1 **The physical demands of Super League rugby: Experiences of a newly promoted franchise**

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3

4 **Abstract**

5

6 The physical match demands for a newly promoted European Super League (ESL) squad

7 were analysed over a full season using global positioning systems. Players were classified

8 into four positional groups; outside backs (OB), pivots (PIV), middle unit forwards (MUF), and

9 wide running forwards (WRF). MUF covered less total distance (4318 ± 570 m) than WRF

10 (6408 ± 629 m), PIV (6549 ± 853) and OB (7246 ± 333 m) ($P<0.05$) and less sprint distance

11 (185 ± 58 m) than WRF (296 ± 82 m), PIV (306 ± 108) and OB (421 ± 89 m) ($P<0.05$), likely

12 attributable to less playing time by MUF (47.8 ± 6.6 min) compared with WRF (77.0 ± 9.0

13 min), PIV (72.8 ± 10.6 min) and OB (86.7 ± 3.4 min) ($P<0.05$). Metres per minute were

14 greater for MUF (90.8 ± 2.2 m.min^{-1}) compared with OB (83.6 ± 2.8 m.min^{-1}) and WRF ($83.4 \pm$

15 2.4 m.min^{-1}) ($P=0.001$) although not different from PIV (90.2 ± 3.3 m.min^{-1}) ($P>0.05$). WRF

16 (36 ± 5) and MUF (35 ± 6) were involved in more collisions than OB (20 ± 3) and PIV (23 ± 3)

17 ($P<0.05$). The high-speed running and collision demands observed here were greater than

18 that previously reported in the ESL, which may reflect increased demands placed on the

19 lower ranked teams. The present data may be used to inform coaches if training provides

20 the physical stimulus to adequately prepare their players for competition which may be

21 especially pertinent for newly promoted franchises.

22

23 **Keywords:** *Time-motion analysis, team sports, microtechnology, positional activity profiles*

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Introduction

Rugby league is a high-speed collision sport that is intermittent in nature. The external demands encompass periods of high-intensity activity (running, high-speed running (HSR), sprinting, collision, and wrestle) and low intensity activity (standing, walking, and jogging) played over two halves of 40 minutes. Teams consist of 13 players that may be classified into four positional groups (hit up forwards, wide running forwards, outside backs and pivots) based upon commonalities in field position and playing role (Gabbett, Jenkins, & Abernethy, 2012). However, these categories are not exhaustive and may differ for teams employing different tactics.

Given the focus on game specific and individualised conditioning for rugby league players (Gabbett, King, & Jenkins, 2008) specifying the content of training periods based upon information sampled from competition offers an appropriate approach to match preparation. However, there is limited data examining the physical demands of elite rugby league, specifically for the Europe based Super League (ESL). Most previous research has focused on the southern hemisphere National Rugby League (NRL) competition, which is perceived to be a better standard of competition (Twist *et al.,* 2014). Previous data have predominantly utilised video analysis to quantify movement demands, however the labour intensive nature of retrospective video analysis is subject to measurement error and can delay the assessment of performance indicators (Dobson & Keogh, 2007). Consequently, such research has also been limited by low sample sizes, and cannot concurrently measure the external loads of collisions and the relative internal physiological load measured through heart rate (HR).

Recently the development of portable global positioning system (GPS) units for use in sport have provided an alternative data acquisition method with the potential to overcome some of the limitations outlined previously. The only published data examining the competitive physical demands of the ESL using GPS is limited by a small sample size (Waldron, Twist, Highton, Worsfold, & Daniels, 2011a) and has tended to focus on established ESL teams competing at the top of the table (Twist et al., 2014; Waldron et al., 2011a). Previous research in the NRL has found that the physical demands are greater when competing against bottom four ranked teams (Gabbett, 2013) and also the amount of HSR has previously been used to differentiate between standards of competition (Gabbett, 2014). Given that ESL has now re-introduced promotion and relegation after operating on a

2

61 licencing franchise system for the past seven seasons, establishing the physical demands

62 placed on newly promoted teams is a pertinent issue. Such information can inform the

63 coaches of newly promoted sides if they are adequately preparing their players for the

64 demands of elite level competition. Moreover, neither of the previous studies using ESL

65 players accounted for the external load of collisions placed on players, with only one study

66 providing information on the internal match load (Waldron et al., 2011a). A further

67 limitation of previous research in the ESL is that they were both performed prior to the 2012

68 ESL season, at which point the number of interchanges allowed in a game reduced from 12

69 to 10.

70

71 To date there are no data that have combined the GPS derived external movement demands

72 with accelerometer or notational performance data to examine the external collision

73 demands, and HR data to examine the internal physiological demands of ESL match play.

74 Accordingly, there is a clear need to gain a better understanding of the entirety of the

75 physical match demands for a newly promoted side over the course of an entire competitive

76 season. It is possible that some of the players from the newly promoted franchise may not

77 have been full-time professionals whilst playing for the team in the lower division and as

78 such the conditioning staff only have a short period of time to recondition the players for the

79 increased physical demands of ESL. Given that the physical demands of lower ranked teams

80 has been previously shown to be greater than higher raked teams in the NRL (Gabbett,

81 2013) it is likely that the newly promoted franchise may in fact have to be able to withstand

82 greater physical demands than the rest of the competition, although to date this suggestion

83 has not been investigated. Therefore, the aim of the present study was to provide

84 comprehensive positional profiles of the external and internal physical match demands for a

85 newly promoted ESL franchise over the entirety of a competitive season and establish what

86 impact this should have on their training and conditioning regimes.

87

88 **Methods**

89

90 *Subjects*

91

92 Thirty-three male elite rugby league players from an English ESL club were recruited for the

93 study. Players were sub-categorised into four positional groups for each game based on

94 which position they would feature pre-dominantly during that game. The groups were: 1.

95   Outside backs (OB) (full back, wingers, centres), 2. Pivots (PIV) (hooker, stand-off, scrum
96   half), 3. Middle unit forwards (MUF) (props, loose forward), and 4. Wide running forwards
97   (WRF) (second row). Two forwards groups (MUF and WRF) were used rather than grouping
98   the forwards as a whole as the tactical requirements imposed on these positions by the
99   coaching staff at the club was substantially different and it was likely that the MUF would
100   play significantly less game time than the WRF. Ethical approval for all experimental
101   procedures was granted by the Ethics committee of Liverpool John Moores University. A
102   summary of the anthropometric profiles of the players in the squad based on the categories
103   they were most represented in throughout the season can be seen in Table 1.

104

105   A total of 459 data files from all 27 ESL regular season games during the 2012 season were
106   originally considered for analysis. If players were not on the pitch for more than 2 standard
107   deviations away from the average for that positional group for that particular game, they
108   were discarded from the analysis (since this was likely the result of an injury rather than a
109   tactical substitution). Files were also discarded if less than eight satellites were found to be
110   available for signal transmission at any point during the game. This left 399 data files that
111   were included in the analysis.

112

113   *Procedures*

114

115   Players wore an individual GPS unit (SPI Pro XII, GPSports, Canberra, Australia) sampling at 5
116   Hz with 15 Hz interpolation, with an integrated accelerometer sampling at 100 Hz displaying
117   data in G force, in a custom designed vest and compatible HR monitor attached to the
118   thoracic region (T34, Polar Electro Oy, Kempele, Finland). A standard tightly fitting squad
119   shirt was worn over the top of the vest. Previous models of this device sampling at 5 Hz
120   have been shown to provide valid and reliable estimates of distance and velocity during
121   linear, multidirectional and team-sport activities (Portas, Harley, Barnes, & Rush, 2010;
122   Randers et al., 2010; Varley, Fairweather, & Aughey, 2012; Waldron, Worsfold, Twist, &
123   Lamb, 2011b). Since the 15 Hz interpolation has been introduced, the reliability of the
124   current device is better than previous 5 Hz devices, albeit not as strong as the devices which
125   sample at 10 Hz (Johnston, Watsford, Kelly, Pine, & Spurrs, 2014). The validity of the HR
126   monitor has also been established (Goodie, Larkin, & Schauss, 2010; Terbizan, Dolezal, &
127   Albano, 2002). Players underwent a familiarisation period using the GPS devices during
128   training sessions and subsequent pre-season trial games. Max HR was obtained prior to data

129   collection, defined as the highest value reached during a modified 150 metre maximal

130   anaerobic shuttle test (Brewer, 2008).

131

132   The GPS devices were switched on 20 minutes prior to warm up to allow acquisition of

133   satellite signals, with only match play used for analysis. Total time on pitch was calculated

134   for "playing time" only, i.e. how much time was the player on the playing field only and time

135   off the field, such as periods interchanged were removed from the analysis. Time off during

136   match play, such as injury time or video referee was included, as this was part of the game

137   duration, hence "time on pitch" may, in some cases exceed the standard 80 minutes of

138   match play.

139

140   All data was downloaded to a computer using Team AMS, Release R1 2012.4 (GPSports,

141   Canberra, Australia). Once appropriately formatted, data were exported to Microsoft Excel

142   (Microsoft Corporation, USA) for the purpose of data management.

143

144   Movement variables included total distance covered (m), locomotive rate (mean $m \cdot min^{-1}$ for

145   games duration), both total distance and locomotive rates within 6 speed zones, namely:

146   walking (0.1-1.6 $m \cdot s^{-1}$), jogging (1.6-2.7 $m \cdot s^{-1}$), cruising (2.7-3.8 $m \cdot s^{-1}$), striding (3.8-5.0 $m \cdot s^{-1}$),

147   HSR (5.0-5.5 $m \cdot s^{-1}$), and sprinting (>5.5 $m \cdot s^{-1}$). These zones have been previously used in

148   rugby league (McLellan, Lovell, & Gass, 2011) and modified to consider forward, backward,

149   and ambulatory movement. Additional movement measures included peak speed ($m \cdot s^{-1}$),

150   number of sprints, number of sprints expressed per minute of time on pitch, average sprint

151   distance (m), and maximum sprint distance (m).

152

153   In order for ease of comparison with previous investigations, the total distance covered

154   above 5.0 $m \cdot s^{-1}$ (the sum of HSR and sprint distance, termed "high-intensity running

155   distance") was also calculated, and expressed per minute on of time on pitch but was

156   excluded from statistical analysis, and used rather to provide a comparison across studies.

157

158   HR data was classified into 6 zones, namely < 60% HR max, 60-70% HR max, 70-80% HR max,

159   80-90% HR max, 90-95% HR max, and > 95% HR max. Data included time spent in zones, and

160   percentage of time on pitch spent in zones, which have been used previously investigating

161   the physiological demands of elite rugby union (Cunniffe, Proctor, Baker, & Davies, 2009).

162

163 As this model of GPS has not been validated to detect collisions outright, the number of ball

164 carries and tackles were expressed as total numbers and per minute of time on pitch. This

165 data was provided by Opta as an independent analysis service provided through contract

166 with the Rugby Football League (the governing body for the sport in the UK). The number of

167 carries only included carries that resulted in a collision from an opposing player through

168 either the ball carrier being tackled by a defending player, or the ball carrier going into a

169 tackle and offloading the ball in the process of being tackled. Tackles did not include missed

170 tackles, which were discarded from the analysis given that the data from Opta cannot

171 distinguish which missed tackles resulted in a collision or not. The total number of collisions

172 was calculated by summing the number of ball carries and number of tackles (although it

173 should be stressed that some additional collisions resulting from missed tackles could have

174 been disregarded using this method). Data was examined for the newly promoted team as

175 well as their opposition over the course of the season to allow for comparison, and was

176 expressed as the number of carries resulting in collisions per game, the number of tackles

177 per game, and subsequently total number of collisions per game for both the team under

178 investigation and the opposition.

179

180 Quantification of accelerometer impacts from GPS were classified into four zones according

181 to system manufacturer guidelines (7-9 G, 9-11 G, 11-13 G, and 13-15 G). High-intensity

182 impacts (> 7 G) commonly occur in sport such as aggressive changes in direction, falling to

183 the ground, landing from jumping, and collisions, therefore impacts less than 7 G were

184 excluded from the analysis as these likely represent foot contacts from walking, running or

185 gentle changes in direction. As well as total number of impacts within each zone, impacts

186 were also expressed per minute of time on pitch.

187

188 Additional Opta data was included to compare the newly promoted team against the

189 opposition including mean time that the 'ball was in play', the mean time in possession of

190 the ball, the mean number of line breaks and mean number of errors.

191

192 *Statistical Analysis*

193

194 One-way analyses of variance (ANOVA) were performed to assess differences between

195 positional groups for all of the variables. Where a significant F value were observed, post-

196 hoc Tukey HSD tests were conducted to identify the location of the differences. Independent

197   t-tests were performed to assess differences between the team under investigation and the

198   opposition for additional Opta data. Statistical significance was set at $P<0.05$ throughout. All

199   data are expressed as mean (± SD).

200

201

202   **Results**

203

204   For the 27 games analysed, six of the games were won with 21 being lost, with the mean

205   number of points scored in each game being 60 ± 13 (mean points for 20 ± 13, mean points

206   against 40 ± 18), equating to the mean total tries scored per game being 11 ± 3 (4 ± 2 scored,

207   7 ± 3 conceded) . The team under investigation finished bottom of the ESL table that year.

208   Opta data revealed the mean ball in play time per game was 48.6 ± 3.5 min. The team under

209   investigation (23.4 ± 3.1 min) spent significantly less time in ball possession ($P=0.03$) than

210   the opposition teams (25.2 ± 2.6 min) across the course of the season. The team under

211   investigation made on average 5 ± 3 line breaks per game, which was significantly lower

212   ($P=0.01$) than opposition sides (10 ± 4). The mean number of errors per game was 28 ± 4

213   although there was no significant difference ($P=0.07$) between the number of errors for the

214   team under investigation (13 ± 3) and opposition sides (15 ± 4).

215

216   *Movement demands*

217

218   Results for the movement demands over the season are presented in Table 2, and show

219   both absolute and relative measures. There was a significant difference between positions

220   for time on pitch ($P=0.001$) with MUF spending significantly less time on the field than all

221   other positions.

222

223

224   *Absolute measures.* There were significant differences between positions for total distance

225   covered ($P=0.001$), distance covered walking ($P=0.001$), jogging ($P=0.001$), cruising

226   ($P=0.001$), striding ($P=0.001$), HSR ($P=0.001$), and sprinting ($P=0.001$). Specific differences

227   between positions are identified in Table 2.

228

229   *Relative measures.* There were significant differences between positions for overall

230   locomotive rate ($P=0.001$), walking ($P=0.001$), jogging ($P=0.001$), cruising ($P=0.001$), and

231 striding (P=0.001). The differences between positions can be seen in Table 2. There were no

232 significant differences in locomotive rates for HSR (P=0.621) or sprinting (P=0.187) between

233 positions.

234

235 *Further sprint variables.* There were significant differences between positions for peak

236 speed (P=0.001), number of sprints (P=0.001), and maximum sprint distance (P=0.019). The

237 locations of significant differences between positions are shown in Table 2. There was no

238 significant difference between positions for average sprint distance (P=0.433), or number of

239 sprints per minute (P=0.344).

240

241 *Collision demands*

242

243 Results for the positional collision demands for the newly promoted team are presented in

244 Table 3, and are expressed as both absolute and relative measures.

245

246 *Absolute measures.* There were no significant differences between positions for the

247 numbers of impacts detected by the accelerometer between 7-9 G (P=0.136), 9-11 G

248 (P=0.066), 11-13 G (P=0.251), and 13-15 G (P=0.316). Opta data confirmed that there were

249 significant differences between positions for the number of carries (P=0.001), number of

250 tackles (P=0.001), and subsequently number of collisions (P=0.001), with significant

251 differences between groups shown in Table 3.

252

253 *Relative measures.* There were significant differences between positions for impacts per

254 minute of time on pitch between 7-9 G (P=0.001), 9-11 G (P=0.001), and 11-13 G (P=0.001).

255 There was no significant difference for the number of impacts per minute between 13-15 G

256 (P=0.249). Opta data revealed significant positional differences for the number of carries per

257 minute (P=0.001), tackles per minute (P=0.001) and subsequently collisions per minute

258 (P=0.001). The locations of specific significant differences between groups are outlined in

259 Table 3.

260

261 Additional Opta data revealed the team under investigation performed significantly more

262 carries resulting in collisions (188 ± 26) per game than opposition sides (136 ± 15, P=0.001).

263 Although the team under investigation performed more tackles per game (289 ± 38) than

264 opposition sides (280 ± 42), this difference was not found to be significant (P=0.403).

265 Overall, the team under investigation experienced a significantly greater number of
266 collisions per game (477 ± 40) than opposition sides (417 ± 40, *P*=0.001).

267

268

269 *Physiological demands*

270

271 Results for the physiological demands over the season are presented in Table 4, and are
272 expressed as both absolute and relative measures.

273 *Absolute measures.* There were significant differences between positions for time spent
274 between 60-70% HR max (*P*=0.001), 70-80% HR max (*P*=0.001), 80-90% HR (*P*=0.001), and >
275 95% HR max (*P*=0.02), with the locations of specific significant differences between groups
276 outlined in Table 4. There were no position specific differences for time spent < 60% HR max
277 (*P*=0.38) and time spent between 90-95% HR max (*P*=0.615).

278 *Relative measures.* There were significant positional differences for percentage of time on
279 the pitch spent between 60-70% HR max (*P*=0.005), 70-80% HR max (*P*=0.003), 80-90% HR
280 max (*P*=0.033), and > 95% HR max (*P*=0.001), with the locations of specific significant
281 differences outlined in Table 4. There were no significant differences for percentage of time
282 on pitch spent between < 60% HR max (*P*=0.362), or 90-95% HR max (*P*=0.135).

283

284 *Comparison of selected variables across studies*

285 Table 5 shows the total distance, metres per minute, high-intensity running distance per
286 minute, and total number of collisions across positional groups in the current investigation
287 compared with previous research. Whilst the total distance covered during the game was
288 similar across studies, the metres per minute was lower in the current investigation
289 compared with all of those previous published, whereas HSR per minute was higher than
290 previously reported in ESL competition, but lower than reported in NRL competition. Total
291 numbers of collisions in the current investigation are lower than those reported in the NRL.

292

293 **Discussion**

294

295 The primary aim of the study was for the first time, to report a full seasons worth of data
296 regarding the external and internal physical match demands of ESL rugby within different
297 positional groups for a newly promoted team. We report that for all positions, the majority
298 of match play is spent in low intensity movement activities, but at a considerable internal
299 physiological demand at/or above 80% of HR max. OB spend more time on the pitch, cover
300 greater total distance, cover significantly more distance sprinting and perform significantly
301 more sprints than other positional groups. MUF were shown to spend significantly less time
302 on the pitch than all other positional groups, but were required to operate at higher overall
303 locomotive rates, and with WRF were involved in significantly more collisions than other
304 positions. We also report that the total distances covered are similar to previous
305 investigations in ESL and NRL competition. However, the newly promoted club in the present
306 study covered substantially less metres per minute, more high-intensity running distance per
307 minute of match play, and a greater total number of collisions compared with ESL opposition
308 sides. These data therefore suggest that the newly promoted ESL teams may be subject to
309 increased high-speed and collision demands, potentially as a result of being unable to
310 control the speed of play as well as established ESL teams. This is something that the
311 coaching staff of newly promoted teams should be aware of and attempt to address in the
312 training and practice.

313

314 We report metres per minute is lower for all positions in the current study when compared
315 with previous investigations. Given the mean number of tries scores per game was 11, the
316 mean errors per game was 28 and the ball was only 'in play' for ~48 minutes per game
317 (which is considerably lower than previously reported in ESL at around 55 min (Sykes, Twist,
318 Hall, Nicholas, & Lamb, 2009) and NRL at around 55 min (Gabbett, 2012)) it is likely that the
319 lower metres per minute is observed is a direct result of the numerous stoppages in play.
320 Contrastingly, the high-intensity distance (>5.0 m·s^{-1}) covered per minute is higher for
321 positions in this study than those previously reported in ESL. It should be noted that in the
322 Waldron *et al.* (2011a) study, 5.8 m·s^{-1} was used as the most comparable speed threshold.
323 When comparing these values to the relative sprint distances for positions in this study (>
324 5.5 m·s^{-1}; Table 2), the values in the current investigation are still considerably higher, but it
325 is difficult to justify this conclusion given the discrepancy of 0.3 m·s^{-1} between the nearest
326 speed threshold for comparison. Due to the high number of game stoppages reported in the
327 present study, it could be argued that players were given more time to recover between
328 passages of play, which could increase their ability to perform high-speed efforts in a more

329   stop-start game. It could also be argued, that due to on average of 40 points per game being

330   scored against the team in the current study, their defensive line was broken frequently, and

331   hence a lot of the HSR volume was achieved in chasing back trying to stop opposition

332   attackers who have broken the line. This suggestion is supported by the fact that the

333   opposition made significantly more line breaks than the team under investigation. Although

334   we have provided preliminary evidence, that the HSR demands are greater for lower ranked

335   ESL teams, the HSR demands are still lower than for those reported in the NRL. Thus, in

336   agreement with previous research (Twist et al., 2014) there is more evidence to suggest that

337   across the course of match play, NRL matches are of greater high-speed intensities than ESL.

338

339

340   Similarly, the collision demands for the team under investigation were greater than for

341   opposition ESL sides, with the newly promoted side experiencing a significantly greater

342   number of collisions per game across the course of the season. Again, the number of

343   collisions is lower in the current investigation than those reported in the NRL. However, we

344   chose not to report missed tackles that resulted in a collision, as the Opta data available is

345   not able to distinguish between which missed tackles resulted in a collision and which did

346   not. These were included in previous investigations in determining the total number of

347   collisions in the NRL (Gabbett, Jenkins, & Abernethy, 2011; Gabbett et al., 2012) which could

348   account for some of the observed differences.

349

350   For the newly promoted side under investigation, there were also significant positional

351   differences within the squad. Greater locomotive rates for MUF are demonstrative of higher

352   relative intensity but less absolute distance covered due to significantly less playing time.

353   Significantly greater overall locomotive rates for MUF and PIV compared to other groups

354   coincide with significantly greater cruising locomotive rates and a significantly greater

355   striding locomotive rate for the MUF compared to the WRF. Sprint performance may be

356   influenced by pitch position, whereby OB are offered larger areas of space with which to

357   develop forward locomotion. In contrast, PIV and the forward groups are often closer to the

358   opposition gain line, and so the capacity to generate high-speed is less (Gabbett, Polley,

359   Dwyer, Kearney, & Corvo, 2014). It is also possible that the forwards are typically slower

360   than backs (Meir, Newton, Curtis, Fardell, & Butler, 2001), thus preventing the attainment of

361   an arbitrary sprint category (> 5.5 $m\cdot s^{-1}$) with the same ease, and could explain why OB

362   recorded significantly greater peak speeds in this study than forwards groups.

363

364   This significantly lower number of absolute and relative carries for the PIV is expected, given

365   that hookers usually pick up and pass the ball on to a teammate from the play the ball. The

366   halfbacks are used mainly to pass and kick the ball rather than perform carries into the

367   opposition defensive line. The absolute and relative number of tackles for the PIV is

368   potentially mainly attributable to the hooker who defends in the centre of the field with the

369   MUF in anticipation of being required as a playmaker if the ball is turned over..

370   Contrastingly, the halfbacks generally defend towards the edge of the defensive line

371   (Gabbett, 2005). Hookers in attack are a PIV, whilst in defence they are acting as a MUF and

372   therefore future research that investigates collision demands may consider hookers as a

373   unique positional category, and therefore may require different conditioning (compared to

374   halfbacks) during training.

375

376   The significantly greater number of relative collisions (and subsequent periods of wrestle),

377   combined with a greater overall locomotive rate contributed to MUF experiencing a greater

378   internal physiological stress in terms of percentage time spent above 95% of HR max than

379   other positions and supports why this group is interchanged so often during games (mean

380   time on pitch 42.8 ± 6.6 min). Given that WRF were involved in a similar number of total

381   collisions, it seems somewhat surprising they spent the least percentage time > 95% max HR.

382   This may reflect the fact that their overall locomotive rate was the lowest (83 m·min^{-1}).

383

384   Impact data from the GPS units revealed no significant differences in the number of impacts

385   in each of the four zones between positions, which is in contrast to that reported by Opta

386   collision data. This again raises serious questions regarding the use of GPS devices to detect

387   and more importantly quantify collision data.

388

389   Despite contributing valuable new data to the literature, the present study is not without its

390   limitations, most of which are due to collecting data in the real world alongside the

391   movement data from GPS being limited to one ESL team. Subsequent follow-up longitudinal

392   studies with the same team are required in future seasons to establish whether there is an

393   evolution in physical game demands with increased exposure to training demands and ESL

394   competition given the team were granted a minimum three year licence to continue

395   competing in the ESL regardless of league position finish.

396

397 This study highlights significant practical implications for the sports science support team
398 within rugby league clubs, especially for those working in the future with newly promoted
399 ESL sides. For newly promoted squads as a whole, it is important to expose players to typical
400 HSR volumes and collisions that they may expect to encounter in games to ensure that
401 players are robust enough to handle the demands they are faced with during competition.
402 The pre-season period therefore is of utmost important to expose players to such demands
403 in training. Furthermore, the nature of conditioning work should differ between positional
404 groups. MUF and WRF should be subject to repeated high-intensity accelerations leading
405 into, and arising from, collisions. The need to be able to withstand approximately 35
406 collisions in a game has significant implications for strength training requirements on the
407 kinetic chain. The larger mass amongst this group of players might also be explained by the
408 role that they play. PIV need to be able to achieve similar maximal sprint speeds to the OB,
409 but typically over less distance and with less frequency, which is indicative of a greater need
410 for a chaotic and multi-directional speed component within their programme. This conforms
411 to the interaction of hookers play around the breakdown and the role of the halfbacks in
412 creating line breaks for others around them. Hookers need to be robust enough to be able
413 to sustain collision forces of comparable impact and frequency to forward groups.
414 Conditioning programmes for OB should focus on the development of repeated prolonged
415 sprint ability over distances typically between 18-60 m with a lesser emphasis on collision.

416

417 In conclusion, the current study has for the first time provided a comprehensive overview of
418 the positional external and internal physical match demands for a newly established ESL
419 franchise and has provided preliminary evidence that the external HSR and collision
420 demands are greater for lower ranked ESL teams than higher ranked teams. However, the
421 HSR demands, along with collision involvements are lower than those experienced in the
422 NRL. The significant positional differences observed provide a reference for rugby league
423 practitioners to follow when designing conditioning and training regimes. The comparison of
424 data from training drills to the physical match demands outlined here can inform coaches of
425 newly promoted sides if they are adequately preparing their players for the physical
426 demands of elite level competition.

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