



26       **Whole, half and peak running demands during club and international youth rugby**  
27   **league match-play**

28

29       **Abstract**

30       This study quantified, and compared, the whole- half- and peak-match running demands of  
31       professional club and international under-16 rugby league match-play. Four professional  
32       Club ( $n = 30$ ) and two International ( $n = 23$ ) under-16 matches were analysed using 10-Hz  
33       micro-technology units, with players analysed according to positional groups. Absolute (m)  
34       and relative (RD;  $\text{m}\cdot\text{min}^{-1}$ ) total, high speed ( $>5 \text{ m}\cdot\text{s}^{-1}$ ; HSR) and sprint ( $>7 \text{ m}\cdot\text{s}^{-1}$ ) distance  
35       were analysed for whole- and half-match alongside maximum velocity ( $V_{\text{MAX}}$ ;  $\text{m}\cdot\text{s}^{-1}$ ). Peak  
36       running demands were determined via moving averages of RD for 10, 30, and 60- to 600-  
37       seconds. International forwards had *most likely* higher whole match relative sprint and  $V_{\text{MAX}}$ ,  
38       and 1<sup>st</sup> half RD than club level, and had *very likely* higher peak running demands at 60-, 180-  
39       and 600-second durations. For backs, whole game RD was *most likely* higher and total and  
40       sprint distance was *likely* higher at club level matches. Peak RD was also *very likely* higher  
41       for club backs at 10- and 60-seconds. The running demand differences between club and  
42       international level at the under-16 age group are position dependent, with greater running  
43       demands at club level match play for backs, but at the international level of forwards.

44 **Whole, half and peak running demands during club and international youth rugby**  
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46

47 **Introduction**

48 Rugby league is an intermittent contact sport, involving frequent bouts of high intensity  
49 activity (e.g., high speed running and tackling), interspersed with periods of low intensity  
50 activity (e.g., walking and repositioning) (Cummins and Orr 2015; Gabbett 2015; McLellan  
51 and Lovell 2013). The sport is played both domestically and internationally, at amateur,  
52 semi-professional, and professional standards across junior and senior levels (Johnston,  
53 Gabbett and Jenkins 2014), with the two major competitions being the Australasian National  
54 Rugby League (NRL) and the European Super League (ESL). Knowledge of the locomotive  
55 (e.g., walking, running, sprinting) demands of rugby league match play at these different  
56 levels is required for practitioners to optimally prepare players for their current standard (i.e.,  
57 age and level) and for playing level progressions (i.e., older age groups, and higher  
58 standards). To date, extensive research exists evaluating the running demands of rugby  
59 league match play using global positioning systems (GPS) across senior levels (Austin and  
60 Kelly 2013; Delaney et al. 2015; Gabbett 2013; Hulin et al. 2015; McLellan et al. 2011;  
61 Waldron et al. 2011), but is limited within youth elite levels (Waldron et al. 2014).

62

63 In the United Kingdom (UK), the first opportunity young players have to train and play  
64 within an elite (i.e., professional) team is when they are recruited by a professional rugby  
65 league club from the amateur game at the under 16 (U16) age category (Till et al. 2015).  
66 Players identified as having the potential to play professionally progress to senior (U19)  
67 academy squads; where the primary aim is to develop players for Super League (Till et al.  
68 2017). The physical qualities of players at different age groups and playing level are well

69 established (Ireton et al. 2017; Till et al. 2011; Till et al. 2014), yet within the youth age  
70 group (i.e., U16), the match demands have received little attention to date. Waldron et al.  
71 (2014) previously investigated the differences in locomotive demands between playing  
72 standards (i.e., players who progressed to the next age group *vs.* those who were released)  
73 within a ESL club team, showing the higher standard players covered a greater total ( $5181 \pm$   
74  $1064$  *vs.*  $3943 \pm 1109$  m) and high-intensity ( $>75\%$  individualized maximal aerobic velocity)  
75 running distance ( $1809 \pm 369$  *vs.*  $1281 \pm 368$  m) during a match, compared to lower standard  
76 players.

77

78 While the most commonly reported locomotive variable is ‘total distance’ covered (Hausler  
79 et al. 2015), the usefulness of this information may be limited, given the numerous ways  
80 (e.g., walking, jogging, sprinting) in which total distance can be accumulated. Expressing  
81 total distance relative to time provides ‘relative distance’ (the distance travelled per minute;  
82  $\text{m} \cdot \text{min}^{-1}$ ), which is considered a reflection of match ‘intensity’ (Cummins et al. 2013).  
83 However, when considering how total distance is calculated (average velocity x duration),  
84 then relative distance is calculated by dividing the total distance covered by total playing  
85 time, it is likely important intense periods of activity are missed (e.g., line breaks). Therefore,  
86 the identification of ‘peak’ running demands is required (Hulin et al. 2015; Furlan et al.  
87 2015). Current research on differences in locomotive match demands between playing  
88 standard focuses on whole- and half-game values (Gabbett 2013; McLellan and Lovel 2013),  
89 thus comparing the peak demands is a novel approach, and may be more sensitive at  
90 identifying differences in match demands between playing standards across sports.

91

92 The peak running demands can be calculated through a moving averages approach (Varley et  
93 al. 2012) for pre-determined duration specific periods. This approach takes a moving average,

94 of a specified duration, of the instantaneous speed ( $\text{m}\cdot\text{s}^{-1}$ ) which is sampled at a given rate  
95 (i.e., 10Hz GPS, 10 instantaneous velocity samples per second). For example, to identify the  
96 peak relative distance for a 5-minute period, a moving average of 3000 data points (300-  
97 seconds with 10 samples per second) would be calculated from the start to the end of a  
98 match. The highest relative distance identified would be deemed the ‘peak’ 5-minute running  
99 demands. This analysis will likely provide more useful information for the practitioners, as  
100 these periods are typically what players should be physically prepared for. Using this method  
101 of analysis, the peak demands of NRL match play have been identified (Delaney et al. 2015;  
102 Delaney et al. 2016). Peak 1-minute periods range from  $\sim 163$  to  $179 \text{ m}\cdot\text{min}^{-1}$ , and peak 10-  
103 minute periods range from  $\sim 98$  to  $109 \text{ m}\cdot\text{min}^{-1}$ , dependent upon position (Delaney et al.  
104 2016), which are greater than previously reported whole-match demands ( $\sim 82$  to  $105 \text{ m}\cdot\text{min}^{-1}$ ) (Austin and Kelly 2014; Gabbett 2013; Kempton et al. 2015; Twist et al. 2014). Current  
105 research has focused on peak demands from 1- to 10-minutes in duration (Delaney et al.  
106 2015; Delaney et al.2016); however, considering changes in the physiological (Buchheit and  
107 Laursen, 2013) and technical-tactical demands as the duration increases, the quantification of  
108 both shorter- (i.e., 10- and 30-seconds), and longer- (i.e., 10-minutes) peak running demands  
109 are required.  
110

111

112 The quantification of running demands is required to provide practitioners with data, which  
113 can be useful in practice (Jones et al. 2017). Practitioners are then in a position to use these  
114 data to prescribe specific running drills and monitor the intensity of coach led rugby drills.  
115 Therefore, the aim of this study was to quantify and compare the whole- half- and peak-  
116 running demands of club and international under-16 rugby league match-play.

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118

## 119 **Methods**

### 120 *Experimental approach*

121 A prospective observational study design was used to establish the locomotive demands of  
122 club and international rugby league match play. GPS data were collected during match play  
123 of a professional club's Scholarship team competing in the Super League under16s  
124 competition, and a representative International Youth (U16s) team (i.e., players recruited  
125 from the Super League under16s competition) during the 2017 season. Whole-, half- and  
126 peak-running demands were quantified for positional groups at each playing level. The  
127 differences between playing levels for positional groups were compared.

128

### 129 *Subjects*

130 Forty-eight male rugby league players participated in the study. Thirty players participated in  
131 professional club Scholarship matches (Club; mean  $\pm$  standard deviation [SD] age  $15.5 \pm 0.7$   
132 years, stature  $178.0 \pm 5.9$  cm, body mass  $81.9 \pm 12.8$  kg) and twenty-three participated in  
133 England International (International; mean  $\pm$  SD age  $15.8 \pm 0.5$  years, stature  $178.0 \pm 5.9$  cm,  
134 body mass  $81.1 \pm 5.0$  kg) matches. Five players were included in both groups, which was  
135 dealt with by the analysis technique used. The study was approved by the university ethics  
136 committee. Prior to the commencement of the study, all participants were informed on the  
137 purpose, benefits and requirements of the study, and written consent was obtained from  
138 players and a parent or guardian.

139

140 The number of observations for each player ranged from 1 to 4 ( $2.3 \pm 1.1$ ) and 1 to 2 ( $1.5 \pm$   
141  $0.5$ ), during Club and International matches, respectively. Based on positional differences  
142 observed at the senior level, players were classified into the two commonly used positional  
143 groups: forwards (Club,  $n = 16$ ; International,  $n = 13$ ) and backs (Club,  $n = 14$ ; International,

144  $n = 10$ ) (Austin and Kelly 2013; McLellan et al. 2011; McLellan and Lovell 2013). Each  
145 match was 70-minutes in duration, with 35-minute halves. The mean  $\pm$  SD playing time was  
146  $54 \pm 19$  and  $58 \pm 18$  minutes during Club and International matches, respectively. Players  
147 were excluded from analysis if their match time was less than 10 minutes per half, due to the  
148 analysis of moving averages being up to 10-minutes. The Club won three and drew one  
149 match with a mean score difference of  $31 \pm 25$  points, and the International side won two out  
150 of two matches with a score difference of  $21 \pm 15$  points.

151

## 152 ***Methodology***

153 The match demands were evaluated using micro-technology units (Optimeye S5, Catapult  
154 Innovations, Melbourne, Victoria) with a GPS receiver sampling at 10-Hz (firmware version  
155 5.27). The use of 10Hz GPS units to quantify distance and speed measurements has been  
156 determined as valid and reliable (Scott et al. 2016). Players were familiarised with wearing  
157 the units prior to study commencement. The GPS units were worn in tight fitted garments and  
158 positioned in the centre of their back between their scapulae. Players wore the same units for  
159 repeated observations and the devices were switched on 30 minutes prior to match play to  
160 ensure adequate satellite connection and data quality (Malone et al. 2017). The number of  
161 satellites and HDOP during match play was  $15.1 \pm 2.2$  (range: 11 - 19) and  $0.8 \pm 0.2$  (range:  
162 0.5 - 1.2) respectively for the Club and  $14.7 \pm 1.8$  (range: 12 - 17) and  $0.8 \pm 0.2$  (range: 0.6 -  
163 1.2) for the International fixtures.

164

## 165 ***Data analysis***

166 The start and end time for each half was recorded and used to truncate the GPS file.  
167 Following each match, data were extracted and analysed using propriety software Openfield  
168 (v1.14, Catapult Innovatons, Melbourne, Victoria). Speed was calculated via the Doppler shift

169 method. The minimum effort duration was set at one second (Varley et al. 2012). Locomotor  
170 variables analysed for whole-, and half-match, demands were: relative distance covered  
171 ( $\text{m}\cdot\text{min}^{-1}$ ), total distance covered (m), which was further differentiated into the distance  
172 covered at high speed running (HSR, m) ( $> 5 \text{ m}\cdot\text{s}^{-1}$ ) and sprinting (m) ( $> 7 \text{ m}\cdot\text{s}^{-1}$ ), relative  
173 distance covered at HSR (rHSR,  $\text{m}\cdot\text{min}^{-1}$ ) and sprinting ( $\text{m}\cdot\text{min}^{-1}$ ), and maximum velocity  
174 ( $V_{\text{MAX}}$ ,  $\text{m}\cdot\text{s}^{-1}$ ).

175

176 To establish peak running demands a file of each sampled instantaneous speed value (i.e., 10-  
177 Hz GPS, 10 speed samples per second) were exported. This was then analysed using  
178 customized software (R, v R-3.1.3) to compute the moving averages for the distance covered  
179 per unit of time (relative distance;  $\text{m}\cdot\text{min}^{-1}$ ) for duration specific periods (Varley et al. 2012).  
180 Peak demand durations of 10- and 30-seconds, and 60- to 600-seconds were calculated. For  
181 example, for the 10-second duration, a moving average was calculated every 100 data points  
182 (10 samples per second, for 10-seconds), e.g., 0 – 100, 1 – 101, 2 – 102, for the duration of  
183 the file. The peak running demands were determined as the highest value for each duration  
184 during the total game time for an individual player, then averaged for positional groups.

185

### 186 *Statistical Analyses*

187 Prior to analyses, data were log-transformed to reduce bias and non-uniform error (Hopkins  
188 et al. 2009). Total and relative sprint distance were analysed as raw data due to the inclusion  
189 of zeros, thus cannot be log-transformed. Descriptive data are presented as mean  $\pm$  SD.

190 Linear mixed-effects models were carried out in SAS Studio Software (4.2, SAS Institute  
191 Inc., Cary, NC, USA) to assess differences in the whole and half game locomotor variables,  
192 and duration specific peak periods, between Club and International matches. Individual  
193 athletes were specified as random effects to account for error associated with repeated



194 measurements, allowing different within-subject SD (Delaney et al. 2016). To account for the  
195 variability between matches (Kempton et al. 2013), match identification was also included as  
196 a random effect. Level of play, positional group and the interaction of level and positional  
197 group, were included as fixed effects to describe their relationships with the dependent  
198 variable. Pairwise comparisons between levels of play and positions were assessed using the  
199 Least Squares mean test. Differences of Least Squares means were back-transformed to  
200 percentage differences, with 90% confidence intervals (CI). Standardized effect sizes (ES)  
201 were quantified (reported as ES with 90% CI), and the magnitude-based inference network  
202 was used to determine the practical importance of the derived percentage difference (Hopkins  
203 2007). The smallest worthwhile difference (SWD) was calculated as 0.2 x the between-  
204 subject SD and assessed qualitatively as follows: <0.5%, *most unlikely*; 0.5 – 5%, *very*  
205 *unlikely*; 5 – 25%, *unlikely*; 25-75%, *possibly*; 75-95% *likely*, 95- 99.5%, *very likely* and  
206 >99.5%, *most likely* (Hopkins 2007). If the 90% CI over-lapped positive and negative values  
207 of the SWD the magnitude was deemed *unclear*.

208

## 209 **Results**

### 210 *Whole- and Half- match demands*

211 The differences in whole- and half- Club and International match running demands for all  
212 variables are displayed in Table 1 for backs and Table 2 for forwards.

213

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

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

216

### 217 *Peak match demands*

218 Figure 1 presents the peak relative distance for forwards and backs, for 10- and 30-second  
219 periods, with the percentage differences between levels and the inference of the differences.  
220 During a Club match, backs have *very likely* higher relative distance than during an  
221 International match for the 10-second duration (International:  $350.3 \pm 8.3$  vs. Club:  $392.7$   
222  $\pm 16.5$  m·min<sup>-1</sup>; ES: -0.74 [-1.2 to -0.2]). The difference for forwards at 10-seconds was  
223 *unclear* (International:  $315.7 \pm 17.4$  vs. Club:  $326.1 \pm 15.2$  m·min<sup>-1</sup>, ES: 0.2 [-0.3 to 6.2]).  
224 For 30-seconds, during the International match, forwards *likely* covered greater relative  
225 distance than during a Club match (International:  $205.0 \pm 10.6$  vs. Club:  $194.1 \pm 11.9$  m·min<sup>-1</sup>;  
226 ES: 0.6 [0.1 to 1.1]). The difference between levels for backs at this duration was *unclear*  
227 (International:  $210.3 \pm 6.3$  vs. Club:  $220.8 \pm 11.7$  m·min<sup>-1</sup>; ES: 0.5 [-0.2 to 1.1]).

228

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

230

231 Figures 2 and 3 present the peak relative distance for backs and forwards, for duration  
232 specific periods of 60- to 600-seconds, with percentage differences and inferences. For backs,  
233 the differences between levels were *unclear* at all durations, except 60-seconds where  
234 International was *very likely* lower (International:  $157.5 \pm 5.6$  vs. Club:  $168.0 \pm 5.8$  m·min<sup>-1</sup>,  
235 ES: -0.7 [-1.0 to -0.3]). The average peak 600-second period during International and Club  
236 matches for backs were  $101.3 \pm 9.5$  and  $102.5 \pm 7.2$  m·min<sup>-1</sup> respectively. Forwards had *very*  
237 *likely* higher peak relative distance at 60-seconds during International compared to Club  
238 matches ( $163.2 \pm 10.1$  vs.  $158.5 \pm 10.5$  m·min<sup>-1</sup>, ES: 0.8 [0.4 to 1.2]). The average peak 600-  
239 second duration was also *very likely* higher during the International matches compared to  
240 Club matches for forwards ( $103.7 \pm 8.8$  vs.  $99.3 \pm 7.6$  m·min<sup>-1</sup>; ES: 0.8 [0.2 to 1.3]).

241

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

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

244

245 **Discussion**

246 This study aimed to quantify and compare the the whole- half- and peak-match running  
247 demands of Club and International under-16 rugby league match-play. It is the first study to  
248 evaluate the peak running demands within youth elite rugby league, and to compare the  
249 demands between playing standards. Findings revealed similar peak running demands to  
250 those previously reported in professional senior NRL match play (Delaney et al. 2015;  
251 Delaney et al. 2016). Contrasting findings between positional groups were found for the  
252 comparison between playing standard, with running demands for backs being greater during  
253 professional club level matches, but greater for forwards during international level matches.

254

255 The differences between the International and Club standard at the youth level show  
256 meaningful differences between the two levels, dependent upon position. For backs, there  
257 was a difference in whole-game relative distance, and total and relative sprint distance  
258 covered between levels, with the largest percentage difference being in the second half for all  
259 three parameters, perhaps due to changes in technical-tactical focus in the second half of  
260 match-play (**Table 1**). In contrast, for forwards the whole game relative sprint distance was  
261 greater during the International compared to Club matches (**Table 2**). Such findings suggest  
262 that the whole- and half-match running demands are harder at the international level for  
263 forwards but club level for backs, highlighting the position-specific nature of rugby league.  
264 However, the differences could also be attributed to differences in the technical-tactical  
265 demands and playing style of international vs. club level matches, which may have a large  
266 impact on due to the small sample size.

267

268 The contrasting findings for the whole- and half-match demands between positional groups  
269 are also present in the peak running demands. For backs, most of the differences between  
270 International and Club matches were *unclear*, except 10- and 60-second durations where  
271 relative distance is 10.1 and 3.9% lower respectively, during International compared to a  
272 Club matches (**Figures 1 and 2**). During International matches, forwards have greater peak  
273 relative distances at several duration specific periods (30-, 60-, 120-, 180-, 300- and 600-  
274 seconds) compared to club matches, with the greatest differences at the 60- and 600-second  
275 periods (**Figures 1 and 3**). The differences in the running demands between levels observed  
276 could be attributed to the closer games (i.e., lower score difference) during International  
277 compared to Club matches. For the backs, the closer score-line could lead to more defensive  
278 involvements, and consequently more collisions and less running (Roe et al. 2017), as well as  
279 fewer chances for line breaks. The higher running demands observed for forwards during  
280 international matches are consistent with other studies in which the higher standard of  
281 competition encounters higher running demands (Johnston et al. 2015; McLellan and Lovell  
282 2013). In the higher standard of competition with the tighter score lines, the teams could be  
283 competing more for field position and spend more time defending. The role forwards play in  
284 making attacking meters and preventing meters gained by the opposition in defense, means  
285 they are likely to be involved in the game more and perhaps have higher running demands,  
286 especially during defensive play (Gabbett et al. 2014; Sykes et al. 2009).

287

288 In addition to progressing players through the playing pathway (e.g., amateur to international)  
289 at the youth level, the progression of players to senior competition is of equal importance.  
290 Therefore, a comparison of the peak running demands of match-play between youth and  
291 senior levels is of interest. Both the forwards and backs during Club and International  
292 matches in the current study covered less total distance than their respective positional group

293 reported in the NRL (Austin and Kelly 2013; Gabbett 2013; Kempton et al. 2015; Twist et al.  
294 2014) and ESL (Twist et al. 2014; Waldron et al. 2011); likely due to the longer game time in  
295 senior NRL and ESL vs. youth level (80-minute vs. 70-minute). When comparing relative  
296 distance, the average match intensities found in this study are within the ranges reported from  
297 NRL (~82 to 102 m·min<sup>-1</sup>) (Austin and Kelly 2014; Gabbett 2013) and ESL match play (~94  
298 to 104 m·min<sup>-1</sup>) (Twist et al. 2014; Waldron et al. 2011). The peak running demands are  
299 comparable to those reported for NRL matches (Delaney et al. 2015; Delaney et al. 2016).  
300 For both playing levels, and positional groups, the duration-specific peak running demands  
301 are within ranges reported for respective positions in the NRL studies. For example, NRL  
302 ‘forwards’ peak relative distances for 10- minutes were ~90 to 108 m·min<sup>-1</sup> (Delaney et al.  
303 2015; Delaney et al. 2016), compared to  $103.7 \pm 8.8$  and  $99.3 \pm 7.6$  m·min<sup>-1</sup> during  
304 International and Club U16 matches in the current study. Similarly, for ‘backs’ the peak 10-  
305 minutes of  $101.3 \pm 9.5$  and  $102.5 \pm 7.2$  m·min<sup>-1</sup> during International and Club matches are  
306 within the range of ~93 to 109 m·min<sup>-1</sup> reported in the NRL (Delaney et al. 2015; Delaney et  
307 al. 2016). Thus, suggesting that the peak running demands are similar to that of NRL match  
308 play.

309

310 It is however important to acknowledge that this study only quantified the running demands,  
311 which does not represent all the physical demands of match play. For example, it is unlikely  
312 that U16 players could cope with the physical demands (i.e., contact) of senior NRL or ESL  
313 match play, despite the similarity in running demands. Furthermore, the junior players are  
314 likely to have a lower body mass than senior players (Ireton et al. 2017) thus it is unlikely  
315 that junior players would be able to maintain that running intensity whilst competing against  
316 bigger and stronger players (Darrall-Jones et al. 2016; Scott et al. 2017).

317

318 The findings demonstrate the running demands are greater during Club and International  
319 matches for backs and forwards respectively. However, considering the contact nature of  
320 rugby league, these findings are not representative of the overall match-demands. Further  
321 research is needed including the collisions encountered during the peak running demands.  
322 Additionally, to provide context to the different findings, and determine technical, tactical  
323 and skill differences video analysis and game statistics (e.g., completed sets, missed tackles)  
324 are necessary. A limitation presented by the current study is the small sample size for  
325 matches, particularly at the International level. This was limited by the structure of the season  
326 and that there were only two games for the International youth squad throughout the season.  
327 The small sample size likely leads to the large confidence intervals observed, thus leading to  
328 many *unclear* findings. However, considering minimal matches are played at that level of  
329 competition, this study does provide a reference of the demands during different levels of  
330 match play, which until now was unknown.

331

332 In conclusion, based on the limited sample available, the difference in whole-, half- and peak-  
333 match running demands between Club and International match-play is position dependent;  
334 for backs they are greater during Club matches, whereas for forwards they are greater during  
335 International matches. These findings should be considered when preparing players for  
336 progression through the playing pathway. This study also provides duration specific peak  
337 running intensities, which can be used to aid in preparing players for intensified periods of  
338 match play.

339

#### 340 **Practical applications**

341 The differences between levels of play highlighted provide coaches and practitioners with  
342 indicators of how the running demands change when progressing players to higher levels. For

343 example, forwards competing at the lower levels require an exposure to a higher intensity of  
344 locomotor activity during training to prepare for the increased demands at International level.  
345 When coaches are selecting or preparing players for International match-play, in addition to  
346 the physical fitness of players, other factors (technical, tactical, decision making) should be  
347 considered, given the observed higher running demands at the lower level. The short-duration  
348 (i.e., 10- and 30-seconds) peak running demands provide duration specific running intensities  
349 for running conditioning drills with repeated exposure, and the longer durations (i.e., 10  
350 minutes) can be used to monitor the intensity of coach led rugby drills to replicate match-  
351 intensity whilst focusing on technical-tactical ability.

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513 Figure 1. Peak relative distance ( $\text{m}\cdot\text{min}^{-1}$ ) of temporal durations of 10- and 30- seconds  
514 during International and Professional Club match play for A) backs and B) forwards.  
515 Differences presented as percentages, standardized effect with 90% confidence limits and  
516 magnitude based inferences.

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518 Figure 2. Peak relative distance ( $\text{m}\cdot\text{min}^{-1}$ ) of temporal durations from 60 to 600 seconds for  
519 backs during International and Professional Club match play. Differences presented as  
520 percentages, standardized effect with 90% confidence limits and magnitude based inferences.

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522 Figure 3. Peak relative distance ( $\text{m}\cdot\text{min}^{-1}$ ) of temporal durations from 60 to 600 seconds for  
523 forwards during International and Professional Club match play. Differences presented as  
524 percentages, standardized effect with 90% confidence limits and magnitude based inferences.

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Table 1. Mean ( $\pm$  standard deviation) differences in running based parameters for U16 rugby league backs during club and international matches.

		<b>Club</b>	<b>International</b>	<b>% Differences</b>	<b>Standardized effect</b>	<b>Inference</b>
Relative distance ( $\text{m}\cdot\text{min}^{-1}$ )	1st half	89.9 $\pm$ 8.7	89.2 $\pm$ 9.0	-1.6 (-6.6 to 3.6)	-0.3 (-1.1 to 0.49)	<i>Unclear</i>
	2nd half	90.3 $\pm$ 8.9	77.8 $\pm$ 10.3	-14.4 (-19.4 to -9.1)	-2.2 (-3.1 to -1.3)	<i>Most likely</i> ↓
	Full game	89.9 $\pm$ 7.3	83.4 $\pm$ 9.3	-7.5 (-11.9 to -2.8)	-1.5 (-2.3 to 0.72)	<i>Most likely</i> ↓
Total distance covered (m)	1st half	3235.4 $\pm$ 366.7	3264.9 $\pm$ 263.5	1.3 (-18.9 to 26.8)	0.0 (-0.0 to 0.1)	<i>Most likely</i> ↔
	2nd half	3144.4 $\pm$ 454.3	3058.8 $\pm$ 451.0	-0.3 (-21.0 to 25.9)	-0.0 (-0.6 to 0.6)	<i>Unclear</i>
	Full game	5706.7 $\pm$ 1566.9	6321.7 $\pm$ 635.2	16.5 (-7.9 to 47.3)	0.4 (-0.1 to 1.0)	<i>Likely</i> ↑
High speed running distance (m)	1st half	203.6 $\pm$ 80.5	207.4 $\pm$ 54.9	10.5 (-23.1 to 58.7)	0.2 (-0.3 to 0.6)	<i>Unclear</i>
	2nd half	206.3 $\pm$ 65.6	190.9 $\pm$ 64.5	-1.1 (-32.8 to 45.4)	-0.0 (-0.6 to 0.5)	<i>Unclear</i>
	Full game	367.3 $\pm$ 155.2	398.3 $\pm$ 83.7	23.4 (-13.0 to 74.8)	0.4 (-0.2 to 1.0)	<i>Possibly</i> ↑
Relative high speed running distance ( $\text{m}\cdot\text{min}^{-1}$ )	1st half	5.7 $\pm$ 2.2	5.7 $\pm$ 1.5	7.4 (-21.9 to 47.6)	0.1 (-0.4 to 0.6)	<i>Unclear</i>
	2nd half	5.9 $\pm$ 1.6	4.9 $\pm$ 1.6	-16.0 (-36.7 to 11.3)	0.4 (-0.1 to 1.0)	<i>Possibly</i> ↑
	Full game	5.7 $\pm$ 1.6	5.3 $\pm$ 1.1	-1.8 (-23.0 to 25.3)	-0.0 (-0.5 to 0.4)	<i>Unclear</i>
Maximum velocity ( $\text{m}\cdot\text{s}^{-1}$ )	1st half	7.7 $\pm$ 0.8	8.2 $\pm$ 0.8	6.8 (-0.4 to 14.4)	0.7 (0.1 to 1.3)	<i>Likely</i> ↑
	2nd half	8.1 $\pm$ 0.8	7.6 $\pm$ 0.7	-6.0 (-12.3 to 0.8)	-0.7 (-1.4 to -0.0)	<i>Likely</i> ↓
	Full game	8.1 $\pm$ 0.8	8.2 $\pm$ 0.8	0.3 (-5.6 to 6.6)	0.6 (0.1 to 1.1)	<i>Likely</i> ↑
Sprint distance (m)	1st half	47.7 $\pm$ 49.2	43.7 $\pm$ 31.9	-5.2 (-28.1 to 17.7)	-0.2 (-0.7 to 0.4)	<i>Unclear</i>
	2nd half	66.5 $\pm$ 46.8	18.9 $\pm$ 24.7	-46.0 (-69.5 to -22.6)	-1.3 (-1.9 to -0.8)	<i>Most likely</i> ↓
	Full game	102.3 $\pm$ 86.8	62.5 $\pm$ 51.0	-38.7 (-77.6 to 0.1)	-0.6 (-1.0 to -0.1)	<i>Likely</i> ↓
Relative sprint distance ( $\text{m}\cdot\text{min}^{-1}$ )	1st half	1.3 $\pm$ 1.4	1.2 $\pm$ 0.9	-0.2 (-1.0 to 0.5)	-0.2 (-0.9 to 0.4)	<i>Unclear</i>
	2nd half	1.9 $\pm$ 1.34	0.5 $\pm$ 0.6	-1.4 (-2.1 to -0.7)	-1.4 (-2.0 to -0.8)	<i>Most likely</i> ↓
	Full game	1.5 $\pm$ 1.2	0.8 $\pm$ 0.7	-0.6 (-1.2 to -0.1)	0.0 (-0.6 to 0.7)	<i>Unclear</i>

Differences presented as percentages, standardized effect with 90% confidence limits and magnitude based inferences.

Table 2. Mean ( $\pm$  standard deviation) differences in running based parameters for U16 rugby league forwards during club and international matches.

		<b>Club</b>	<b>International</b>	<b>% Differences</b>	<b>Standardized effect</b>	<b>Inference</b>
Relative distance ( $\text{m}\cdot\text{min}^{-1}$ )	1st half	85.6 $\pm$ 10.4	96.2 $\pm$ 8.0	6.6 (1.5 to 11.9)	1.2 (0.4 to 1.9)	<i>Very likely</i> $\uparrow$
	2nd half	89.5 $\pm$ 9.8	86.7 $\pm$ 8.9	-3.4 (-8.5 to 2.0)	0.5 (-0.2 to 1.1)	<i>Likely</i> $\uparrow$
	Full game	88.7 $\pm$ 8.8	91.1 $\pm$ 7.9	0.8 (-3.5 to 5.2)	0.2 (-0.6 to 0.9)	<i>Unclear</i>
Total distance covered (m)	1st half	2403.6 $\pm$ 858.1	2535.1 $\pm$ 967.5	4.5 (-15.4 to 29.0)	0.1 (-0.1 to 0.4)	<i>Possibly</i> $\leftrightarrow$
	2nd half	2288.4 $\pm$ 866.6	2121.0 $\pm$ 850.8	-12.4 (-28.9 to 8.0)	0.4 (-0.1 to 1.0)	<i>Likely</i> $\uparrow$
	Full game	4063.4 $\pm$ 1380.8	4167.9 $\pm$ 1651.7	-0.8 (-19.2 to 21.8)	-0.0 (-0.52 to 0.47)	<i>Unclear</i>
High speed running distance (m)	1st half	122.7 $\pm$ 72.4	138.1 $\pm$ 68.6	18.1 (-16.5 to 67.0)	0.3 (-1.1 to 1.2)	<i>Unclear</i>
	2nd half	128.5 $\pm$ 60.0	103.9 $\pm$ 68.3	-37.3 (-55.6 to -11.4)	-0.3 (-0.49 to -0.12)	<i>Likely</i> $\downarrow$
	Full game	217.9 $\pm$ 102.7	217.8 $\pm$ 122.3	-11.3 (-34.9 to 20.9)	-0.2 (-0.7 to 0.3)	<i>Unclear</i>
Relative high speed running distance ( $\text{m}\cdot\text{min}^{-1}$ )	1st half	4.6 $\pm$ 2.3	5.3 $\pm$ 1.9	26.8 (-6.8 to 72.4)	0.4 (-0.0 to 0.86)	<i>Likely</i> $\uparrow$
	2nd half	5.2 $\pm$ 1.9	4.0 $\pm$ 1.8	-27.0(-43.5 to -5.8)	0.7 (0.2 to 1.2)	<i>Very likely</i> $\downarrow$
	Full game	5.0 $\pm$ 1.7	4.6 $\pm$ 1.4	-10.2 (-27.8 to 11.6)	0.3 (-0.2 to 0.9)	<i>Unclear</i>
Maximum velocity ( $\text{m}\cdot\text{s}^{-1}$ )	1st half	7.1 $\pm$ 0.8	7.6 $\pm$ 0.7	7.6 (0.7 to 14.9)	0.8 (0.2 to 1.4)	<i>Likely</i> $\uparrow$
	2nd half	7.1 $\pm$ 0.7	7.4 $\pm$ 0.8	1.1 (-5.0 to 7.6)	0.1 (-0.5 to 0.8)	<i>Unclear</i>
	Full game	7.4 $\pm$ 0.7	7.9 $\pm$ 0.5	7.1 (1.6 to 13.0)	0.9 (0.3 to 1.5)	<i>Very likely</i> $\uparrow$
Sprint distance (m)	1st half	7.6 $\pm$ 13.1	25.6 $\pm$ 23.8	16.0 (-6.0 to 38.0)	0.5 (-0.0 to 1.0)	<i>Likely</i> $\uparrow$
	2nd half	13.3 $\pm$ 27.8	21.4 $\pm$ 23.2	6.0 (-15.1 to 27.0)	0.2 (-0.3 to 0.7)	<i>Unclear</i>
	Full game	18.8 $\pm$ 31.4	44.4 $\pm$ 34.1	23.3 (-11.0 to 57.5)	0.4 (-0.1 to 0.8)	<i>Possibly</i> $\uparrow$
Relative sprint distance ( $\text{m}\cdot\text{min}^{-1}$ )	1st half	0.4 $\pm$ 1.0	0.8 $\pm$ 0.7	0.4 (-0.31 to 1.12)	0.5 (-0.2 to 1.2)	<i>Unclear</i>
	2nd half	0.6 $\pm$ 1.0	0.8 $\pm$ 0.8	0.2 (-0.42 to 0.88)	0.2 (-0.3 to 0.8)	<i>Unclear</i>
	Full game	0.4 $\pm$ 0.6	1.0 $\pm$ 0.6	0.6 (0.09 to 1.07)	0.8 (0.5 to 1.1)	<i>Most likely</i> $\uparrow$

Differences presented as percentages, standardized effect with 90% confidence limits and magnitude based inferences.