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Research article

Movement Demands and Running Intensities of Semi-Professional Rugby League Players during A 9's Tournament: A Case Study

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Abstract
The objective of the study was to describe the movement demands and running intensities of semi-professional rugby league players during a rugby league 9's (RL9's) tournament. Six semi-professional rugby league players competed in a RL9's tournament over a two-day period comprising of six games. Movement demands and running intensities were recorded using Global Positioning System (GPS) devices providing data on distance and speeds. Data is presented as mean (95% Confidence Intervals) with changes (≥ 75%) likely to exceed the smallest worthwhile change (0.2) considered practically important. Outside backs performed significantly ($p < 0.05$) more relative VHSR (3.9 m [3.5-4.3] vs 2.4 m [2.1-2.8]) absolute (97.7 m [81.3 - 114.1] vs 22.6m [15.8 - 29.3]) and relative (5.0 $m \cdot min^{-1}$ [4.2 - 5.9] vs 1.2 $m \cdot min^{-1}$ [0.8 - 1.6]) sprint distance than the forwards. Outside backs also performed significantly ($p < 0.05$) more absolute (97.7 m [81.3 - 114.1] vs 43.9 m [27.2 - 60.7]) and relative (5.0 $m \cdot min^{-1}$ [4.2 - 5.9] vs 2.3 $m \cdot min^{-1}$ [1.4 - 3.2]) sprint distance than the adjustables. Moderate (0.6 – 1.2) to very large (> 2.0) decreases in performance variables were observed over the two days. The biggest magnitude of change over the two days was seen with very large decreases in relative HSR (- 2.10) and sprint (- 2.14) distance. Between playing groups, the outside backs had the biggest decrease in running intensity with a very large (- 2.32) significant ($p < 0.05$) decrease in VHSR on day 2 (3.3 $m \cdot min^{-1}$ [2.5 – 4.1]) compared to day 1 (4.9 $m \cdot min^{-1}$ [4.4 – 5.4]). Running intensities are decreased during an intensified RL9's tournament in semi-professional rugby league players. The observed decreases in running performances between playing groups are in agreement with previous research and may support the use of individualized player monitoring and recovery management during a RL9's tournament-style competition.

Key words: Rugby league, 9's GPS, Running intensity.

Introduction

Rugby league is a collision sport consisting of intermittent bursts of high intensity activity (e.g., sprinting, change of direction, and tackling) and low intensity activity (e.g., walking, jogging and standing) (Gabbett, 2005), played on a grass surface (100 meters long by 68 meters wide) by two teams of 13 players, with an additional four interchange players. A team consists of two main playing groups, these being forwards and backs, which may further be categorized as (i) adjustables (fullback, five-eight, half-back, hooker); (ii) outside backs (winger, center); (iii) edge forwards (second-row, lock); and (iv) core forwards (front row). A rugby league match duration is 80-minutes comprising two 40-minute halves with a 10-minute break in between. During the match both teams are permitted a maximum of eight interchanges from players that are on the interchange bench. Depending on playing position and playing level, players have been reported to cover distance up to 8500 meters per game (Hausler et al., 2016).

A modified version of the game, called rugby league 9's (RL9's) involves two teams of nine players on the field and six players on the interchange bench. A RL9's game is played over two 9-minute halves with a 2-minute break on a full sized playing field (Kempton and Coutts, 2015). Unlike the traditional version of rugby league, during a RL9's match teams are allowed unlimited interchanges from the bench players. The unique characteristics of the RL9's format, with fewer players on a full size field, shorter playing halves and unlimited interchanges results in higher running intensities compared to the traditional format, with professional rugby league players reported to cover up to 1529 meters in a single 9's game (Kempton and Coutts, 2015).

During a rugby league season players compete on a weekly basis over a 6-month period with 5-9 days between matches. Studies from rugby league (Johnston et al., 2013a; 2013b) and other team sports (Gescheit et al., 2015; Montgomery et al., 2008; Rowsell et al., 2011; Spencer et al., 2005) have found that during intensified competitions with less than 5 days between games both playing performances and match intensities are reduced, which may be due, in part, to the accumulative effects of residual fatigue. Johnson et al. (2013) reported reductions in high-intensity activities and work-rates during an intensified junior rugby league competition and suggested that this was due to fatigue and muscle damage accumulated over the course of the tournament. Additionally, a series of studies by McLellan and colleagues (2011a; 2011b; 2012) demonstrated that following match-play neuromuscular function is compromised for up to 2 days and skeletal muscle damage is elevated for 5 days in elite rugby league players.

Typically, a 9's tournament runs over consecutive days with multiple games (6-7) played with 1-3 hour break between games. It has yet to be elucidated what effect a 9's tournament has on running intensities, as to date no studies have yet provided information on the physical demands of semi-professional rugby league players under the 9's format. Therefore, the aim of the current study was to report the physical demands and running intensities of semi-professional rugby league

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players during a 9's tournament and describe the magnitude of change of these variables over the course of the tournament. It is hypothesized that running intensities would be reduced over the course of the tournament, and these reductions would be position-related (Suarez-Arrones et al., 2014).

Methods

Subjects

Six male rugby league players (mean ± SD; age 23.2 ± 2.1 yrs., height 1.84 ± 0.06 m, weight 93.2 ± 13.4 kg) were recruited from a semi-professional rugby league team competing in the Queensland Cup competition (Australia). Players were categorized into playing positions of either *adjustables* (n = 2), *outside backs* (n = 2) or *forwards* (n = 2). Data was collected during the 2016 pre-season 9's tournament consisting of five group matches, one final match (5 wins and 1 loss; RL9's Tournament Winners) over two days, with three matches played on day 1 and three on day 2 (six matches in total). All players participated in every match with a total of 36 individual players' match files obtained for analysis. Informed consent and ethics approval were obtained before data collection.

Study design

This case study used observational quasi-experimental design where subjects acted as their own control, with GPS data collected from semi-professional rugby league players who competed in a RL9's tournament over a two-day period. The RL9's tournament was played during the 2016 pre-season (three weeks before round 1 of the regular season and 12 weeks into preseason training) and involved both semi-professional and amateur rugby league players. Each match was 18 minutes (2 × 9 minute halves) in duration with a 2-minute half time break. The GPS data was collected during three matches on day 1 and day 2, respectively, with the last game on day 2 being the RL9's Tournament Final. All matches were played during fine and dry conditions (mean; temperature: 31.6°C; humidity: 63%) on a natural grass surface. A standardized recovery protocol (Harrington, 2016) was completed by all players after the final game on day 1 and consisted of lower-body cold water immersion (Ice bath: 12°C for 8 minutes); foam roller self-myofascial release (8 minutes); and lower-body massage (8 minutes). Players were also required to sleep in lower-body compression garments.

Methodology

The physical demands and running intensities of the players during the matches were recorded via GPS units (minimax, Catapult Innovations, Melbourne, Australia) sampling at 10 Hz, and provided data on distance (m), speed ($km \cdot h^{-1}$), relative distance (m/min). The GPS units were worn in a small vest worn under the playing jersey with the unit positioned high on the player's back. All players wore the same GPS unit for each match during the tournament to minimize interunit error (Jennings et al., 2010). Data was downloaded through the docking station (Sprint 5.0.9.2, Catapult Sports, Victoria, Australia) and cleaned so that data analysis was performed only on time spent on the field. Data was then categorised into total distance (m), relative distance ($m \cdot min^{-1}$), high-speed running (HSR) distance (> 14.4 $km \cdot h^{-1}$), very-high-speed-running (VHSR) distance (> 19.0 $km \cdot h^{-1}$), sprint distance (> 23.0 $km \cdot h^{-1}$) and number of sprint efforts (Kempton and Coutts, 2015).

Statistical analysis

Performance variables were reported in both absolute and relative values and displayed as mean with 95% confidence intervals, with assumptions of normality verified before all parametric statistical analysis. Differences in the physical demands and running intensities among playing positons were compared using a one-way analysis of variance. A magnitude-based approach (Batterham and Hopkins, 2005; Hopkins, 2007a; 2007b) was used to assess the chances of true differences between the physical demands and the different days and games played over the tournament (i.e. greater than the smallest worthwhile change). The smallest worthwhile change was calculated as 0.20 times the between-groups standard deviation. Quantitative chances of real differences in variables were assessed qualitatively as <1%, almost certainly not; 1%-5%, very unlikely; 5-25%, probably not; 25-75%, possibly; 75-97.5%, likely; 97.5-99%, most likely. Effect sizes were interpreted as <0.2, trivial; 0.2-0.6, small; 0.6-1.2, moderate; 1.2-2.0, large; >2.0, very large (Batterham and Hopkins, 2005).

Results

The players time on field per game was similar for both *Day 1* and *Day 2* (16.6 ± 1.4 min vs. 17.4 ± 1.2), with the time between games shorter for *Day 1* compared to *Day 2* (1:15 h vs. 2:30 h, respectively). Table 1 displays the physical demands across positional groups. Outside backs covered significantly ($p < 0.05$) more absolute distance, absolute and relative VHSR than forwards, and significantly ($p < 0.05$) more relative distance than both the forwards and adjustables. Adjustables covered significantly ($p < 0.05$) more absolute distance and absolute sprint distance than the forwards. Outside backs covered significantly ($p < 0.05$) more absolute and relative sprint distance and sprint efforts than both the forwards and the adjustables. When comparing the performance variables over the two days there was significantly ($p < 0.05$) less VHSR distance covered during day 2 compared to day 1 (Table 2), with moderate to very large magnitude of change with all performance variables being lower on day 2 (Table 2). The largest magnitude of change over the two days was reported for relative HSR distance and relative sprint distance.

Table 3 displays the magnitude of change between games over the tournament. Small to trivial negative changes are reported in all performance variables from *Game 1* to *Game 4*, with moderate to large negative changes reported between *Game 1* and *Game 6*. Table 4 displays differences in the physical demands and running intensities for the positional groups between the two days of the tournament. Significant ($p < 0.05$) changes were observed with the outside backs performing significantly ($p < 0.05$) less VHSR in *Day 2* compared to *Day 1*, while the forwards and adjustables performed significantly ($p < 0.05$) less sprint efforts during *Day 2*.

Table 1. Physical demands across positional groups and as a whole team. Data is displayed as Means (and 95% confidence intervals).

Absolute	Outside backs	Forwards	Adjustables	Whole Team
Total Dist (m)	1644 (1571 - 1717) †	1375 (1308 – 1443) *	1409 (1220–1598)	1466.4 (1369 – 1564)
HSR (m)	121.6 (111.1 - 132.1)	117.0 (105.1 – 128.9)	117.9 (82.7 – 153.2)	118.7 (103.1 – 134.3)
VHSR (m)	75.9 (68.7 - 83.1) †	45.8 (39.3 – 52.2)	60.9 (40.6 – 81.2)	60.0 (49.8 – 70.1)
Sprint (m)	97.7 (81.3 - 114.1) *†	22.6 (15.8 - 29.3) *	43.9 (27.2 – 60.7)	52.2 (36.4 – 68.0)
Sprint efforts (n)	4.5 (3.9 - 5.1) *†	2.0 (1.7 - 2.3) *	2.6 (1.8 – 3.4)	2.9 (2.3 – 3.5)
Relative	**Outside backs**	**Forwards**	**Adjustables**	**Whole Team**
Total Dist (m·min^{-1})	84.8 (81.0 – 88.5) *†	73.55 (73.2 - 73.9)	74.6 (64.5 – 84.6)	77.2 (72.0 – 82.3)
HSR (m·min^{-1})	6.3 (5.7 - 6.8)	6.2 (5.6 - 6.9)	6.2 (4.4 – 8.1)	6.2 (5.4 - 7.1)
VHSR (m·min^{-1})	3.9 (3.5 - 4.3) †	2.4 (2.1 – 2.8)	3.2 (2.1 – 4.3)	3.2 (2.6 - 3.7)
Sprint (m·min^{-1})	5.0 (4.2 - 5.9) *†	1.2 (0.8 – 1.6)	2.3 (1.4 – 3.2)	2.7 (1.9 – 3.6)
Sprint effort (efforts/min)	.23 (.2 - .3) *†	.1 (.1 - .2)	.1 (.1 - .2)	.2 (.1 - .2)

HSR, high-speed running (>14.4 km·h^{-1}); VHSR, very-high-speed running (>19.0 km·h^{-1}); Sprint, sprint distance (>23.0 km·h^{-1}); Sprint Efforts, number of sprint efforts (>23.0 km·h^{-1}). * Significantly different from Adjustables ($p < 0.05$); † Significantly different from Forwards ($p < 0.05$).

Table 2. Relative performance variables over the course a 9's tournament. Data displayed as Means (and 95% confidence intervals).

Variable	Day 1			Day2		
	Game 1	**Game 2**	**Game 3**	**Game 1**	**Game 2**	**Game 3**
Total Dist (m·min^{-1})	82.3 (73.4–91.3)	75.9 (50.4–101.5)	78.6 (62.9–94.3)	78.5 (70.6–86.4)	74.7 (61.0–88.4)	72.8 (65.1–80.4)
HSR (m·min^{-1})	7.3 (5.2 - 9.4)	7.9 (3.7 - 12.1)	5.5 (3.8 - 7.1)	5.4 (4.7 - 6.1)	5.5 (3.7 - 7.3)	6.2 (4.5 - 7.9)
VHSR (m·min^{-1})	4.1 (2.9 - 5.4)	2.8 (1.2 - 4.3)	4.1 (2.5 – 5.7)	3.1 (2.3 - 3.8)	2.7 (1.4 – 3.9)	2.5 (1.3 – 3.8)
Sprint (m·min^{-1})	3.1 (1.5 - 4.6)	1.9 (0.4 - 3.4)	3.2 (1.8 - 4.6)	3.6 (0.3 - 6.9)	2.5 (0.7 - 4.2)	2.1 (0.5 – 3.7)
Sprint Efforts (Efforts/min)	.2 (.1 - .3)	.1 (.1 - .2)	.2 (.1 - .2)	.2 (.1 - .3)	.2 (.1 - .2)	.1 (.1 -0.2)

HSR, high-speed running (>14.4 km·h^{-1}); VHSR, very-high-speed running (>19.0 km·h^{-1}); Sprint, sprint distance (>23.0 km·h^{-1}); Sprint Efforts, number of sprint efforts (>23.0 km·h^{-1}).

Table 3. Magnitude of change and effect sizes of relative performance variables over the course a 9's tournament. Chance that magnitude of change between two games is higher/no difference/lower (100/0/0).

Variable	Game 1 Vs Game 3	Game 1 Vs Game 4	Game 1 Vs Game 6	Day 1 Vs Day 2
Total Dist (m·min^{-1})	Likely (7/12/81) Moderate -0.69	Possibly (34/44/22) Trivial 0.07	Possibly (13/14/73) Moderate -0.63	Likely (7/8/85) Moderate -0.95
HSR (m·min^{-1})	Likely (2/13/85) Trivial -0.15	Likely (7/18/75) Small -0.48	Possibly (18/22/60) Small -0.34	Most Likely (0/1/99) Very Large -2.10
VHSR (m·min^{-1})	Possibly (42/39/19) Trivial 0.13	Likely (0/4/96) Small -0.52	Likely (8/9/83) Moderate -0.92	Most Likely (0/0/100) Large -1.81
Sprint (m·min^{-1})	Possibly (10/38/52) Small -0.22	Likely (12/8/80) Moderate -0.95	Likely (9/6/85) Large -1.23	Likely (12/4/84) Very Large -2.14
Sprint effort (efforts/min)	Likely (5/14/81) Small -0.57	Likely (6/7/87) Moderate -0.99	Likely (3/3/94) Large -1.53	Most Likely (2/2/96) Large -1.67

Effect sizes were interpreted as <0.2, trivial; 0.2-0.6, small; 0.6-1.2, moderate; 1.2-2.0, large; >2.0, very large. HSR, high-speed running (>14.4 km·h^{-1}); VHSR, very-high-speed running (>19.0 km·h^{-1}); Sprint, sprint distance (>23.0 km·h^{-1}); Sprint Efforts, number of sprint efforts (>23.0 km·h^{-1}).

Discussion

This case study quantified the movement demands and running intensities of semi-professional rugby league players during a RL9's tournament. In agreement with previous research (Kempton and Coutts, 2015), the results from the current study support the hypothesis that running intensities are reduced during the course of a RL9's tournament over consecutive days. Differences in the running intensities were observed between the playing positions with the biggest differences observed in high intensity running speeds. It must be noted that there was also variation in playing time, and when distances were expressed relative to time on field, there were fewer differences and these related more to higher-speed efforts. The outside backs covered significantly more distance in VHSR and sprint than the forwards and more sprint distance and sprint efforts than the adjustables. These observed changes in movement intensities may not only reflect the differences in physical capabilities of the positional groups but also the specific positional role requirements and the space available due to their location on the field (Gabbett, 2002).

The absolute and relative running intensities observed in the current study are lower than those reported by Kempton and Coutts (2015), who describe relative running distances of 115 to 121 m·min^{-1} for professional players during an International RL9's tournament. These variances reflect the differences in the playing level and hence the intensities between the two studies. Studies involving rugby league typically show that playing intensities at the professional level are higher than those at the semi-professional and amateur level (Catterick et al., 2009). Gradual reductions in running intensities were

Table 4. Positional differences in running intensities over the two days competition. Chance that magnitude of change between two games is higher/no difference/lower (100/0/0).

Variable	Variable	Day 1	Day 2	Magnitude of change and effect size
Outside Backs	$m \cdot min^{-1}$	92.6 (91.3-94.0)	80.1 (70.5-89.7)	Likely (8/8/84); Moderate -0.88
	HSR	7.1 (5.4-8.9)	5.8 (4.5-7.1)	Likely (1/4/94); Moderate -0.74
	VHSR	4.9 (4.4-5.4)	3.3 (2.5-4.1)*	Most Likely (1/1/98); Very Large -2.32
	Sprint	4.3 (2.9-5.6)	5.6 (3.3-7.9)	Possibly (67/15/18); Small 0.46
	# Sprint Eff	.2 (.3-.1)	.3 (.2-.3)	Possibly (72/17/11); Small 0.44
Forwards	$m \cdot min^{-1}$	77.9 (72.2-83.5)	69.3 (63.8-74.9)	Possibly (5/27/69); Small -0.28
	HSR	6.6 (5.0-8.2)	6.0 (4.5-7.5)	Possibly (24/18/57); Small -0.29
	VHSR	3.0 (2.3-3.7)	2.0 (1.2-2.7)	Most Likely (2/2/97); Moderate -0.93
	Sprint	1.6 (.8-2.3)	.9 (.1-1.7)	Possibly (21/7/72); Moderate -0.93
	# Sprint Eff	.1 (.1-.2)	.1 (.1-.1) *	Likely (4/6/89); Moderate -0.87
Adjustables	$m \cdot min^{-1}$	72.4 (57.8-87.0)	75.2 (70.3-80.1)	Possibly (7/18/75); Small -0.41
	HSR	7.1 (3.9-10.3)	5.2 (4.4-6.0)	Possibly (13/26/62); Small -0.28
	VHSR	3.6 (1.9-5.3)	2.6 (1.7-3.6)	Possibly (24/21/55); Small -0.24
	Sprint	3.0 (1.6-4.4)	1.6 (1.0-2.1)	Most Likely (2/1/97); Very Large -2.19
	# Sprint Eff	.2 (.1-0.2)	.1 (.1-0.1) *	Most Likely (2/3/95); Large -1.35
Whole Team	$m \cdot min^{-1}$	79.1 (70.1 – 88.0)	75.1 (69.4 – 80.1)	Possibly (3/32/65); Small -0.28
	HSR	6.8 (5.4 - 8.2)	5.1 (4.9 - 6.5)	Likely (2/20/78); Small -0.39
	VHSR	3.2 (2.8- 4.5)	2.8 (2.2 - 3.3) *	Likely (1/12/87); Small -0.49
	Sprint	2.8 (1.9 – 3.6)	2.7 (1.3 – 4.1)	Likely (3/18/79); Small -0.45
	# Sprint Eff	.2 (.1 – .2)	.1 (.1 –0.2)	Likely (3/25/71); Small -0.35

Effect sizes were interpreted as <0.2, trivial; 0.2-0.6, small; 0.6-1.2, moderate; 1.2-2.0, large; >2.0, very large. HSR, high-speed running (>14.4 $km \cdot h^{-1}$); VHSR, very-high-speed running (>19.0 $km \cdot h^{-1}$); Sprint, sprint distance (>23.0 $km \cdot h^{-1}$); Sprint Efforts, number of sprint efforts (>23.0 $km \cdot h^{-1}$).

observed over the course of the tournament with trivial to moderate decreases in running intensities reported between the individual games. This gradual reduction over the course of the tournament resulted in a moderate to very large decrease in running intensities when comparing the first game in the tournament on day 1 to the last game in day 2. Conversely, a decrease in running intensity was detected not only between individual games but also between the two days of the tournament. When analyzing the team as a whole the biggest decreases were observed in the high intensity running activities with very large reductions in HSR and sprint on the second day of the tournament. These reductions in running intensities are in accordance with previous studies of intensified competitions involving soccer (Rowsell et al., 2011), rugby league (Johnston et al., 2013b) and field hockey (Spencer et al., 2005).

Research suggests that during intensified competitions residual fatigue prior to games contributes to reductions in high-intensity match activities (Johnston et al., 2013a). Johnston et al. (2013b) reported that when senior rugby league players have only 48 hours between matches there are progressive reductions in neuromuscular function, perceptions of wellbeing and increases in markers of muscle damage. While there is limited data on RL9's competition (Kempton and Coutts, 2015), when taken in context with studies from other team sports, the implications of accumulative residual fatigue become more apparent. Research involving junior basketball players noted that fatigue accumulated over a 3-day tournament culminated in reductions in speed, agility and vertical jump performances (Montgomery et al., 2008). Furthermore, a study monitoring junior soccer players across a 4-day tournament reported reductions in high speed running, total distance and time spent in heart rate zones (Rowsell et al., 2011). While acute measures of physiological fatigue were not collected in the current study, the abovementioned studies highlight the potential negative effects of residual fatigue on performance outcomes.

When comparing the different positional groups running intensities over the two days of the tournament in the current study, it was found that the outside backs covered significantly less relative distance at VHSR while the forwards and backs performed significantly less sprint efforts on day two than they did in day one. It is likely that the reduction in running intensities observed were, in part, the result of residual fatigue from the previous games. This attenuation in running intensities may have ramifications on match outcomes. Gabbett (2014) found that successful semiprofessional rugby league teams (Top 4 teams) perform a greater amount of sprinting than less successful teams (Bottom 4 teams), which could be related to more line breaks being made by the more successful teams. However, the magnitude of difference in sprinting performance between Top 4 and Bottom 4 teams is not clear.

Conclusion

These results of this case study highlight the value of monitoring athletes' running intensities over the course of a RL9's tournament style competition where players are involved in high intensity match play with short rest periods between games. This is an important consideration, especially for players who regularly perform high intensity running (like outside backs), as they may experience a larger decrease in running performance than other positions. Such decreases in running intensities may also have implications on match outcomes, as less successful teams cover less sprinting distance than successful teams (Gabbett, 2014). The frequency of repeated high-intensity-effort bouts is also reported to be greater in winning teams (Gabbett, 2013). Therefore, maintenance of this performance quality should be emphasized in the planning and implementation of recovery strategies between games to reduce the accumulation of residual fatigue.

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Key points

- Running intensities are decreased during an intensified rugby league 9's tournament in semi-professional rugby league players.
- Forwards and backs performed significantly less high-intensity sprint efforts on day two than day one of the tournament.
- Appropriate planning and implementation of recovery strategies between games may reduce the potential effects of residual fatigue.

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