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

Abstract

The physical match demands for a newly promoted European Super League (ESL) squad were analysed over a full season using global positioning systems. Players were classified into four positional groups; outside backs (OB), pivots (PIV), middle unit forwards (MUF), and wide running forwards (WRF). MUF covered less total distance (4318 ± 570 m) than WRF (6408 ± 629 m), PIV (6549 ± 853) and OB (7246 ± 333 m) ($P<0.05$) and less sprint distance (185 ± 58 m) than WRF (296 ± 82 m), PIV (306 ± 108) and OB (421 ± 89 m) ($P<0.05$), likely attributable to less playing time by MUF (47.8 ± 6.6 min) compared with WRF (77.0 ± 9.0 min), PIV (72.8 ± 10.6 min) and OB (86.7 ± 3.4 min) ($P<0.05$). Metres per minute were greater for MUF (90.8 ± 2.2 $m.min^{-1}$) compared with OB (83.6 ± 2.8 $m.min^{-1}$) and WRF (83.4 ± 2.4 $m.min^{-1}$) ($P=0.001$) although not different from PIV (90.2 ± 3.3 $m.min^{-1}$) ($P>0.05$). WRF (36 ± 5) and MUF (35 ± 6) were involved in more collisions than OB (20 ± 3) and PIV (23 ± 3) ($P<0.05$). The high-speed running and collision demands observed here were greater than that previously reported in the ESL, which may reflect increased demands placed on the lower ranked teams. The present data may be used to inform coaches if training provides the physical stimulus to adequately prepare their players for competition which may be especially pertinent for newly promoted franchises.

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

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 licencing franchise system for the past seven seasons, establishing the physical demands placed on newly promoted teams is a pertinent issue. Such information can inform the coaches of newly promoted sides if they are adequately preparing their players for the demands of elite level competition. Moreover, neither of the previous studies using ESL players accounted for the external load of collisions placed on players, with only one study providing information on the internal match load (Waldron et al., 2011a). A further limitation of previous research in the ESL is that they were both performed prior to the 2012 ESL season, at which point the number of interchanges allowed in a game reduced from 12 to 10.

To date there are no data that have combined the GPS derived external movement demands with accelerometer or notational performance data to examine the external collision demands, and HR data to examine the internal physiological demands of ESL match play. Accordingly, there is a clear need to gain a better understanding of the entirety of the physical match demands for a newly promoted side over the course of an entire competitive season. It is possible that some of the players from the newly promoted franchise may not have been full-time professionals whilst playing for the team in the lower division and as such the conditioning staff only have a short period of time to recondition the players for the increased physical demands of ESL. Given that the physical demands of lower ranked teams has been previously shown to be greater than higher raked teams in the NRL (Gabbett, 2013) it is likely that the newly promoted franchise may in fact have to be able to withstand greater physical demands than the rest of the competition, although to date this suggestion has not been investigated. Therefore, the aim of the present study was to provide comprehensive positional profiles of the external and internal physical match demands for a newly promoted ESL franchise over the entirety of a competitive season and establish what impact this should have on their training and conditioning regimes.

Methods

Subjects

Thirty-three male elite rugby league players from an English ESL club were recruited for the study. Players were sub-categorised into four positional groups for each game based on which position they would feature pre-dominantly during that game. The groups were: 1.

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

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

Procedures

Players wore an individual GPS unit (SPI Pro XII, GPSports, Canberra, Australia) sampling at 5 Hz with 15 Hz interpolation, with an integrated accelerometer sampling at 100 Hz displaying data in G force, in a custom designed vest and compatible HR monitor attached to the thoracic region (T34, Polar Electro Oy, Kempele, Finland). A standard tightly fitting squad shirt was worn over the top of the vest. Previous models of this device sampling at 5 Hz have been shown to provide valid and reliable estimates of distance and velocity during linear, multidirectional and team-sport activities (Portas, Harley, Barnes, & Rush, 2010; Randers et al., 2010; Varley, Fairweather, & Aughey, 2012; Waldron, Worsfold, Twist, & Lamb, 2011b). Since the 15 Hz interpolation has been introduced, the reliability of the current device is better than previous 5 Hz devices, albeit not as strong as the devices which sample at 10 Hz (Johnston, Watsford, Kelly, Pine, & Spurrs, 2014). The validity of the HR monitor has also been established (Goodie, Larkin, & Schauss, 2010; Terbizan, Dolezal, & Albano, 2002). Players underwent a familiarisation period using the GPS devices during training sessions and subsequent pre-season trial games. Max HR was obtained prior to data collection, defined as the highest value reached during a modified 150 metre maximal anaerobic shuttle test (Brewer, 2008).

The GPS devices were switched on 20 minutes prior to warm up to allow acquisition of satellite signals, with only match play used for analysis. Total time on pitch was calculated for “playing time” only, i.e. how much time was the player on the playing field only and time off the field, such as periods interchanged were removed from the analysis. Time off during match play, such as injury time or video referee was included, as this was part of the game duration, hence “time on pitch” may, in some cases exceed the standard 80 minutes of match play.

All data was downloaded to a computer using Team AMS, Release R1 2012.4 (GPSports, Canberra, Australia). Once appropriately formatted, data were exported to Microsoft Excel (Microsoft Corporation, USA) for the purpose of data management.

Movement variables included total distance covered (m), locomotive rate (mean $m \cdot min^{-1}$ for games duration), both total distance and locomotive rates within 6 speed zones, namely: 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 $m \cdot s^{-1}$), HSR (5.0-5.5 $m \cdot s^{-1}$), and sprinting (>5.5 $m \cdot s^{-1}$). These zones have been previously used in rugby league (McLellan, Lovell, & Gass, 2011) and modified to consider forward, backward, and ambulatory movement. Additional movement measures included peak speed ($m \cdot s^{-1}$), number of sprints, number of sprints expressed per minute of time on pitch, average sprint distance (m), and maximum sprint distance (m).

In order for ease of comparison with previous investigations, the total distance covered above 5.0 $m \cdot s^{-1}$ (the sum of HSR and sprint distance, termed “high-intensity running distance”) was also calculated, and expressed per minute on of time on pitch but was excluded from statistical analysis, and used rather to provide a comparison across studies.

HR data was classified into 6 zones, namely < 60% HR max, 60-70% HR max, 70-80% HR max, 80-90% HR max, 90-95% HR max, and > 95% HR max. Data included time spent in zones, and percentage of time on pitch spent in zones, which have been used previously investigating the physiological demands of elite rugby union (Cunniffe, Proctor, Baker, & Davies, 2009).

As this model of GPS has not been validated to detect collisions outright, the number of ball carries and tackles were expressed as total numbers and per minute of time on pitch. This data was provided by Opta as an independent analysis service provided through contract with the Rugby Football League (the governing body for the sport in the UK). The number of carries only included carries that resulted in a collision from an opposing player through either the ball carrier being tackled by a defending player, or the ball carrier going into a tackle and offloading the ball in the process of being tackled. Tackles did not include missed tackles, which were discarded from the analysis given that the data from Opta cannot distinguish which missed tackles resulted in a collision or not. The total number of collisions was calculated by summing the number of ball carries and number of tackles (although it should be stressed that some additional collisions resulting from missed tackles could have been disregarded using this method). Data was examined for the newly promoted team as well as their opposition over the course of the season to allow for comparison, and was expressed as the number of carries resulting in collisions per game, the number of tackles per game, and subsequently total number of collisions per game for both the team under investigation and the opposition.

Quantification of accelerometer impacts from GPS were classified into four zones according to system manufacturer guidelines (7-9 G, 9-11 G, 11-13 G, and 13-15 G). High-intensity impacts (> 7 G) commonly occur in sport such as aggressive changes in direction, falling to the ground, landing from jumping, and collisions, therefore impacts less than 7 G were excluded from the analysis as these likely represent foot contacts from walking, running or gentle changes in direction. As well as total number of impacts within each zone, impacts were also expressed per minute of time on pitch.

Additional Opta data was included to compare the newly promoted team against the opposition including mean time that the ‘ball was in play’, the mean time in possession of the ball, the mean number of line breaks and mean number of errors.

Statistical Analysis

One-way analyses of variance (ANOVA) were performed to assess differences between positional groups for all of the variables. Where a significant F value were observed, post-hoc Tukey HSD tests were conducted to identify the location of the differences. Independent t-tests were performed to assess differences between the team under investigation and the opposition for additional Opta data. Statistical significance was set at $P<0.05$ throughout. All data are expressed as mean (± SD).

Results

For the 27 games analysed, six of the games were won with 21 being lost, with the mean number of points scored in each game being 60 ± 13 (mean points for 20 ± 13, mean points against 40 ± 18), equating to the mean total tries scored per game being 11 ± 3 (4 ± 2 scored, 7 ± 3 conceded) . The team under investigation finished bottom of the ESL table that year. Opta data revealed the mean ball in play time per game was 48.6 ± 3.5 min. The team under investigation (23.4 ± 3.1 min) spent significantly less time in ball possession (P=0.03) than the opposition teams (25.2 ± 2.6 min) across the course of the season. The team under investigation made on average 5 ± 3 line breaks per game, which was significantly lower (P=0.01) than opposition sides (10 ± 4). The mean number of errors per game was 28 ± 4 although there was no significant difference (P=0.07) between the number of errors for the team under investigation (13 ± 3) and opposition sides (15 ± 4).

Movement demands

Results for the movement demands over the season are presented in Table 2, and show both absolute and relative measures. There was a significant difference between positions for time on pitch (P=0.001) with MUF spending significantly less time on the field than all other positions.

Absolute measures. There were significant differences between positions for total distance covered (P=0.001), distance covered walking (P=0.001), jogging (P=0.001), cruising (P=0.001), striding (P=0.001), HSR (P=0.001), and sprinting (P=0.001). Specific differences between positions are identified in Table 2.

Relative measures. There were significant differences between positions for overall locomotive rate (P=0.001), walking (P=0.001), jogging (P=0.001), cruising (P=0.001), and striding (*P*=0.001). The differences between positions can be seen in Table 2. There were no significant differences in locomotive rates for HSR (*P*=0.621) or sprinting (*P*=0.187) between positions.

Further sprint variables. There were significant differences between positions for peak speed (*P*=0.001), number of sprints (*P*=0.001), and maximum sprint distance (*P*=0.019). The locations of significant differences between positions are shown in Table 2. There was no significant difference between positions for average sprint distance (*P*=0.433), or number of sprints per minute (*P*=0.344).

Collision demands

Results for the positional collision demands for the newly promoted team are presented in Table 3, and are expressed as both absolute and relative measures.

Absolute measures. There were no significant differences between positions for the numbers of impacts detected by the accelerometer between 7-9 G (*P*=0.136), 9-11 G (*P*=0.066), 11-13 G (*P*=0.251), and 13-15 G (*P*=0.316). Opta data confirmed that there were significant differences between positions for the number of carries (*P*=0.001), number of tackles (*P*=0.001), and subsequently number of collisions (*P*=0.001), with significant differences between groups shown in Table 3.

Relative measures. There were significant differences between positions for impacts per 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). There was no significant difference for the number of impacts per minute between 13-15 G (*P*=0.249). Opta data revealed significant positional differences for the number of carries per minute (*P*=0.001), tackles per minute (*P*=0.001) and subsequently collisions per minute (*P*=0.001). The locations of specific significant differences between groups are outlined in Table 3.

Additional Opta data revealed the team under investigation performed significantly more carries resulting in collisions (188 ± 26) per game than opposition sides (136 ± 15, *P*=0.001). Although the team under investigation performed more tackles per game (289 ± 38) than opposition sides (280 ± 42), this difference was not found to be significant (*P*=0.403).

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

Physiological demands

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

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

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

Comparison of selected variables across studies

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

Discussion

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

We report metres per minute is lower for all positions in the current study when compared with previous investigations. Given the mean number of tries scores per game was 11, the mean errors per game was 28 and the ball was only 'in play' for ~48 minutes per game (which is considerably lower than previously reported in ESL at around 55 min (Sykes, Twist, Hall, Nicholas, & Lamb, 2009) and NRL at around 55 min (Gabbett, 2012)) it is likely that the lower metres per minute is observed is a direct result of the numerous stoppages in play. Contrastingly, the high-intensity distance (>5.0 $m \cdot s^{-1}$) covered per minute is higher for positions in this study than those previously reported in ESL. It should be noted that in the Waldron *et al.* (2011a) study, 5.8 $m \cdot s^{-1}$ was used as the most comparable speed threshold. When comparing these values to the relative sprint distances for positions in this study (> 5.5 $m \cdot s^{-1}$; Table 2), the values in the current investigation are still considerably higher, but it is difficult to justify this conclusion given the discrepancy of 0.3 $m \cdot s^{-1}$ between the nearest speed threshold for comparison. Due to the high number of game stoppages reported in the present study, it could be argued that players were given more time to recover between passages of play, which could increase their ability to perform high-speed efforts in a more stop-start game. It could also be argued, that due to on average of 40 points per game being scored against the team in the current study, their defensive line was broken frequently, and hence a lot of the HSR volume was achieved in chasing back trying to stop opposition attackers who have broken the line. This suggestion is supported by the fact that the opposition made significantly more line breaks than the team under investigation. Although we have provided preliminary evidence, that the HSR demands are greater for lower ranked ESL teams, the HSR demands are still lower than for those reported in the NRL. Thus, in agreement with previous research (Twist et al., 2014) there is more evidence to suggest that across the course of match play, NRL matches are of greater high-speed intensities than ESL.

Similarly, the collision demands for the team under investigation were greater than for opposition ESL sides, with the newly promoted side experiencing a significantly greater number of collisions per game across the course of the season. Again, the number of collisions is lower in the current investigation than those reported in the NRL. However, we chose not to report missed tackles that resulted in a collision, as the Opta data available is not able to distinguish between which missed tackles resulted in a collision and which did not. These were included in previous investigations in determining the total number of collisions in the NRL (Gabbett, Jenkins, & Abernethy, 2011; Gabbett et al., 2012) which could account for some of the observed differences.

For the newly promoted side under investigation, there were also significant positional differences within the squad. Greater locomotive rates for MUF are demonstrative of higher relative intensity but less absolute distance covered due to significantly less playing time. Significantly greater overall locomotive rates for MUF and PIV compared to other groups coincide with significantly greater cruising locomotive rates and a significantly greater striding locomotive rate for the MUF compared to the WRF. Sprint performance may be influenced by pitch position, whereby OB are offered larger areas of space with which to develop forward locomotion. In contrast, PIV and the forward groups are often closer to the opposition gain line, and so the capacity to generate high-speed is less (Gabbett, Polley, Dwyer, Kearney, & Corvo, 2014). It is also possible that the forwards are typically slower than backs (Meir, Newton, Curtis, Fardell, & Butler, 2001), thus preventing the attainment of an arbitrary sprint category (> 5.5 $m \cdot s^{-1}$) with the same ease, and could explain why OB recorded significantly greater peak speeds in this study than forwards groups.

This significantly lower number of absolute and relative carries for the PIV is expected, given that hookers usually pick up and pass the ball on to a teammate from the play the ball. The halfbacks are used mainly to pass and kick the ball rather than perform carries into the opposition defensive line. The absolute and relative number of tackles for the PIV is potentially mainly attributable to the hooker who defends in the centre of the field with the MUF in anticipation of being required as a playmaker if the ball is turned over.. Contrastingly, the halfbacks generally defend towards the edge of the defensive line (Gabbett, 2005). Hookers in attack are a PIV, whilst in defence they are acting as a MUF and therefore future research that investigates collision demands may consider hookers as a unique positional category, and therefore may require different conditioning (compared to halfbacks) during training.

The significantly greater number of relative collisions (and subsequent periods of wrestle), combined with a greater overall locomotive rate contributed to MUF experiencing a greater internal physiological stress in terms of percentage time spent above 95% of HR max than other positions and supports why this group is interchanged so often during games (mean time on pitch 42.8 ± 6.6 min). Given that WRF were involved in a similar number of total collisions, it seems somewhat surprising they spent the least percentage time > 95% max HR. This may reflect the fact that their overall locomotive rate was the lowest (83 $m \cdot min^{-1}$).

Impact data from the GPS units revealed no significant differences in the number of impacts in each of the four zones between positions, which is in contrast to that reported by Opta collision data. This again raises serious questions regarding the use of GPS devices to detect and more importantly quantify collision data.

Despite contributing valuable new data to the literature, the present study is not without its limitations, most of which are due to collecting data in the real world alongside the movement data from GPS being limited to one ESL team. Subsequent follow-up longitudinal studies with the same team are required in future seasons to establish whether there is an evolution in physical game demands with increased exposure to training demands and ESL competition given the team were granted a minimum three year licence to continue competing in the ESL regardless of league position finish.

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

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

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