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Influence of field position and phase of play on the physical demands of match-play in professional rugby league forwards

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ABSTRACT

Objectives: No study has investigated the influence of field position and phase of play on the physical demands of match-play in professional rugby league forwards. We investigated the physical demands placed on forwards in elite rugby league matches, with special reference to how these demands differed between attack and defence, and in different field positions.
Design: Cohort study.
Methods: Twenty-two rugby league players (26 ± 3 years) from the same professional club participated in this study. Global positioning system (GPS) analysis was completed during 23 matches. Video footage was synchronised with the GPS files and coded for the time spent in attack and defence, and in one of three different field positions (0–30 m, 31–70 m, 71–100 m).
Results: The physical demands of defence were consistently greater than attack. Moderate to large differences (ES = 0.62–1.41) were found between defence and attack for distance covered (109 ± 16 m/min vs. 82 ± 12 m/min), low speed distance (104 ± 15 m/min vs. 78 ± 11 m/min), frequency of collisions (1.9 ± 0.7/min vs. 0.8 ± 0.3/min), and repeated high-intensity effort bouts (1 every 4.9 ± 5.1 min vs. 1 every 9.4 ± 6.1 min). The running demands and frequency of repeated high-intensity effort bouts were greater when defending in the opposition's 30 m zone (i.e. 71–100 m), with repeated high-intensity effort bouts also occurring more frequently when defending the team's own try-line and when attacking the opposition's try-line.
Conclusions: Specific training drills designed to replicate the attacking and defensive demands of different field positional zones are likely to be effective in preparing players for the most demanding activities that occur in professional rugby league match-play.

1. Introduction

Rugby league is a collision sport, characterised by intermittent, high intensity efforts and tackles,[1–3] that are separated by short bouts of lower intensity activity.[4–6] The game is played over two, 40-min halves, separated by a 10-min rest interval. A team consists of 17 players, with 13 players allowed on the field at any one time, and a maximum of 10 interchanges permitted per match. Positions can generally be divided into 2 categories (forwards and backs), and further sub-divided into hit up forwards (i.e. prop), wide running forwards (i.e. second row and lock), adjustables (i.e. hooker, half-back, five-eighth, and fullback), and outside backs (i.e. centre and wing). As rugby league is a physically demanding sport, players require a range of physical qualities including muscular strength, power, speed, and endurance,[7] and the ability to perform and withstand physical collisions during defensive and attacking phases of play.[8]

The physical demands of rugby league are different between playing positions,[9–11] with backs typically covering greater total distances than forwards. Gabbett et al.[5] reported higher absolute distances covered during match-play for outside backs than hit-up forwards, wide running forwards, and adjustables, but similar relative distances (~93–101 m/min) among positions. Austin and Kelly[9] studied rugby league players across an entire National Rugby League season and also showed similar relative distances between forwards (75–97 m/min) and backs (72–100 m/min). During the course of a rugby league match, players are also exposed to a large number of tackles and physical collisions with hit-up forwards and wide running forwards recording a higher number of collisions than adjustables, and outside backs.[5,12,13] It is generally

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considered that forwards are predominantly involved in larger numbers of physical collisions and tackles, whilst backs spend more time free running, with a greater emphasis on high speed running and sprinting.[6,14]

Due to the large number of collisions in which forwards engage during competition, and the considerable fatigue associated with these collisions,[15] forwards are typically the only players interchanged during a match.[16] As such, professional rugby league teams often use 'real-time' global positioning system data to inform these interchanges and ensure players are rested before experiencing significant reductions in playing intensity.[17] Forwards have been shown to experience greater muscle damage than backs, which is thought to occur as a result of repeated blunt force trauma.[18] Moreover, significant associations have been reported between the total number of physical collisions experienced by forwards during match-play and the increase in post-match muscle soreness ($r = 0.62$), perceptual fatigue ($r = 0.69$), creatine kinase activity ($r = 0.74$), and lower-body neuromuscular fatigue ($r = 0.55$).[14] Similar findings have not been observed in backs, demonstrating the intense physical demands associated with forwards match-play.

To date, only one study has assessed the demands of rugby league attack and defence.[12] Sykes et al.[12] used semi-automated video analysis to investigate the physical demands of the English Super League competition. Outside backs covered significantly less total distance and had less demanding work to rest ratios (1:13) than all other positional groups, with the most demanding work to rest ratio (1:9) occurring for back rowers. The results also showed that all positional groups spent significantly less time walking, and more time jogging when defending, compared to attacking. Outside backs, adjustables, and props were shown to spend significantly more time running when defending than attacking, with back rowers spending significantly less time walking and more time in physical contact when defending. Overall, the study highlighted that with the exception of outside backs, defending was more physically demanding than attacking, due to decreased recovery whilst defending.

While the study by Sykes et al.[12] provided important information on the physical demands of attack and defence, data were only collected from 3 matches. Given the large between match variability in team sport activity profiles, observations from multiple matches may be necessary in order to obtain an accurate representation of the physical demands of match-play.[17,19] In addition, no information was provided on the influence of field position on these movement demands. It has recently been shown that ~70% of tries scored in the elite National Rugby League competition occur in close proximity to repeated high-intensity effort bouts,[20] suggesting that the intensity of matches may increase when players are either attacking or defending the try-line. Moreover, tactical strategies employed by attacking and defending teams typically change depending on field position; teams will generally focus on ball security and maintaining possession when attacking in their own territory, and pass the ball more freely when attacking the opposition's try-line. Equally, defending teams will generally compress their defensive line when defending in the opposition's 30 m zone, with players required to defend greater spaces closer to their own try-line. These tactical strategies are likely to influence both the contact and running demands of match-play. In the present study, we investigated the physical demands of match-play in elite rugby league forwards, during matches played across an entire National Rugby League season. In addition, the extent to which these demands differed between attack and defence, and in different field positions was investigated.

2. Methods

Twenty-two elite rugby league players (mean ± SD age, 26 ± 3 years) from the same professional National Rugby League club participated in this study. All participants received a clear explanation of the study, including information on the risks and benefits, and written consent was obtained. All experimental procedures were approved by the Institutional Ethics Committee for Human Investigation.

Global positioning system (GPS) analysis was completed during 23 matches (totalling 226 appearances). Of the 23 matches, the team won 16 and lost 7 with an average points scored and conceded of 24 ± 12 and 15 ± 8, respectively. The team won the premiership for the season under analysis. Due to a club emphasis on monitoring the demands placed on forwards, only hit-up forwards (i.e. props), wide-running forwards (i.e. second rowers and locks), and hookers were included in the analysis. As most forwards (particularly the props) do not play the entire 80 min of a match, and often only play 40 min, players were required to have competed in at least 28 min of the match (i.e. 70% of game-time)[21] to be included in the analysis.

Movement was recorded by a minimaxX GPS unit (Catapult Innovations, Melbourne, Australia) sampling at 10 Hz. The GPS signal provided information on speed, distance, position, and acceleration. The GPS unit also included tri-axial accelerometers and gyroscopes sampling at 100 Hz, to provide information on physical collisions and repeated high-intensity efforts. The minimaxX units used the accelerometers and gyroscopes to detect collisions. For a collision to be detected, the unit was required to be in a non-vertical position, meaning the player was leaning forward, backward, or to the left or right. Instantaneous player load was calculated from the sum of the three axes of acceleration. A spike in the instantaneous player load shortly before the change in orientation of the unit was also required for the collision to be detected.[8] All mild (1–2 G; contact made with player but able to continue forward progress/momentum out of tackle), moderate (2.1–4 G; contact made with player, forward progress/momentum continued until tackled), and heavy (>4 G; contact made with player, forward progress/momentum stopped, and forced backwards in tackle) collisions were summed to provide the total number of collisions for each player. The unit was worn in a small vest, on the upper back of the players.

Data were categorised into (i) movement speed bands corresponding to low (0–5 m s^{-1}) and high (>5 m s^{-1}) speeds[5]; (ii) collisions[8]; and (iii) repeated high-intensity effort bouts.[5] A repeated high-intensity effort bout was defined as 3 or more high acceleration (≥2.79 m s^{-2}), high speed, or contact efforts with less than 21 s recovery between efforts.[5] The 10 Hz minimaxX units have been shown to have acceptable validity and reliability for measuring the movements commonly performed in team sport competition.[22] In addition, the minimaxX units have been shown to offer a valid measurement of the collisions that commonly occur in rugby league, with the standard error of the estimate between collisions recorded by the minimaxX units and those coded from video recordings of the actual collision events reported to be 4.7%.[3] The intraclass correlation coefficient for test-retest reliability and typical error of measurement for the detection of collisions was 0.95% and 3.0%, respectively.[8] Finally, the validity of the minimaxX units to quantify repeated high-intensity effort bouts was determined by having players perform 2 to 4 bouts of 6 tackles, with each tackle separated by ~10 s of low-intensity activity. The standard error of the estimate between repeated high-intensity efforts recorded by the minimaxX units and those coded from video recordings of the actual repeated high-intensity effort bout was 5.6%.[3]

Video footage from the 23 matches was obtained from the official competition broadcaster and manually analysed post game. All matches were filmed from an elevated position on the half-way