

## **Performance indicators that discriminate winning and losing in elite men's and women's Rugby Union**

HUGHES, Angus, BARNES, Andrew <<http://orcid.org/0000-0001-8262-5132>>, CHURCHILL, Sarah <<http://orcid.org/0000-0001-9542-3812>> and STONE, Joseph <<http://orcid.org/0000-0002-9861-4443>>

Available from Sheffield Hallam University Research Archive (SHURA) at:

<http://shura.shu.ac.uk/16611/>

---

This document is the author deposited version. You are advised to consult the publisher's version if you wish to cite from it.

### **Published version**

HUGHES, Angus, BARNES, Andrew, CHURCHILL, Sarah and STONE, Joseph (2017). Performance indicators that discriminate winning and losing in elite men's and women's Rugby Union. *International Journal of Performance Analysis in Sport*, 17 (4), 534-544.

---

### **Copyright and re-use policy**

See <http://shura.shu.ac.uk/information.html>

# Performance indicators that discriminate winning and losing in elite men's and women's Rugby Union.

## Abstract

*This study aimed to identify performance indicators that discriminate winning and losing in elite men's and women's Rugby Union during the latest World Cup competitions. The knockout stages of the men's 2015 Rugby World Cup (n = 8) and women's 2014 Rugby World Cup (n = 8) were compared. Findings suggest that in the men's game, winning teams kicked a greater percentage of possession in the opposition 22-50m with a view to gaining territory and pressuring the opposition (winners = 16%, losers = 7%). In the women's game successful teams adopted a more possession driven attacking approach in this area of the pitch. Successful women's teams appear more willing to attack with ball in hand following a kick receipt and adopt a more expansive game through attacking with wider carries in the outside channels. The percentage of lineouts won on the opposition ball was found to be an important performance indicator that discriminates winners and losers, regardless of sex (winners = 18%, losers = 11%). Findings suggest successful men's and women's teams adopt different tactical approaches to knockout competitions, this knowledge should be used as a basis for coaches to develop tactical approaches and training methods which are sex dependent.*

**Key words:** performance analysis, match success, tactical approaches, KPI.

## 1 **Introduction**

2  
3 The observational study of teams and players has become an important factor when  
4 applying effective coaching, training and selection in team sports (Hughes & Bartlett,  
5 2002). Understanding factors that determine game success is crucial to enable coaches  
6 to adopt effective tactical strategies, with Rugby Union benefiting significantly from the  
7 introduction of performance analysis and the professional era leading to a drive to  
8 maximize performance through improved scientific and analytic support (Vaz,  
9 Mouchet, Carreras, & Morente, 2011). Seminal work primarily focused on patterns of  
10 play (Eaves & Hughes, 2003; Eaves, Hughes, & Lamb, 2005) and the physiological  
11 demands of the sport (Austin, Gabbett, & Jenkins, 2011; Cunniffe, Proctor, Baker, &  
12 Davis, 2009; Deutsch, Kearney, & Rehrer, 2007). However, more recently the focus of  
13 research has been to establish performance profiles for individuals or teams and  
14 importantly to apply these to match outcome (Vaz et al., 2011). As such, several studies  
15 have identified factors that discriminate successful and unsuccessful performance in the  
16 elite game (Bishop & Barnes, 2013; Hughes et al., 2012; James, Mellalieu, & Jones,  
17 2005; Jones, Mellalieu, & James, 2004; Ortega, Villarejo, & Palao, 2009).

18 Performance indicators may be defined as “a selection, or combination, of action  
19 variables that aim to define some or all aspects of a performance” (Hughes & Bartlett,  
20 2002, p.739). With the aim of informing tactical approaches to the game, previous  
21 research has focused on identifying performance indicators that determine match  
22 outcome (Bishop & Barnes, 2013; Bremner, Robinson, & Williams, 2013; Ortega et al.,  
23 2009; Stanhope & Hughes, 1997; Van Rooyen, Diedrick, & Noakes, 2010; Vaz et al.,  
24 2010). Those indicators previously related to winning include, lineout success (Jones,  
25 Mellalieu, & James, 2004; Ortega et al., 2009; Vaz et al., 2010), turnovers conceded

26 (Ortega et al., 2009; Vaz et al., 2011), ruck speed (Bremner et al., 2013) and number of  
27 kicks out of hand (Ortega et al., 2009; Stanhope & Hughes, 1997; Vaz et al., 2011). In  
28 addition, winning teams have been found to be more effective at crossing the gain line  
29 (Bremner et al., 2013; Diedrick & Van Rooyen, 2011), miss fewer tackles (Ortega et al.,  
30 2009; Vaz et al., 2011), make more line breaks (Ortega et al., 2009) and make fewer  
31 carries (Bishop & Barnes, 2013) than losing teams. Variation between studies in the key  
32 performance indicators that relate to match outcome, may be the result of the sample  
33 studied which was a mixture of domestic and international competitions, Northern and  
34 Southern hemisphere and league and knockout competitions. Van Rooyen et al. (2010)  
35 found differences in the performance indicators between the knockout and the pool  
36 stages of the 2007 World Cup. This supports the notion that a team's tactical approach  
37 may, indeed, be influenced by the format of the competition and the quality of  
38 opposition.

39 The Rugby World Cup brings together the best players and international teams in the  
40 world. Analysis of this competition allows an understanding of how the game is played  
41 at the elite level and the tactics used by successful teams. Despite this, the game is  
42 changing rapidly and research conducted on different competitions suggests the style of  
43 play used by successful teams has evolved over time. Van Rooyen and Noakes (2006)  
44 found successful teams adopted a more possession based approach to attacking when  
45 studying the semi-finalists of the 2003 Rugby World Cup. However, at the 2007 World  
46 Cup, all eight of the knockout matches were won by teams with a lower ruck frequency  
47 (Van Rooyen et al., 2010). This suggests a more territory-based approach through  
48 kicking and pressuring the opposition compared to a possession orientated strategy.  
49 More recent evidence from the 2011 Rugby World Cup supports this notion with

50 winning teams making fewer carries (25 fewer) and completing fewer rucks (22 fewer)  
51 than losing teams (Bishop & Barnes, 2013). These data suggest that in knockout rugby  
52 at the highest elite level, winning teams favour a territory based rather than a possession  
53 based approach to the game. However, since 2011 World Rugby have introduced  
54 several new laws, many of which aim to increase the ball in play time, speed up the  
55 game and make it a more attractive prospect for spectators (World Rugby, 2015). This  
56 suggests that tactical approaches may also have developed overtime to meet the needs  
57 of the modern game. An up-to-date analysis is warranted to establish if styles of play  
58 have changed since the 2011 Rugby World Cup and help to establish game based  
59 knowledge and ensure coaching strategies and tactical approaches are current.

60

61 Although traditionally a male sport, the International Rugby Board included female  
62 rugby within the union in 1994. In more recent years, women's rugby has seen a 90%  
63 increase in participation levels since 2004 with over 15000 registered players in the  
64 2013 season (England Rugby, 2013). At the elite level, many international teams now  
65 have full-time professional players. Despite this, there is a clear lack of published  
66 research on the women's game, how it is played, and what factors are important for  
67 match success.). Elite female players have been found to travel less distance in a match  
68 at a lower average speed than male players, as well as spending 10.5% less time in the  
69 high intensity running or sprinting zones (Cunniffe et al., 2009; Suarez-Arrones et al.,  
70 2014). In addition, a lower average number of impacts in the female game (n=704.8  
71 impacts; Suarez-Arrones et al., 2014) compared with the male game (n=1274 impacts;  
72 Cunniffe et al., 2009) have been reported. Although based on a small sample of eight  
73 elite players (Suarez-Arrones et al., 2014), these initial findings suggest that the

74 women's game is played at a slower pace with fewer game related impacts. Physical  
75 characteristics measured in male rugby players have been found to play a critical part in  
76 performance behaviours associated with success (Smart, Hopkins, Kenneth, Quarrie, &  
77 Gill, 2014). Smart et al. (2014) found player speed to correlate with line breaks, tackles,  
78 breaks and tries scored during games, variables that have previously been shown to  
79 relate to match success (Bremner et al., 2013; Diedrick & Van Rooyen, 2011; Ortega et  
80 al., 2009; Vaz et al., 2011). In the women's game, a slower paced match with fewer  
81 impacts associated with tackles, carries and rucks suggests the style of play adopted by  
82 elite men's and women's teams may differ. Therefore, a comparison of men's and  
83 women's competitions is warranted to help establish sex specific performance indicators  
84 that discriminate winning and losing.

85 The aim of this study was to compare performance indicators in elite men's and  
86 women's Rugby Union and identify those that discriminate winning and losing teams  
87 based on the most recent World Cup competitions. An understanding of these factors  
88 will help inform coaching methods and establish a basis from which tactical approaches  
89 can be developed specific to both men's and women's Rugby Union.

90

## 91 **Methods**

### 92 *Design and Sample*

93 The study compared teams from the men's 2015 Rugby World Cup and women's 2014  
94 Rugby World Cup. Performance indicators were compared between winners and losers  
95 to identify which may discriminate successful and unsuccessful performance. The  
96 sample included the knockout games of the men's 2015 Rugby World Cup including the

97 3<sup>rd</sup> place play off (n = 8) and the games in the 1<sup>st</sup>-4<sup>th</sup> place play off and 5<sup>th</sup>-8<sup>th</sup> place play  
98 off in the women's 2014 world cup (n = 8).

### 99 ***Performance indicators***

100 Following a review of previous research (Bishop & Barnes, 2013; Bremner et al., 2013;  
101 Hughes et al., 2012; James et al., 2005; Jones et al., 2004; Ortega et al., 2009; Vaz et al.,  
102 2010, 2011) performance indicators were established. These were: tries, penalty kick  
103 success, conversion success, drop goals lineout success, scrum success, ruck frequency  
104 (by area of pitch), kick in play (by area of pitch), tackle completion, carries (categorised  
105 as pick and go, carry off 9, carry off 10, support carry, kick return, other carry), breaks,  
106 visit to opponents 22 (divided into points scored and no points scored), turnover  
107 conceded (divided into unforced and forced), penalty conceded (by area of pitch). In  
108 addition, total possession of the ball when in play was coded as a descriptive variable.  
109 For those performance indicators that were expressed in terms of the area of the pitch,  
110 the pitch was divided into four areas: the attacking team's dead ball line to the 22 m line,  
111 the attacking team's 22 m line to halfway, the defensive team's halfway to the 22 m line  
112 and the defensive team's 22 m line to the dead ball line.

### 113 ***Procedure***

114 Games were analysed using the sports analysis software Sportscodelite (Version 10.3,  
115 Sportstec, Warriewood, Australia). Each match was analysed by the same experienced  
116 analyst who had an in-depth knowledge of Rugby Union using an analysis template to  
117 allow the coding of the performance indicators as well as a timeline for when the event  
118 took place. Data were then exported to Microsoft Excel 2010 (Microsoft Corporation,  
119 Washington, USA) for further analysis.

120 ***System Reliability***

121 Intra-observer and inter-observer reliability were both assessed using two randomly  
122 selected matches from each World Cup competition. Cohen's Kappa Coefficient (K)  
123 was used as the measure of reliability (equation 1):

124

$$125 \quad K = (P_o - P_c) / (1 - P_c) \quad (\text{equation 1})$$

126

127 Where  $P_o$  is the percentage value of agreement and  $P_c$  is the percentage value of  
128 expected agreement by guessing.

129

130 For intra-observer reliability, two matches were re-analysed by the primary analyst.  
131 Classification of Kappa values (Altman, 1991) showed that a very good level of  
132 agreement across the range of KPI's coded (range,  $K = 0.95-1.00$ ). Inter-Observer  
133 reliability was assessed by having two matches re-analysed by a secondary analyst. The  
134 secondary analyst also had an in depth knowledge of Rugby Union and was an  
135 experienced performance analyst. Again, a very good level of agreement was found  
136 (range,  $K = 0.88- 0.98$ ).

137

138 ***Data Analysis***

139 Data analysis was completed using Microsoft Excel 2010 (Microsoft Corporation,  
140 Washington, USA) and SPSS 23.0.0 (IBM Corporation, New York, USA). Using a  
141 Shapiro Wilkes test, a large proportion of variables (91%) were found to be normally  
142 distributed. Thus, parametric tests were used for statistical analysis. A Two-way mixed



143 ANOVA was used to identify statistical differences both between winning and losing  
144 teams (within subjects factor) and between sexes (between subjects factor). Statistical  
145 significance was accepted at the 95% level. In order to allow comparison between  
146 groups, data was presented as descriptive statistics (mean and standard deviation).  
147 Effect sizes (ES) were determined using Cohen's  $d$  (Cohen, 1969) where  $d$  less than or  
148 equal to 0.20 represent a small ES,  $d$  greater than 0.20 but less than 0.80 a moderate ES  
149 and  $d$  greater than or equal to 0.80 a large ES.

150

## 151 **Results**

152 Descriptive statistics of performance indicators between sexes are displayed in Table 1.  
153 Inferential statistical results are displayed (Table 1) to demonstrate any interactions or  
154 main effects present for each performance indicators, with significant findings  
155 highlighted in bold.

156

157 INSERT TABLE 1 NEAR HERE

### 158 *Tries and Possession*

159

160 Number of tries scored affected match outcome ( $F_{(1, 14)} = 15.16, p = 0.002, d = 1.41$ )  
161 with winning teams ( $4.4 \pm 2.8$  tries) scoring more tries than losing teams ( $1.8 \pm 1.1$   
162 tries). However, no differences were seen in total possession either between winners and  
163 losers or between sexes (Table 1).

164

165 **Breaks**

166 A match outcome\*Sex interaction was present for number of breaks ( $F_{(1, 14)} = 7.22$ ,  
167  $p = 0.018$ ) (Table 1). Winning women's teams had a higher number of breaks compared  
168 to losing teams, whereas the number of breaks made by men's teams were consistent  
169 between winners and losers. This was demonstrated by a main effect for sex ( $F_{(1, 14)} =$   
170  $6.69$ ,  $p = 0.048$ ,  $d = 0.65$ ), with women making more breaks ( $5.7 \pm 3.2$ ) than men ( $3.75$   
171  $\pm 2.6$ ) irrespective of match outcome. A main effect for match outcome was also seen,  
172 ( $F_{(1, 14)} = 5.66$ ,  $p = 0.032$ ,  $d = 0.66$ ), with winning teams ( $5.7 \pm 3.8$ ) making more breaks  
173 than losing teams ( $3.8 \pm 1.7$ ).

174

175 **Tackle Completion**

176 A match outcome\*sex interaction for tackle completion was present ( $F_{(1, 14)} = 5.22$ ,  
177  $p = 0.038$ ). Losing teams completed fewer tackles than winning teams, but this was sex  
178 dependent with women's teams displaying a greater difference in tackle completions  
179 between winners and losers in comparison to men's team's. The importance of tackle  
180 completion was demonstrated be a large effect size ( $d = 1.94$ ) between winning and  
181 losing women's teams. A main effect was shown for match outcome ( $F_{(1, 14)} = 12.74$ ,  
182  $p = 0.003$ ,  $d = 1.24$ ) with winning teams having a higher tackle completion rate ( $92.3\%$   
183  $\pm 3.9\%$ ) than losing teams ( $86.8\% \pm 4.9\%$ ).

184

INSERT FIGURE 3 NEAR HERE

185 **Carries**

186 A match outcome\*sex interaction for the percentage of pick and go carries was present  
187 ( $F_{(1, 14)} = 13.15, p = 0.003$ ). Losing teams had a higher use of pick and go carries  
188 compared to winning teams, with women's teams having the greatest difference between  
189 winners and losers compared to men. There was also a main effect displayed for match  
190 outcome ( $F_{(1, 14)} = 19.37, p = 0.001$ ), with winning teams ( $11.6\% \pm 7.4\%$ ) using pick  
191 and go carries less than losing teams ( $21.6\% \pm 13.9\%$ ). A main effect for sex ( $F_{(1,14)} =$   
192  $38.80, p = 0.001, d = 1.79$ ) showed women's teams used more pick and go carries  
193 ( $24.4\% \pm 11.9\%$ ) than men's teams ( $8.3\% \pm 4.2\%$ ). A main effect for sex on carries off 9  
194 ( $F_{(1, 14)} = 19.58, p = 0.001, d = 1.84$ ) showed that men's team's had a higher percentage  
195 of carries off 9 ( $38.5\% \pm 6.9\%$ ) than women's teams ( $24.9\% \pm 7.91\%$ ). Total carries,  
196 pick and go, and kick return carries showed large effect sizes ( $d = 1.32-1.52$ ) between  
197 wining and losing women's teams.

### 198 ***Rucking***

199 Rucking in the opposition 22-50 showed a match outcome\*sex interaction ( $F_{(1,14)} =$   
200  $25.98, p = 0.001$ ), winning men's teams had a greater proportion of rucks in the  
201 opposition 22-50 ( $51.1\% \pm 12.1\%$ ) compared to losing ( $43.8\% \pm 8.5\%$ ) teams, while  
202 winning women's teams had fewer rucks in this area ( $34.1\% \pm 8.5\%$ ) compared to  
203 losers ( $48.25\% \pm 7.4\%$ ). A match outcome\*sex interaction for Ruck own 22-50 was  
204 present  $F_{(1, 14)} = 7.71, p = 0.015$ . A number of other effects were seen, such as winning  
205 teams having increased ruck percentage in the opposition 22 compared to losing teams  
206 and sex effecting rucking percentage in the opposition 22 (Table 1). Finally rucks in  
207 their own 22 was affected by sex, with men's teams having an increased proportion of  
208 their rucks in this area ( $10.5\% \pm 6.8\%$ ) compared to women's teams ( $4.42\% \pm 3.11\%$ ).

209 ***Kicking***

210 Total number of kicks was affected by Sex ( $F_{(1, 14)} = 13.25, p = 0.003$ ), with men's teams  
211 kicking ( $23.6 \pm 7.1$ ) more than women's teams on average ( $13.8 \pm 4.6$ ). An interaction  
212 for the proportion of kicks made in opposition 22-50 was present ( $F_{(1, 14)} = 8.24, p =$   
213  $0.012$ ) with winning men's teams kicking more in this area of the pitch than losing  
214 teams, while winning women's teams kicked less in this area than losing teams. A main  
215 effect for match outcome for kicks in their own 22-50m ( $F_{(1, 14)} = 8.84, p = 0.010$ ),  
216 showed winning teams made more of their kicks in this area ( $48.5\% \pm 10.7\%$ ) compared  
217 to losing teams ( $41.4\% \pm 8.4\%$ ).

218

219

220

221 ***Penalties***

222 Total penalties and penalty success did not affect match outcome, sex or match  
223 outcome\*sex interaction (all  $p > 0.05$ ). A match outcome\*sex interaction was present  
224 for penalties in own 22 ( $F_{(1,14)} = 7.15, p = 0.018$ ). Percentage of penalties in own 22  
225 increased for women's losing teams ( $41.2\% \pm 16.7\%$ ) compared to winning ( $18.7\% \pm$   
226  $15.4\%$ ), whereas men's teams percentage of penalties conceded were similar between  
227 winning ( $23.3\% \pm 13.7\%$ ) and losing ( $18.5\% \pm 15.1\%$ ) teams.

228 ***Line Out and Scrums***

229 There was a main effect for match outcome for lineout success on the opposition ball  
230 ( $F_{(1, 14)} = 12.38, p = 0.042$ ). Winning teams won a higher percentage of opposition  
231 lineout ball ( $18.4\% \pm 10.91\%$ ) than losing teams ( $11.3\% \pm 9.1\%$ ), irrespective of sex.

232 The large effect size ( $d = 1.03$ ) suggests this variable to be important in discriminating  
233 winning ( $17.4\% \pm 12.8\%$ ) and losing teams ( $7.4 \pm 5.0\%$ ) in the men's game. In  
234 addition, a large effect between winners and losers ( $d = 0.97$ ) was seen for lineout  
235 success on their own ball in the men's game, with winners successfully securing a  
236 higher percentage ( $92.6 \pm 5.7\%$ ) than losers ( $82.6 \pm 12.9\%$ ). No differences in scrum  
237 success on their own ball or the opposition ball were observed between winners and  
238 losers, regardless of sex.

239

## 240 **Discussion**

241 The aim of this study was to compare performance indicators in elite men's and  
242 women's Rugby Union and identify those that discriminate winning and losing teams.  
243 In the women's competition a range of performance indicators discriminated winning  
244 and losing teams, in contrast, fewer performance indicators discriminated match  
245 outcome for the men's competition. An example of this was that the number of breaks  
246 influenced match outcome, however, this was dependent on sex. Breaks in the women's  
247 World Cup showed winners to have on average five more breaks per game than losers,  
248 whereas, the number amount of breaks in the men's World Cup were similar regardless  
249 of match outcome. This increased number of breaks for winning women's teams could  
250 be attributed to tackle completion rates, with losers having a lower percentage of tackle  
251 completions ( $84.9\%$ ) compared to winners ( $93.9\%$ ). This supports the notion that losing  
252 women's teams missed a larger number of tackles which resulted in more line breaks  
253 and the potential for increased scoring opportunities. However, these data do not  
254 provide evidence of the attacking and defensive strategies that may have resulted in

255 these observed differences between winners and losers. In line with previous research,  
256 similar tackle completion rates and number of breaks were seen between winners and  
257 losers in the men's game (Bishop & Barnes, 2013; Jones et al., 2004), suggesting missed  
258 tackles and any resulting breaks could not be related to success.

259 Previous research on analysis of attacking parameters of men's rugby have  
260 demonstrated winning teams make fewer carries and completed fewer rucks than losing  
261 teams (Bishop & Barnes, 2013; Van Rooyen et al., 2010;). However, the present study  
262 suggests that in the men's game both total carries and ruck frequency were similar  
263 between winners and losers. Nevertheless, in the women's World Cup, a trend was  
264 noted towards a higher number of total carries by winners (98.1 carries) compared to  
265 losers (72.9 carries;  $d = 1.32$ ). Further analysis of carry type revealed that at the  
266 women's World Cup, losers made more pick and go carries (32.9%) compared to  
267 winners (15.8%) ( $d = 1.42$ ), while winning teams completed more carries off 9  
268 ( $d = 0.86$ ), support carries ( $d = 1.0$ ) and carries following kick receipt ( $d = 1.52$ ) than  
269 losing teams. These findings suggest that successful women's teams appear more  
270 willing to attack with ball in hand following a kick receipt and adopt a more expansive  
271 game through attacking with wider carries in the midfield and outside channels.

272 Whereas, losers in the women's game had more pick and go carries, which may be  
273 reflective of a limited game plan lacking width, or as a result of the defending team  
274 effectively slowing the ball down at the breakdown resulting in an organised defence  
275 and fewer opportunities to move the ball wide.

276 The total number of kicks per match did not affect match outcome. In the men's World  
277 Cup, winners kicked away more possession in the opposition 22-50 m than losers  
278 (winners = 16.3%, losers = 7.3%), while in the women's World Cup, winning teams

279 kicked less in the opposition 22-50 m than losers (winners = 9.3%, losers = 19.2%).  
280 These findings suggest that in the opposition half, successful women's teams favoured a  
281 possession driven strategy using phase play to break down a defence, while successful  
282 men's teams opted to kick and apply pressure to the opposition with the hope of forcing  
283 a turnover, leading to an attacking field position from which points can be scored.  
284 Winners kicked away more possession in their own 22-50 m area of the pitch than  
285 losers (winners = 51.9%, losers = 42.3%), regardless of sex. This finding supports the  
286 notion that winning teams favoured a more territory based approach in this area (own  
287 22-50 m) through kicking for territory and pressuring the opposition.

288 The total number of penalties conceded by winning and losing teams was similar for  
289 men and women, this is in line with previous research (Bishop & Barnes, 2013; Jones,  
290 et al., 2004; Vaz et al., 2010). For the men's World Cup, no differences were seen in the  
291 distribution of these penalties on the pitch between winner and losers. However, in the  
292 women's competition, winning teams conceded fewer penalties in their own 22 m than  
293 losing teams (22% less). Conceding penalties in this area will increase the chance of the  
294 opposition scoring points through penalty goals or from gaining an optimum attacking  
295 field position. These findings suggest that pitch location of penalties conceded  
296 influenced match outcome with winning teams being awarded more penalties in  
297 attacking positions than losing teams. It is suggested that the ability of the winning  
298 teams to apply more pressure and force more penalties in attacking positions was  
299 indicative of success at the 2011 Rugby World Cup (Bishop & Barnes, 2013), a theory  
300 supported by differences between winners and losers at the most recent women's World  
301 Cup. However, this may also suggest better discipline by winning teams when

302 defending in their own 22 m given the increased likelihood of a scoring opportunity  
303 from a penalty.

304 Results from the present study found the percentage of lineouts won on the opposition  
305 ball to be an important performance indicator that discriminates winners and losers,  
306 regardless of sex. Winning teams stole more line outs than losing teams, this was  
307 particularly the case in males where winners stole an average of 17.4% of lineouts per  
308 game compared to 7.4% for losers. In addition, winners in the men's game were more  
309 successful at securing their own ball ( $92.6 \pm 5.7\%$ ) than losers ( $82.6 \pm 12.9\%$ ). These  
310 findings support previous research which has established success at the lineout to be a  
311 key indicator that discriminates winning and losing teams (Jones et al., 2004; Ortega et  
312 al., 2009; Vaz et al., 2010, 2011). Therefore, regardless of sex, teams should place a  
313 significant emphasis on the lineout and development of a successful attacking lineout  
314 which minimises the chances of losing the ball as well focusing on defensive lineout  
315 strategies which can increase the chances of stealing possession.

316 The current study has supplemented existing research identifying performance  
317 indicators that discriminate winning and losing teams in elite Rugby Union. It is  
318 important that the findings of the current study are interpreted cautiously as the results  
319 are only based on performances from the 2015 Rugby World Cup knockout stages and  
320 the 2014 Women's Rugby World Cup top eight playoffs, therefore they cannot be  
321 generalised to lower playing levels or different competition formats. Future work should  
322 focus on non-knockout competition formats, particularly in the women's game. This will  
323 help direct tactical approaches and methods of coaching across female Rugby Union.  
324 An important consideration when interpreting these results was the clear difference in  
325 how balanced the matches were in the two different competitions. The women's Rugby



326 World Cup games had an average point's difference of 24 points per game where as in  
327 the men's competition this was 15 points. Vaz et al. (2011) suggested a general profile  
328 of performance indicators could be created in unbalanced games (16-34 points), but  
329 found no performance indicators discriminated winning and losers teams in a sample of  
330 close international games. This supports the findings of the present study which found  
331 few performance indicators discriminated winners and losers in the elite men's game.  
332 However, the larger average points difference in the women's games could account for  
333 the wider range of performance indicators found to influence match outcome. A further  
334 limitation relates to the interpretation of the findings based on conducting numerous  
335 ANOVAs on multiple variables which inflates the likely hood of a type 1 error in the  
336 analysis.

337

338

### 339 **Conclusion**

340 In conclusion, these findings identify performance indicators discriminating winning  
341 and losing in the knockout stages of the most recent men's and women's World Cup  
342 competitions. Findings demonstrated that a small number of performance indicators  
343 were able to discriminate winning and losing teams in the knockout stages of the men's  
344 Rugby World Cup, with lineout success on opposition ball appearing crucial. Hence,  
345 teams should place an emphasis on the development of a successful attacking lineout  
346 which minimises the chances of losing the ball as well as focusing on defensive lineout  
347 strategies which can increase the chances of stealing possession. In the women's Rugby  
348 World Cup, successful teams favoured a more possession based strategy through

349 attacking with wider carries in the midfield, outside channels and following kick receipt.  
350 Results from the men's competition were found to be similar to findings of Bishop and  
351 Barnes (2013) from the 2011 world cup which found a territory based approach to be  
352 the most effective strategy for success. The findings reaffirm previous knowledge and  
353 further support the use of this tactical approach for success in the men's game at the  
354 elite level. These differences in game strategy between sexes provide a basis for tactical  
355 support to help maximise success in both the men's and women's game. Importantly,  
356 coaches should consider these strategies when designing appropriate coaching and  
357 training tools which are sex dependent

358 **Acknowledgements:** None declared

359 **Funding** None declared

360 **Competing interests** None declared

## References

- Altman, D.G. (1991). *Practical Statistics for Medical Research*. London: Chapman and Hall.
- Austin, D., Gabbett, T., & Jenkins, D. (2011). The physical demands of Super 14 Rugby Union. *Journal of Science and Medicine in Sport, 14*, 259-263.
- Bishop, L., & Barnes, A. (2013), Performance indicators that discriminate winning and losing in the knockout stages of the 2011 Rugby World Cup. *International Journal of Performance Analysis in Sport, 13*, 149-159.
- Bremner, S., Robinson, G., & Williams, M. D. (2013). A Retrospective Evaluation Of Team Performance Indicators In Rugby Union. *International Journal of Performance Analysis in Sport, 13*, 461-473.
- Cohen, J. (1969). *Statistical Power analysis for the behavioural sciences*. San Diego: Academic Press.
- Cunniffe, B., Proctor, W., Baker, J.S., & Davis, B (2009). An evaluation of the physiological demands of elite rugby union using global positioning system tracking software. *Journal of Strength and Conditioning Research, 23*, 1195-1203.
- Deutsch, M.U., Kearney, G.A., & Rehrer, N.J. (2007). Time-motion analysis of professional rugby union players during match-play. *Journal of Sports Sciences, 25*, 461-472.
- Diedrick, E., & Van Rooyen, M. (2011). Line breaks situations in international rugby. *International Journal of Performance Analysis in Sport, 11*, 522-534.

- Eaves, S., & Hughes, M. (2003). Patterns of play of international rugby union teams before and after the introduction of professional status. *International Journal of Performance Analysis in Sport*, 3, 103-111.
- Eaves, S., Hughes, M., & Lamb, K. (2005). The consequences of the introduction of professional playing status on game action variables in international northern hemisphere Rugby Union Football. *International Journal of Performance Analysis in Sport*, 5, 58-86.
- England Rugby. (2013). *This is England Women Rugby- RFU*. Retrieved from: [http://www.englandrugby.com/mm/Document/MyRugby/Players/01/30/54/41/RFU\\_Women\\_and\\_girls\\_strategy\\_Neutral.pdf](http://www.englandrugby.com/mm/Document/MyRugby/Players/01/30/54/41/RFU_Women_and_girls_strategy_Neutral.pdf) Last accessed 23<sup>rd</sup> November 2016
- Hughes, M. & Bartlett, R. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, 15, 137-149.
- Hughes, M. T., Hughes, M. D., Williams, J., James, N., Vučković, G., & Locke, D. (2012). Performance indicators in rugby union. *Journal of Human Sport and Exercise*, 7, 383-401.
- James, N., Mellalieu, S.D. & Jones, N. (2005). The development of position-specific performance indicators in professional rugby union. *Journal of Sports Sciences*, 23, 63-72.
- Jones, N., Mellalieu, S. & James, N. (2004). Team performance indicators as a function of winning and losing in rugby union. *International Journal of Performance Analysis in Sport*, 4, 61-71.
- Ortega, E., Villarejo, D. & Palao, J.M. (2009). Differences in game statistics between winning and losing rugby teams in the Six Nations tournament. *Journal of Sports Science and Medicine*, 8, 523-527.

Stanhope, J. & Hughes, M.D. (1997). An analysis of scoring in the 1991 rugby union World Cup. In M. Hughes, *Notational Analysis of Sport III* (pp 167-176).

Cardiff: University of Wales Institute Cardiff.

Smart, D., Hopkins, W.G., Kenneth, L., Quarrie, K.L., & Gill, N. (2014). The relationship between physical fitness and game behaviours in rugby union players. *European Journal of Sport Science*, 14, 8-17.

Suarez-Arrones, L., Portillo, J., Pareja-Blanco, F., Saez, E., Sanchez-Medina, L., & Munguia-Izquierdo, D (2014). Match running performance and exercise intensity in elite female rugby sevens. *Journal of Strength and Conditioning Research*, 28, 452-458.

Van Rooyen, M., & Noakes, T. (2006). An analysis of the movements, both duration and field location, of 4 teams in the 2003 rugby world cup. *International Journal of Performance Analysis in Sport*, 6, 40-56.

Van Rooyen, M., Diedrick, E., & Noakes, T. (2010). Ruck frequency as a predictor of success in the 2007 Rugby World Cup tournament. *International Journal of Performance Analysis in Sport*, 10, 33-46.

Vaz, L., Van Rooyen, M. & Sampaio, J. (2010). Rugby game-related statistics that discriminate between winning and losing teams in IRB and super twelve close games. *Journal of Sports Science and Medicine*, 9, 51-55.

Vaz, L., Mouchet, A., Carreras, D., & Morente, H. (2011). The importance of rugby game-related statistics to discriminate winners and losers at the elite level competitions in close and balanced games. *International Journal of Performance Analysis in Sport*, 11, 130-14

World Rugby (2016). *Laws of the Game 2016*. Dublin: World Rugby.

Table 1. Descriptive statistics of performance indicators between winners and losers and between sexes.

	Men				Women				Interaction <i>p</i>	Sex <i>p</i>	Outcome <i>p</i>
	Winning		Losing		Winning		Losing				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Tries	3.63	2.20	1.38	1.30	5.13	3.27	1.38	0.92	0.347	0.339	<b>0.002</b>
Possession (%)	51.1	8.3	48.9	8.3	54.4	6.3	45.6	6.3	0.392	1.000	0.157
Breaks	3.6	3.1	3.9	2.2	7.8	3.3	3.6	1.3	<b>0.018</b>	0.048	<b>0.032</b>
Tackle Completion (%)	90.8	4.5	88.8	2.6	93.8	2.6	84.9	6.0	<b>0.038</b>	0.780	<b>0.003</b>
Total Carries	100.5	15.8	98.0	32.5	98.1	16.8	72.8	21.1	0.241	<b>0.049</b>	0.157
Carries- kick return (%)	9.6	2.9	10.2	4.3	11.2	4.7	8.3	3.3	0.206	0.892	0.110
Carries- off 10 (%)	17.2	3.7	18.2	5.1	14.6	5.0	17.7	2.5	0.454	0.360	0.165
Carries- off 9 (%)	38.2	7.0	38.8	7.2	26.6	9.1	23.1	6.7	0.335	<b>0.001</b>	0.517
Carries- other (%)	21.2	6.1	18.1	4.7	22.5	8.8	12	6.2	0.131	<b>0.007</b>	0.317
Carries- pick and go (%)	7.4	4.2	9.2	4.3	15.8	7.8	32.9	8.7	<b>0.003</b>	<b>0.001</b>	<b>0.001</b>
Carries- support carry (%)	6.3	3.4	5.6	3.1	9.2	5.1	5.9	2.0	0.289	0.246	0.099
Total Rucks	77.6	19.4	78.1	26.7	77.0	17.2	68.4	17.0	0.591	0.403	0.632
Ruck opposition 22 (%)	17.6	4.9	14.3	6.1	24.3	6.8	18.8	4.7	0.485	<b>0.033</b>	<b>0.012</b>
Ruck opposition 22-50 (%)	51.1	12.1	43.8	8.5	34.1	8.5	48.3	7.4	<b>0.030</b>	0.233	0.736
Ruck own 22 (%)	8.3	6.6	12.8	6.7	4.0	3.7	4.8	2.7	0.172	<b>0.019</b>	0.1052
Ruck own 22-50 (%)	18.9	8.7	26.4	6.4	28.7	9.8	23.3	6.6	<b>0.015</b>	0.307	0.686
Total Kicks	24.9	7.9	22.3	6.5	14.8	3.1	12.8	5.9	0.829	<b>0.003</b>	0.126
Kick in opposition 22 (%)	1.3	1.9	0.8	2.4	2.2	4.2	0.0	0.0	0.385	0.980	0.178
Kick in opposition 22-50 (%)	16.3	8.2	7.3	7.8	9.3	8.6	19.2	7.7	<b>0.012</b>	0.316	0.894
Kick in own 22 (%)	36.9	10.6	51.3	10.2	37.1	9.3	38.6	13.3	0.141	0.105	0.073
Kick in own 22-50 (%)	45.5	8.9	40.6	6.4	51.5	12.0	42.3	10.4	0.377	0.379	<b>0.010</b>
Total Penalties conceded	10.0	3.4	9.1	3.8	8.0	2.9	9.3	3.1	0.418	0.386	0.885
Penalty Success (%)	79.4	20.9	86.5	19.9	83.3	25.8	70.0	27.4	0.322	0.461	0.864
Pen opposition 22 (%)	14.6	7.3	11.8	11.7	19.3	14.1	13.7	13.2	0.743	0.438	0.336
Pen opposition 22-50 (%)	28.2	16.0	26.9	12.7	17.3	17.4	17.7	13.2	0.852	0.123	0.926
Pen own 22 (%)	23.3	13.7	18.5	15.1	18.7	15.5	41.2	16.7	<b>0.018</b>	0.133	0.105
Pen own 22-50 (%)	33.9	12.6	42.8	19.9	44.7	28.9	27.4	15.4	0.088	0.746	0.565
Lineout Success opposition ball (%)	17.4	12.7	7.4	5.0	19.3	10.9	15.2	10.8	0.358	0.222	<b>0.042</b>
Lineout Success own ball (%)	92.6	5.7	82.6	12.9	84.8	11.9	80.7	10.9	0.358	0.222	0.042
Scrum Success opposition ball (%)	6.8	9.6	6.7	12.9	7.6	12.6	3.3	6.4	0.496	0.908	0.524
Scrum Success own ball (%)	93.3	12.9	93.2	9.9	96.7	6.1	92.4	11.3	0.629	0.690	0.612

