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Movement patterns in rugby sevens: Effects of tournament level, fatigue and substitute players

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Abstract

Objectives: Understanding of the physical demands and the effects of fatigue and substitute players in rugby sevens is limited. This study quantified the differences in movement patterns between domestic and international rugby sevens tournaments, the effects of fatigue within and between matches during tournaments, and movement patterns of second half substitute players.
Design: Movement patterns of 19 international-level male rugby sevens players were recorded using a Global Positioning System (GPS) device during 11 international and 16 domestic matches ($n = 174$ files).
Methods: Maximum velocity, total distance covered, distance covered in velocity zones and number of moderate and high accelerations and decelerations are reported per min of match time. Movement patterns were compared between international and domestic matches, first and second half, first and last tournament match and substitute and full-match players.
Results: Substantially greater distance was covered at high velocity (~27% at $\geq 6\,m\,s^{-1}$) and 4–39% more accelerations and decelerations were performed in international than domestic matches. The relative distance covered by players at velocities $>2\,m\,s^{-1}$ and the number of changes in velocity were reduced by 1–16% from first to second half. Small differences were observed in activity at $<5\,m\,s^{-1}$ (−8–8%) and moderate accelerations (−18%) from first to last tournament match. All movement variables were higher (2–123%) for substitute players.
Conclusions: International rugby sevens competition is more intense than domestic matches. Despite reductions in work-rate within individual matches, there is little indication of accumulated fatigue over a multi-day tournament.

Keywords: GPS; Time-motion analysis; Game analysis; Acceleration; Sprint

1. Introduction

The popularity of rugby sevens has spread rapidly in recent years and the sport is now played at the domestic and international level all over the world. In 2009, rugby sevens was formally included in the Olympic Games from 2016. Rugby sevens is an abbreviated variant of rugby union in which two teams, each with seven players on the field, compete for two 7 min halves with a 2 min half time interval. Rugby sevens is played on a full dimension rugby union field under substantially the same laws as 15-player rugby union. Given the increasing number of international competitions in rugby sevens, the transition from the domestic to international stage is an important consideration for players and coaches, yet to date, there is no scientific review of the likely differences in game demands between international- and domestic-level competition.

Rugby sevens competitions differ from 15-player rugby union in that they are usually played over 2- or sometimes 3-day tournaments. Teams play three group stage matches on day one and two, typically with ~3 h between matches and then, depending on results, up to three finals matches on the last day. The ability of players to repeat short duration, high intensity running efforts on multiple occasions over several

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days and changes in movement patterns over the duration of a tournament have not been previously examined. The use of tactical player substitutions in the latter stages of a match is a strategy often adopted by coaches to mitigate the potential effect of fatigue in reducing individual and team performance. However, the work-rate contribution of substitute players in rugby sevens is unknown.

Only one previous study has examined the movement patterns of players during rugby sevens competition.[1] This study was conducted during a tournament in 1996 and its relevance to the modern game is limited by changing game demands and player characteristics observed in rugby union over recent years.[2,3] Furthermore, the introduction of new measurement and analysis techniques such as Global Positioning System (GPS) technology now allows for the velocity and distances covered by players to be quantified.[4,5] Understanding the movement patterns of rugby sevens will assist coaches prescribing and implementing sport-specific training programs that replicate the physical demands of competition. The aims of this study were to use GPS technology to: (1) quantify the differences in movement patterns between domestic and international tournaments; (2) quantify changes in movement patterns within and between matches during tournaments to examine the effects of player fatigue; and (3) assess the movement patterns of second half substitute players.

2. Methods

A prospective, observational, longitudinal study design was used to assess the movement patterns of 19 international-level male rugby sevens players (age 21.2 ± 2.7 y; body mass 89.7 ± 7.3 kg; height 1.81 ± 0.05 m; mean $\pm$ SD) during 16 matches played over three domestic tournaments and 11 matches played over two international (International Rugby Board World Series) tournaments. Written informed consent was obtained from all players. The study was approved by the University of Canberra Committee for Ethics in Human Research and Australian Institute of Sport Ethics Committee.

The international tournaments were in Adelaide, Australia and Wellington, New Zealand in the Southern Hemisphere summer and autumn months. The domestic Australian tournaments were played in Central Coast, Gold Coast and Darwin during the spring and summer months. Domestic tournaments were sanctioned by the Australian Rugby Union but not part of a formal series. These tournaments were contested for prize money by teams comprising of amateur through to semi-professional players and officiated by local referees. Typically teams arrive ~4 days before an international tournament and undertake one or two training sessions each day. For domestic tournaments, most teams arrive 1–2 days before commencement and also undertake a light training session per day. All matches were played on standard outdoor natural grass fields.

Movement patterns were assessed by fitting players with a MinimaxX GPS device (Team Sport v2.5, Catapult Innovations, Melbourne, Australia) recording at 5 Hz. The standard error of the estimate (validity) of distance covered at <2–5 m s^{-1} for these units ranges from 1.7–3.8% and CV (reliability) from 1.2–2.6%.[5] For a 20 m sprint, the estimate for validity is 17% and 23% for reliability.[4] The GPS device was positioned between the scapulae of the player using an elasticised harness worn underneath the playing attire. The device was activated and satellite lock established for a minimum of 15 min before the commencement of each match. Data were downloaded and analysed using Logan Plus 4.4.0 software (Catapult Innovations, Melbourne, Australia). Movement patterns were quantified based on distance covered in specific velocity zones (0–2 m s^{-1}, 2–3.5 m s^{-1}, 3.5–5 m s^{-1}, 5–6 m s^{-1} and $\geq$6 m s^{-1}), maximum instantaneous velocity and an acceleration/deceleration profile. The chosen velocity zones represent the range of locomotor activity profiles typical of intermittent team sport and are routinely used during GPS monitoring in Australian rugby union. Acceleration and deceleration characteristics were assessed by the number of times a player performed a moderate (2–4 m s^{-2}) or high (>4 m s^{-2}) acceleration or deceleration (moderate -4 to -2 m s^{-2} and high <-4 m s^{-2}) for a minimum duration of 0.4 s. Matches were categorised based on the tournament level (domestic or international) and the order of match played within the tournament (first or last). The effect of player substitutions on movement patterns was assessed by comparing the second half measures of players that played the entire match with those that played less than 4 min. The half time interval, any time a player spent off the field and stoppage time were excluded from analyses. A total of 174 match files were included for analysis.

Data were log-transformed prior to analysis to reduce the non-uniformity of error and back-transformed to obtain differences in means and variation as percents. Descriptive statistics (mean $\pm$ SD) were used to characterise movement patterns. Data are expressed relative to game time played (per min) to account for variations in playing time from match to match and for player substitutions. Magnitude-based inferences on differences within and between tournaments were made by standardising differences using the between-subject SD. Precision of estimates are indicated with 90% confidence limits (CL). Magnitudes of standardised effects were assessed as 0–0.2 trivial, 0.2–0.6 small, 0.6–1.2 moderate, 1.2–2.0 large, and >2.0 very large.[6] The effect was reported as unclear when the confidence interval of the standardised difference crossed the threshold for both substantially positive (0.2) and negative (-0.2) values. The coefficient of variation (CV) expressed as a percent was calculated to characterise the variability of movement pattern parameters.

3. Results

Substantial differences between movement patterns during international and domestic tournament matches were