4; ±.6	4.1	1.4	3.8	.12
	Rucks per try scored	4.4; ±.5	3.9	1.1	3.7	.08
	Mauls	.43; ±.09	.74	.18	.71	.06
	Rucks and mauls per min of possession	2.46; ±.16	.86	.41	.76	.23
	Ruck and maul retention (%)	79.3; ±1.7	15.6	2.8	15.4	.03
	Kicks	1.18; ±.17	1.20	.39	1.14	.11
	Kicks per min of possession	.36; ±.05	.38	.12	.36	.10
	Kicks per pass	.043; ±.007	.053	.014	.051	.07
	Rucks and mauls per kick	6.3; ±.6	4.2	1.2	4.0	.09
	Turnovers conceded	2.42; ±.15	1.51	.20	1.49	.02
	Turnovers conceded per min of possession	.72; ±.05	.48	.09	.47	.03

CL = confidence limits; SD = standard deviation; ICC = intraclass correlation coefficient; 90% confidence limits: *×/÷1.1, †×/÷1.4 to 5.8

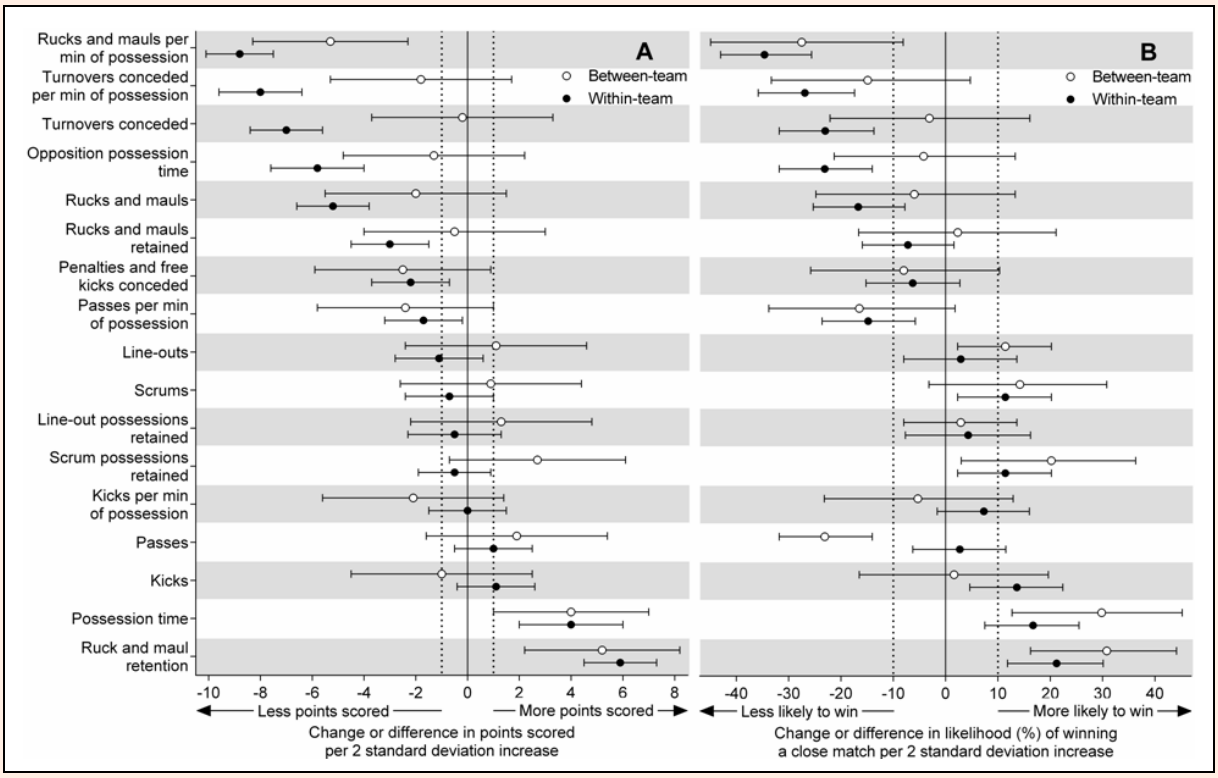

Figure 1. Effect of two standard deviations of within-team changes and between-team differences of team performance indicators on (A) points scored during an international rugby sevens match, and (B) likelihood of winning a close match. Bars are 90% confidence intervals. Dotted lines represent thresholds for smallest meaningful difference: (A) ±1 point and (B) ±10%. Where error bars simultaneously cross the negative and positive values of the smallest meaningful difference, the effect is unclear.

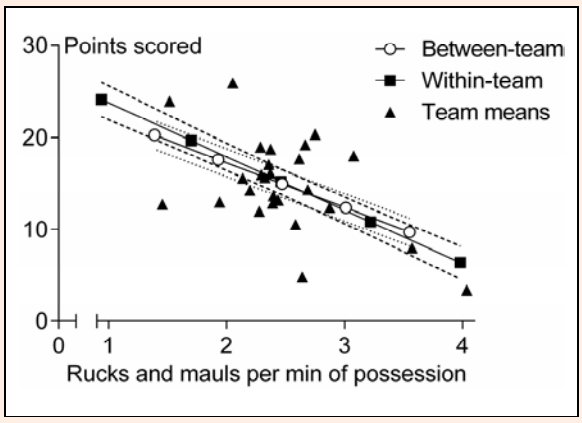

Figure 2. Example of strong between- and within-team relationships between a performance indicator (rucks and mauls per min of possession) and points scored in international rugby sevens matches. Each filled triangle represents the mean values for one of 26 teams. Best-fitting lines are shown with symbols representing increments of one between- and within-team standard deviation (open circles and filled squares, respectively). Dotted and dashed lines represent the 90% confidence limits of predicted mean points scored for the between- and within-team relationships, respectively.

Results for analyses of the effect of performance indicators on the likelihood of winning close matches generally followed the trends for points scoring (Figure 1B). All within-team effects of performance indicators on probability of winning were clear. However, rucks and mauls retained, penalties and free kicks conceded, number of line-outs, line-out possessions retained, kicks per min of possession, and passes had a trivial effect. For the between-team analyses, a team with two standard deviations higher number of rucks and mauls per min of possession, turnovers conceded per min of possession, passes, and passes per min of possession on average had a 15 to 28% lower probability of winning a close match. Conversely, two standard deviations greater ruck and maul retention, possession time, number of scrums, number of line-outs, and scrum possessions retained resulted in an 11 to 31% higher likelihood of winning an even match. All other between-team effects on the probability of winning were unclear or trivial.

Discussion

This is the first study of the relationship of performance indicators and points scoring or probability of winning in rugby sevens. Analysis of match statistics collected from a large sample of matches during four international tournaments allowed reference values for common team performance indicators to be generated. The analysis also quantified the typical variability between matches in performance indicator values for a given team. There was greater variability in changes in performance indicator values within a team than between teams. Excluding performance indicators representing points-scoring actions or events occurring on average less than once per match, 13 of 17 indicators had substantial clear relationships with a team's points score and/or likelihood of victory. In gen-

eral, the within- and between-team effects of performance indicators were similar for a team's points score and probability of winning an evenly-contested match. A higher number of rucks and mauls per min of possession had the largest negative association with a team's points and likelihood of winning. Conversely, the percentage of rucks and mauls retained had the largest positive effect. The observed relationships indicate priorities for technical and tactical development of teams at the international level.

The relationships between performance indicators, points scoring and likelihood of winning support findings from international matches played in 2001, which identified differences in the tactics employed by successful and unsuccessful teams (Hughes and Jones, 2005). When in possession of the ball, successful teams adopted a more evasive style of play, whereas unsuccessful teams were more direct in their patterns of play. The current findings of higher possession time having a positive effect on points scoring and chances of winning are in agreement with these observations, suggesting successful teams are more patient and have greater control of the game. A more direct approach, resulting in a higher frequency of rucks and mauls, was related to a lower points score and probability of a successful match outcome, even when the ruck and maul possession was retained. Unsurprisingly, a higher point score was associated with greater relative ruck and maul possession retention, and fewer turnovers in possession and penalties and free kicks conceded.

Absolute frequency of passing and kicking within a team were positively related with points scored, but when these actions were standardized relative to possession time the results were reversed and unclear, respectively. The positive relationships of absolute frequency of these events and points scoring appear more indicative of the higher ball possession time of higher-scoring teams than the technical actions alone. During international matches played in 2001, successful teams tended to kick less frequently than less-successful teams (Hughes and Jones, 2005). Furthermore, although the number of passes per match was similar between the teams, successful teams performed fewer normal passes and loop passes, and more miss (cut-out) passes and dummy passes (Hughes and Jones, 2005). These differences, coupled with the fewer rucks and mauls performed by successful teams, suggest the tactical approach of better teams is to keep the ball "alive" and attack with more width and deception in preference to going into contact when in possession.

To increase the opportunities for points-scoring movements and probability of winning in international competition, teams should aim to maintain ball possession. The importance of maintaining possession concurs with the observation that teams progressing beyond the quarter-final in the 2005 IRB Rugby World Cup Sevens secured and maintained control of the ball for periods between 30 and 60 s, and converted over 30% of possessions into points-scoring movements (van Rooyen et al., 2008). The possession-based approach of successful teams in international rugby sevens contrasts with observations in international rugby union competition. Winning in international rugby union has been associated with a territory-based strategy, where teams are more likely to kick the ball when in possession (Bishop and Barnes, 2013; Ortega et al., 2009). The difference in successful tactics between rugby sevens and rugby union likely represents the additional space available for players in the abridged format. The reduced number of players on the field in rugby sevens compared with 15-player rugby union increases the opportunity for teams to initiate points-scoring movements from any position on the field. This scenario results in a greater importance of ball possession and less significance of field position and set-piece plays.

Teams conceding more penalties and free kicks tended to score fewer points. Nevertheless, the effect on the likelihood of winning was unclear between teams and trivial within teams. In 2001, successful international teams with a win rate of ≥70% conceded more penalties per match than unsuccessful teams (Hughes and Jones, 2005). This discrepancy in the number of penalties conceded may be explained by successful teams being more likely to utilize the advantage rule to continue play following an infringement by the opposition. Although conceding points to the opposition through penalty goals is very rare in rugby sevens (and hence not included in Table 2), conceding penalties and free kicks limits a team's opportunities to score by giving the opposition territory and possession. The association between poorer discipline and lower scoring performances warrants further investigation into the timing and circumstances of penalties and free kicks being awarded. It is unclear whether there are differences between successful and unsuccessful teams in the frequency of law infringements when in possession of the ball or when defending.

Previous studies of team performance indicators have been limited by analytical methods that consider only the collective characteristics of successful and unsuccessful performances, leading to subtleties in individual team performances becoming indistinguishable (Taylor et al., 2005). The limitation of generalizing trends in match statistics to individual teams was accounted for in the current study by analyzing the relationship of within-team changes in performance indicators with points scoring and probability of success. This model allowed individual differences between teams in tactical approaches to be preserved while still estimating the mean effect on points scored and likelihood of winning. The within-team relationships characterized in this study represent the observed and achievable change in points scored and odds of winning as a team changes its performance indicator, whereas the between-team relationships represent stable long-term differences in performance between teams. A similar approach could be employed to determine the influence of performance indicators on success in other sports and with other frequent match events or player actions.

It should be noted that the analysis of the relationships between performance indicators, points scoring and winning does not imply a cumulative effect when indicators are combined. Although it is possible to prioritize the importance of individual statistics based on their association with scoring and successful outcomes, it is likely

there are substantial correlations between some performance indicators. For example, in most matches, increasing a team's absolute possession time will simultaneously restrict their opposing team's possession. However, preliminary analyses of the effects of a performance indicator adjusted for a second performance indicator demonstrated independent effects on points scoring and probability of winning (results not shown). These results suggest that in some circumstances a team's performance may be improved by independently changing performance indicator values.

Given the open nature of rugby sevens with additional space afforded to players compared with 15-player rugby union, defensive actions and structures are crucial in determining the outcome of matches. The current study focused on performance indicators representative of actions performed by teams when in possession of the ball. As it is impossible to maintain possession of the ball for an entire match, future studies could investigate relationships between defensive performance indicators and points scored by the opposition. This investigation was limited to official match statistics routinely collected by the IRB during the international IRB Sevens World Series. Subsequent research should examine additional performance indicators that may further inform the technical and tactical preparation of teams for competition.

While it is apparent the team performance indicators described in this study are representative of technical and tactical factors associated with successful match outcomes, clearly other elements also influence team performance. Factors such as players' physiques, fitness and physical ability, skill and technical proficiency are all determinants of the success of a team. Although some of the performance indicators examined may be partially representative of these factors and the strategies employed by successful teams, coaches must consider the interaction of the multitude of components related to performance in rugby sevens at the international level.

Conclusion

Coaches and support staff can use the performance indicator values presented in this study as a reference to monitor and assess the performance of their team as well as opposing teams. Coaches can then devise strategies and assign priorities for team preparation based on each performance indicator's effect on points scoring and chances of winning. There is greater variability in within-team changes than between-team differences in team performance indicator values. The associations of performance indicators with points scoring and probability of winning suggest higher-scoring and more-successful teams tend to control possession of the ball and play a patient, disciplined and evasive style of game. A less disciplined and more direct approach, characterized by conceding more penalties and free kicks and performing more rucks and mauls, gives the opposition greater opportunity to gain ball possession and is associated with lower scores. Team tactics that maximize the amount of points scored and likelihood of winning should be based on strategies that promote greater ball possession, minimize rucks and mauls, turnovers, penalties and free kicks, and limit passes.

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Key points

- Successful international rugby sevens teams tend to maintain ball possession; more frequently avoid taking the ball into contact; concede fewer turnovers, penalties and free kicks; retain possession in scrums, rucks and mauls; and limit passing the ball.
- Selected performance indicators may be used to evaluate team performances and plan more effective tactical approaches to competition.
- There is greater match-to-match variability in performance indicator values within than between international rugby sevens teams.
- The priorities for a rugby sevens team's technical and tactical preparation should reflect the magnitudes of the relationships between performance indicators, points scoring and the likelihood of winning.

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