Variable Changes in Body Composition, Strength and Lower-Body Power During an International Rugby Sevens Season

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Abstract

Mitchell, JA, Pumpa, KL, Williams, KJ, and Pyne, DB. Variable changes in body composition, strength and lower-body power during an international rugby sevens season. *J Strength Cond Res* 30(4): 1127–1136, 2016—This study determined whether body composition, strength, and power changes that occur during preseason can be maintained during an international rugby sevens season. Fourteen male international rugby sevens players (age 21.4 ± 2.2 years; mean ± *SD*) were categorized as forward ($n = 7$) or back ($n = 7$), and assessed for height, mass (M), skinfolds (S) ($\sum 7$), upper-body (UB) strength, lower-body (LB) strength, and LB power. Bench press, back squat, and a countermovement jump were used to measure strength and power at 3 time points: initial, early season, and late season. Forwards were taller (185 ± 4 cm), heavier (95 ± 6 kg), and possessed a greater lean body mass (55.5 ± 4.0 $M \cdot S^{-0.14}$) than backs (181 ± 8 cm, 88.5 ± 5.5 kg, and 51.9 ± 3.4 $M \cdot S^{-0.14}$). Over the full season, small (~5 ± 5%; mean ± 90% confidence limits) positive changes occurred in body composition. Lower-body strength gained during the preseason, decayed in-season, whereas UB strength increased moderately (~10 ± 3%) across the season. Power showed inconsistencies between measured variables with a moderate positive change across the season in mean velocity and relative peak power. Forwards showed a small decrease in peak power (relative and absolute). Moderate changes were observed in mean power over the season, forwards decreasing (~6 ± 6%) and backs increasing (~8 ± 6%). Rugby sevens forwards in this study found it difficult to maintain and improve power qualities in-season. Training loads of forwards and backs should be differentiated to maximize strength and power in-season.

KEY WORDS preseason, in-season, back squat, bench press, countermovement jump

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Introduction

Rugby sevens is a collision-based, high-intensity modified version of 15-a-side rugby union. The Sevens World Series (SWS) is regarded as the highest level of competition in which 15 core nations compete in 9 tournaments played in 9 different countries over a period of 8 months. International rugby sevens players require highly developed speed, mobility, power, and endurance to tolerate the physical demands of competition (16,23). Players demonstrate acceleration, speed, muscular power, and endurance qualities that are similar to, if not better than, professional rugby union players (17). Rugby sevens players are categorized into 2 distinct playing positions i.e., forward or back and typically commence their playing career in rugby union as a loose forward or back (26). Rugby sevens players cover on an average 113 $m \cdot min^{-1}$, 45% greater distance per min than rugby union with a higher proportion of that distance at high velocity (>6 $m \cdot s^{-1}$) highlighting the high running demands required (16). Game analyses indicate rugby sevens forwards spend 19% more time jogging, and backs spend 8% more time running (24,26), although other studies reported no clear delineation between playing positions in rugby sevens (17,27). However, rugby sevens forwards perform exclusive skill sets such as scrummaging, line outs, and restarts in training and competition. These exclusive skills require careful consideration when planning the strength and conditioning program to maximize the expression of lower-body strength and power.

To meet the demands of rugby sevens, players possess similar body mass and height to professional backs in rugby union, while being substantially leaner (17). Forwards in rugby sevens are typically taller and heavier than backs, although the magnitude of difference is less than in rugby union (25), whereas international players are taller and heavier than provincial level players (25). The anthropometric characteristics of international rugby sevens players correlate with estimates of work-rate such as work-to-rest ratios, distance, intensity, and time (23). As such, an investigation into the effect that body mass has on relative strength and power characteristics would be valuable, to assist in determining appropriate training variables and in the selection of rugby sevens players.

Field-based contact team sports such as rugby union and rugby league, are characterized by frequent high-intensity sprints and a high degree of physical contact (29). In rugby league, high levels of strength and power are required to effectively perform tackling, lifting, pushing and pulling tasks, and to tolerate the heavy tackles and collisions that occur during a match (15). High levels of muscular strength and power are thought to be critical to success in collision-based sports (26). Given the high collision nature of rugby sevens, it follows that assessment of strength and power qualities would be advantageous in determining player readiness to participate in high collision activities.

Several authors have highlighted the importance of strength and power in rugby sevens (17,26,30). Other collision-based sports such as rugby union and rugby league have reported comparable ranges of lower- and upper-body strength in players (1,4,9). Forwards in rugby union are generally stronger than backs in the lower and upper body, likely due to requirements of strength in scrums and a higher frequency of tackles and rucks (21,29,30). More recently, rugby union players were physically assessed in the preseason and then differentiated at the end of the season by the coach into high- and low-playing ability groups. Backs identified as having high-playing ability by the coach demonstrated higher absolute lower-body strength as measured by a 1 repetition maximum (RM) back squat suggesting a relationship between lower-body strength and playing performance (1). In rugby sevens, international players appear to be stronger in the upper body than provincial level players, and forwards are stronger than backs (25). Although cross-sectional comparisons are useful, practitioners need more information on the patterns of within-and-between athlete changes, and differences in lower-body and upper-body strength that may occur across a full international rugby sevens season.

Power in rugby sevens, expressed through the skills of sprinting, jumping, and tackling, is typically assessed in a countermovement jump using a linear position transducer to measure speed of movement and distance (25,26). Peak power and relative peak power are the primary variables of interest when analyzing neuromuscular fatigue and performance in rugby sevens (25,33). In the testing completed 1month before rugby sevens tournaments (1 international and 1 provincial), international level players and forwards were more powerful (than backs) in both absolute and relative measures (25). Players reported as possessing greater peak power in countermovement jumps were more effective in both attacking and defensive rucks during game play (28). Further research is required in characterizing power output variables and the time course, direction, and magnitude of changes that may occur over a full season of rugby sevens. This information is useful in determining any player positional differences that may occur as a result of specific training requirements and game demands associated with scrummaging, line outs, and restarts.

It is apparent that concurrent strength, rugby sevens skills practice, and energy system training (or endurance) across the rugby sevens season needs to be considered carefully to optimize the physical requirements of players. To date there has been limited research into the strength and power requirements of rugby sevens players. With the inclusion of rugby sevens as an Olympic sport, the strength and power characteristics of rugby sevens playing positions, and how they change across an international SWS season becomes increasingly important when formulating a periodized annual plan.

Methods

Experimental Approach to the Problem

To establish whether changes occurred across the season, initial upper-body and lower-body strength, and lower-body power measurements were collected in bench press, back squat, and an instrumented countermovement jump at the start of the preseason (initial), start of the competition season (early season), and end of the competition season (late season). Changes within-subjects, and differences between forwards and backs were assessed for preseason (initial to early season), in-season (early to late season), and full season (initial to late season). Effects were quantified to establish whether there had been substantial changes between phases and the full season as a result of the training and game demands of playing international rugby sevens.

Subjects

Fourteen male international rugby sevens squad players (7 backs and 7 forwards) participated in this study (age 21.4 ± 2.2 years; mean ± *SD*). These players had ~1.7 years of specific international rugby sevens training and playing experience (range 1–4 years). Each player was informed of the benefits and risks of this investigation before signing a University of Canberra informed consent document to participate in this study. This study was approved by the University of Canberra Committee for Ethics in Human Research (Project 12–68).

Procedures

The SWS season consisted of 40 weeks that were divided into preseason and in-season training periods. The preseason training period consisted of 12 weeks, 1 regional international tournament, and ~3 lifting sessions per week ($n = 13$ upper-body, $n = 12$ lower-body and $n = 11$ combined upper and lower sessions) with an average weekly running volume of ~12 km. The in-season training period consisted of 28 weeks, 9 SWS tournaments, ~2.5 lifting sessions per week ($n = 40$ upper-body, $n = 33$ lower-body sessions) with an average weekly running volume of ~15 km. Players completed lifting programs that were tailored to the individual's training experience, musculo-skeletal concerns, and rugby sevens requirements. Testing was conducted as part of regular strength and conditioning lifting sessions (see Table 1) in line with the rugby sevens periodized plan. Tables 2 and 3

Table 1. Key exercises performed during strength and conditioning lifting sessions.

			In-tournament	
Upper body lift	Lower-body lift	Combined lift	Lift 1-strength	Lift 2-power
Jump squats Bench press Chin ups Military press	Olympic lift* Squat or box squat Romanian deadlift	Olympic lift* Deadlift Bench pull	Olympic lift* Squats Bench press Chin ups	Jump squats Bench press† Push press

*Power Clean or Snatch variations.
†Explosive with bands for accommodative resistance.

provide examples of preseason, in-season, and tournament training weekly schedules. Tests were selected using recommendations for the assessment of rugby union players as previously documented (32). Players were instructed to consume their regular pretraining diet, and where possible, refrain from intense exercise at least 48 hours before any scheduled testing. Only data collected on players free of injury and illness at the time of testing are reported.

Body composition was assessed by measurement of body mass, height, and skinfold thickness using standard laboratory techniques (32). The sum of 7 sites (millimeter) biceps, triceps, subscapular, suprailiac, abdomen, front thigh, and medial calf skinfolds is reported. The typical error of measurement for sum of 7 skinfolds is 1.3 mm and <1% for body mass and height. Lean mass index (LMI) was calculated for each subject as $M \cdot S^{-0.14}$, where M is body mass (kg) and S is sum of skinfolds (millimeter) (32).

Upper-body and lower-body strengths were assessed using an estimated 1RM for the bench press and back squat exercises, respectively (1,32). The bench press required the player to lay in a supine position, and using a self-selected grip width, lower a free weight barbell to their chest and then return the barbell to full arm extension. Players were not permitted to bounce the bar off the chest, and the feet and hips had to remain in contact with the ground and bench, respectively. The grip width was self-selected by the subject in accordance with previous protocols. The back squat required the subject to support a free weight barbell on their upper back, and through movements of the lower body, descend to a depth whereby the anatomical hip crease had moved below the apex of the patella. Players were instructed to have a comfortable foot placement approximately shoulder width apart with feet abducted. No supportive equipment of any kind was permitted during the back squat. Testing loads were based on previous training loads as determined by the strength and conditioning coach (1). Subjects then completed the following preliminary loads 5 × 65%, 5 × 75% and 3 × 85% of their predicted 1RM. Players were required to lift 95% of their prescribed 1RM load to failure. An estimated 1RM was determined from the final number of completed repetitions at the 95% load using an established 1RM prediction equation (10). Data for the bench press and back squat is presented in absolute and relative terms, and scaled allometrically to the power of 0.62 as recommended in previous studies (11,26).

Lower-body muscular power assessment was assessed using a linear position transducer given acceptable validity, reliability, and portability to estimate power similar to a force

Table 2. Preseason and in-season standard weekly training plans.

Phase	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Preseason	Combined lift conditioning field skills training	Upper lift speed skills	Conditioning	Speed lower lift	Field skills training	Recovery	Off
In-season	Lift*; speed; field skills training	Lift*; conditioning; field skills training	Recovery	Speed; field skills training	Lift*; conditioning; field skills training	Field skills training	Off

*Lift is alternate day upper the lower-body focus.

Table 3. Example of a SWS tournament week.*

Game +1†	Game +2	Game −3‡	Game −2	Game −1	Game day 1	Game day 2
Recovery Field skills training	Mixed lift 1 Game simulation	Recovery Field skills training	Mixed lift 2	Field skills training	3 games Recovery	2/3 games Recovery

*SWS = Sevens World Series.
†+1 representing 1 day post games or travel.
‡−3 representing 3 days before game day 1.

plate when measuring jump performance (12). Before the lower-body muscular power assessment, all players completed a 10 minutes standardized warm-up using a space approximately 20 m long and 3 m wide consisting of a series of dynamic exercises (e.g., 60–70% jogging, lateral or carioca, low to high skipping, jumping or hopping, dynamic hamstring or quadriceps or low-back movements) (33). The linear position transducer was anchored to the ground on the right side of the player and attached to the right hand side of a broomstick (45 g). In the start position, the subject was required to support the broomstick on their upper back (with their hands), and through movements of the lower body perform a countermovement jump. The foot position and depth of the countermovement jump was self-selected by the player with the instruction to jump as high as possible (3). Players completed 6 countermovement jumps with allowance to reset the feet to the start position between repetitions, with the mean value of all 6 jumps being reported. A displacement-time curve for each jump was obtained by attaching a digital optical encoder through a cable (GYMAWARE Power Tool; Kinetic Performance Technologies, Canberra, Australia) to one side of the broomstick.

Table 4. Changes in anthropometric measures from the initial to early season (preseason), early season to late season (in-season), initial to late season (full season) phases.*†

	Time point			Standardized mean change (Cohen's)		
	Initial	Early season	Late season	Preseason	In-season	Full season
Body composition	$x \pm SD$	$x \pm SD$	$x \pm SD$	$\Delta x \pm$ 90% CL	$\Delta x \pm$ 90% CL	$\Delta x \pm$ 90% CL
Players combined, $n = 14$						
Height (cm)	183.2 ± 6.4	183.2 ± 6.4	183.1 ± 6.3			
Mass (kg)	92.1 ± 7.1	91.5 ± 6.3	92.2 ± 6.5	−0.07 ± 0.11	0.09 ± 0.09	0.02 ± 0.15
Skinfolds-∑7 sites (mm)	54.5 ± 11.6	53.59 ± 10.9	51.65 ± 12.5	−0.07 ± 0.25	−0.16 ± 0.18	−0.23 ± 0.34‡
LMI ($M \cdot S^{-0.14}$)	53.6 ± 3.9	53.4 ± 3.8	54.09 ± 4.0	−0.06 ± 0.09	0.17 ± 0.07	0.11 ± 0.13
Backs, $n = 7$						
Height (cm)	181.1 ± 7.8	181.1 ± 7.8	181.1 ± 7.8			
Mass (kg)	89.1 ± 6.3	88.0 ± 5.6	88.6 ± 5.0	−0.14 ± 0.14	0.08 ± 0.12	−0.06 ± 0.20
Skinfolds-∑7 sites (mm)	50.8 ± 7.6	49.2 ± 9.4	46.7 ± 10.0	−0.18 ± 0.38	−0.29 ± 0.27‡	−0.47 ± 0.55‡
LMI ($M \cdot S^{-0.14}$)	51.8 ± 3.6	51.5 ± 3.3	52.3 ± 3.40	−0.08 ± 0.10	0.21 ± 0.11‡	0.13 ± 0.17
Forwards, $n = 7$						
Height (cm)	185.2 ± 4.2	185.3 ± 4.1	185.1 ± 4.2			
Mass (kg)	95.1 ± 6.7	95.0 ± 5.2	95.8 ± 6.1	−0.01 ± 0.20	0.11 ± 0.15	0.10 ± 0.25
Skinfolds-∑7 sites (mm)	58.2 ± 14.2	57.94 ± 11.0	56.6 ± 13.5	−0.01 ± 0.39	−0.08 ± 0.28	−0.10 ± 0.50
LMI ($M \cdot S^{-0.14}$)	55.5 ± 3.6	55.3 ± 3.5	55.8 ± 3.9	−0.03 ± 0.19	0.12 ± 0.12	0.09 ± 0.25

*LMI = lean mass index.
†Mean change ± 90% confidence limits (CL).
‡0.2–0.6 small.
§0.6–1.2 moderate.

TABLE 5. Changes in lower- and upper-body strength measures from the initial to early season (preseason), early season to late season (in-season), initial to late season (full season) phases.*

	Time point			Standardized mean change (Cohen's)		
	Initial	Early season	Late season	Preseason	In-season	Full season
Strength	$x \pm SD$	$x \pm SD$	$x \pm SD$	$\Delta x \pm$ 90% CL	$\Delta x \pm$ 90% CL	$\Delta x \pm$ 90% CL
Players combined, $n = 14$						
Lower-body strength						
Squat absolute (kg)	143.4 ± 23.3	152.10 ± 22.3	142.4 ± 17.9	0.35 ± 0.24†	−0.39 ± 0.23†	−0.04 ± 0.17
Squat relative ($w \cdot kg^{-1}$)	1.6 ± 0.2	1.7 ± 0.2	1.6 ± 0.2	0.43 ± 0.30†	−0.48 ± 0.27†	−0.05 ± 0.22
Squat ($w \cdot kg^{0.62}$)	8.6 ± 1.0	9.2 ± 1.1	8.6 ± 1.0	0.59 ± 0.34‡	−0.59 ± 0.34‡	0 ± 0
Upper body strength						
Bench absolute (kg)	114.2 ± 12.5	120 ± 11.2	124.4 ± 12.3	0.44 ± 0.25†	0.33 ± 0.17†	0.77 ± 0.30‡
Bench relative ($w \cdot kg^{-1}$)	1.2 ± 0.1	1.3 ± 0.2	1.4 ± 0.2	0.45 ± 0.26†	0.24 ± 0.15†	0.70 ± 0.27‡
Bench ($w \cdot kg^{0.62}$)	6.9 ± 0.8	7.3 ± 0.7	7.5 ± 0.8	0.29 ± 0.17†	0.29 ± 0.17†	0.76 ± 0.29‡
Backs, $n = 7$						
Lower-body strength						
Squat absolute (kg)	133.7 ± 22.0	145.6 ± 20.7	138.3 ± 18.7	0.47 ± 0.34†	−0.29 ± 0.34†	0.18 ± 0.19
Squat relative ($w \cdot kg^{-1}$)	1.5 ± 0.2	1.7 ± 0.2	1.6 ± 0.2	0.75 ± 0.52‡	−0.46 ± 0.46†	0.29 ± 0.22†
Squat ($w \cdot kg^{0.62}$)	8.3 ± 1.1	9.1 ± 1.0	8.6 ± 0.9	0.64 ± 0.45‡	−0.39 ± 0.41†	0.25 ± 0.21†
Upper body strength						
Bench absolute (kg)	114.8 ± 9.8	122.3 ± 10.9	124.5 ± 12.0	0.66 ± 0.39‡	0.20 ± 0.34†	0.86 ± 0.47‡
Bench relative ($w \cdot kg^{-1}$)	1.3 ± 0.1	1.4 ± 0.2	1.4 ± 0.2	0.69 ± 0.39‡	0.12 ± 0.26	0.80 ± 0.34‡
Bench ($w \cdot kg^{0.62}$)	7.1 ± 0.6	7.6 ± 0.7	7.7 ± 0.8	0.72 ± 0.41‡	0.16 ± 0.30	0.88 ± 0.41‡
Forwards, $n = 7$						
Lower-body strength						
Squat absolute (kg)	153.2 ± 21.6	158.6 ± 23.4	146.6 ± 17.5	0.22 ± 0.39†	−0.48 ± 0.39†	−0.26 ± 0.22†
Squat relative ($w \cdot kg^{-1}$)	1.6 ± 0.3	1.7 ± 0.2	1.5 ± 0.2	0.16 ± 0.37	−0.44 ± 0.37†	−0.28 ± 0.26
Squat ($w \cdot kg^{0.62}$)	9.1 ± 1.4	9.4 ± 1.3	8.7 ± 1.1	0.19 ± 0.38	−0.46 ± 0.39†	−0.28 ± 0.24
Upper body strength						
Bench absolute (kg)	113.7 ± 15.5	117.8 ± 11.7	124.4 ± 13.7	0.23 ± 0.33†	0.37 ± 0.15†	0.60 ± 0.41‡
Bench relative ($w \cdot kg^{-1}$)	1.2 ± 0.2	1.2 ± 0.1	1.3 ± 0.1	0.23 ± 0.37†	0.32 ± 0.18†	0.55 ± 0.45†
Bench ($w \cdot kg^{0.62}$)	6.8 ± 0.88	7.0 ± 0.6	7.4 ± 0.7	0.24 ± 0.36†	0.35 ± 0.17†	0.58 ± 0.44†

*Mean change ± 90% confidence limits (CL).
†0.2–0.6 small.
‡0.6–1.2 moderate.

TABLE 6. Changes in lower-body power measures from the initial to early season (preseason), early season to late season (in-season), initial to late season (full season) phases.*

	Time point			Standardized mean change (Cohen's)		
	Initial	Early season	Late season	Preseason	In-season	Full season
Power	$x \pm SD$	$x \pm SD$	$x \pm SD$	$\Delta x \pm$ 90% CL	$\Delta x \pm$ 90% CL	$\Delta x \pm$ 90% CL
Players combined, $n = 14$						
Jump height (m)	0.49 ± 0.07	0.50 ± 0.06	0.50 ± 0.07	0.21 ± 0.41	−0.01 ± 0.23	0.20 ± 0.38†
Peak velocity ($m \cdot s^{-1}$)	3.8 ± 0.3	3.9 ± 0.3	3.8 ± 0.4	0.30 ± 0.29†	−0.17 ± 0.24	0.14 ± 0.34
Mean velocity ($m \cdot s^{-1}$)	2.4 ± 0.2	2.5 ± 0.2	2.5 ± 0.2	0.45 ± 0.52†	0.23 ± 0.44	0.69 ± 0.56‡
Peak power (W)	7,764 ± 1,443	7,643 ± 1,177	7,194 ± 1,526	−0.08 ± 0.22	−0.29 ± 0.31	−0.37 ± 0.38
Mean power (W)	4,402 ± 558	4,502 ± 442	4,453 ± 615	0.17 ± 0.40	−0.08 ± 0.32	0.09 ± 0.41
Peak power ($w \cdot kg^{-1}$)	84.7 ± 15.2	83.7 ± 13.6	78.1 ± 17.4	−0.07 ± 0.20	−0.34 ± 0.34†	−0.41 ± 0.39†
Mean power ($w \cdot kg^{-1}$)	48.0 ± 5.7	49.2 ± 5.3	48.4 ± 7.5	0.20 ± 0.39†	−0.14 ± 0.34	0.06 ± 0.43
Backs, $n = 7$						
Jump height (m)	0.52 ± 0.88	0.54 ± 0.06	0.55 ± 0.07	0.30 ± 0.62	0.03 ± 0.36	0.33 ± 0.57
Peak velocity ($m \cdot s^{-1}$)	3.9 ± 0.3	4.0 ± 0.3	4.0 ± 0.3	0.28 ± 0.50	0.08 ± 0.32	0.36 ± 0.54†
Mean velocity ($m \cdot s^{-1}$)	2.4 ± 0.2	2.5 ± 0.2	2.6 ± 0.1	0.49 ± 0.75	0.46 ± 0.61†	0.96 ± 0.56‡
Peak power (W)	7,752 ± 1,236	7,755 ± 1,119	7,991 ± 1,507	0.00 ± 0.39	0.17 ± 0.45	0.17 ± 0.44
Mean power (W)	4,451 ± 445	4,640 ± 492	4,821 ± 467	0.37 ± 0.79†	0.35 ± 0.59†	0.72 ± 0.51‡
Peak power ($w \cdot kg^{-1}$)	87.7 ± 13.4	87.7 ± 12.4	89.5 ± 16.2	0.00 ± 0.33	0.12 ± 0.51	0.12 ± 0.47
Mean power ($w \cdot kg^{-1}$)	50.4 ± 4.9	52.4 ± 5.3	54.0 ± 5.3	0.36 ± 0.68	0.30 ± 0.60	0.66 ± 0.53‡
Forwards, $n = 7$						
Jump height (m)	0.46 ± 0.04	0.46 ± 0.03	0.46 ± 0.03	0.03 ± 0.68	−0.09 ± 0.33	−0.06 ± 0.52
Peak velocity ($m \cdot s^{-1}$)	3.6 ± 0.3	3.7 ± 0.3	3.6 ± 0.3	0.34 ± 0.42†	−0.50 ± 0.35†	−0.16 ± 0.43
Mean velocity ($m \cdot s^{-1}$)	2.4 ± 0.1	2.4 ± 0.1	2.4 ± 0.1	0.29 ± 0.69	−0.18 ± 0.45	0.11 ± 0.90
Peak power (W)	7,777 ± 1,726	7,531 ± 1,312	6,397 ± 1,137	−0.12 ± 0.26	−0.57 ± 0.22†	−0.70 ± 0.36‡
Mean power (W)	4,352 ± 686	4,364 ± 369	4,084 ± 535	0.02 ± 0.45	−0.36 ± 0.22†	−0.34 ± 0.43†
Peak power ($w \cdot kg^{-1}$)	81.8 ± 17.4	79.6 ± 14.6	66.8 ± 9.7	−0.11 ± 0.27	−0.64 ± 0.27‡	−0.75 ± 0.40‡
Mean power ($w \cdot kg^{-1}$)	45.7 ± 5.9	46.0 ± 3.0	42.7 ± 4.2	0.05 ± 0.56	−0.49 ± 0.25†	−0.44 ± 0.52†

*Mean change ± 90% confidence limits (CL).
†0.2–0.6 small.
‡0.6–1.2 moderate.

This data was uploaded to the GYMAWARE website and exported to Excel for analysis. This system recorded displacement-time data for reported measures (see Table 6) with a mean coefficient of variation of 13% and intraclass correlation of 0.815.

Statistical Analyses

Descriptive data are reported as mean and *SD*. Inferences on changes in body composition or strength and power test score from phase to phase of the rugby sevens season were made using a student's *t*-test for dependent samples. Precision of estimation was indicated with 90% confidence limits (CLs). Effect sizes were reported in standardized (Cohen) units as the change in the mean with 90% CLs (18). Criteria to assess the magnitude of observed changes were 0.0–0.2 trivial; 0.20–0.60 small; 0.60–1.20 moderate; and >1.20 large. An effect was deemed unclear if its confidence interval spanned both substantial positive and substantial negative values (±0.20 × between-subject *SD*) (18).

Results

Rugby sevens forwards were substantially taller, heavier, and possessed greater lean muscle mass than backs (see Table 4). The combined cohort of backs and forwards showed little change in body mass, skinfolds, and lean muscle mass across the overall course of the season. The backs showed small (~5 ± 5%; mean ± 90% CL) decreases in skinfolds over the full season, with a small increase in lean mass in-season.

Both forwards and backs showed small (~7 ± 4%) increases in lower-body strength in the preseason (see Table 5). Backs had a moderate (~10 ± 3%) increase in lower-body strength (back squat) in the preseason when expressed relative to body weight and allometrically scaled, whereas changes in the forwards were unclear and trivial, respectively. The increases in lower-body strength gained during the preseason were lost in-season with the backs having the same levels by the end of the season, and the forwards decreasing (~4 ± 3%) below initial levels. Conversely, upper-body strength (bench press) showed small (forwards) to moderate (backs) improvements over the full season. Backs exhibited the biggest increases in the preseason (~9 ± 4%) plateauing in-season to show a moderate increase by the end of the season, whereas the forwards continued to have small increases in upper-body strength throughout the season (~5 ± 3%).

Lower-body power scores in the countermovement jump are presented in Table 6. The combined cohort showed moderate positive changes (~6 ± 4%) across the season in mean velocity. Backs had a small increase in peak velocity with moderate increases in mean velocity, mean power, and mean power $w \cdot kg^{-1}$ (~8 ± 6%). Forwards showed small increases (~3 ± 3%) in peak velocity in the preseason with moderate (~18 ± 7%) decreases in peak power, both absolute and relative with no change in jump height. All power variables for forwards showed a marked decrease over the full season. In both backs and forwards, moderate changes (positive and negative) were observed in mean power, both relative and absolute for the full season.

Discussion

This is the first study to quantify the changes in body composition, strength, and power as they relate to playing position over a full season of international rugby sevens. During the preseason, early season, and late season phases, upper-body strength showed small improvements for the full season, whereas lower-body strength increased in the preseason before falling away in-season. Lower-body power increased in the backs and decreased in the forwards over the duration of the season. The upper-body and lower-body strength scores confirm preliminary reports that rugby sevens players display similar physical qualities to outside backs in rugby union. Given the different time course of changes in strength and power between forwards and backs, it is prudent for the strength and conditioning coach to prescribe position-specific training programs that account for potential auxiliary lower limb loading on field during specific skill practice.

The rugby sevens players as a combined group were younger and heavier with similar stature to other reports (17,25,30). When differentiating between playing position, the backs were ~2% heavier and within the height ranges previously reported, whereas the forwards were ~2% heavier at the same height in 1 study (24) and ~2% lighter and ~1% shorter than players in 2 other studies (14,25). In this study the weight and stature of rugby sevens forwards and backs compared closely with outside backs in rugby union (14). When players were differentiated by playing ability and position, both forwards and backs showed similar body composition to backs of high-playing ability in rugby union and to rugby sevens players of international standard (1,25). The combined player sum of 7 skinfolds was consistent with previous rugby sevens research whereas lean mass was 3.3% higher across the full season (17). Rugby sevens skinfolds and lean mass presented over 1 season is substantially leaner than professional rugby union players reported over a period of 2 full seasons (13). Forwards had higher total skinfolds than backs, which is consistent with the 2 other studies that investigated skinfolds and differentiated between playing positions in rugby sevens (24,25). The higher sum of 7 skinfolds in forwards is likely related to the extra collisions in scrums, rucking, mauling, and tackling (21,29,30). Across the full season the backs showed small decreases in skinfolds with a small increase in lean mass in-season as shown previously (20). Significantly, there was no negative body composition change for the full season suggesting that the training and nutritional program maintained player body composition for a full international rugby sevens season.

To date, no other study has reported on the assessment of lower-body strength in rugby sevens using a back squat.

Lower-body strength showed a small increase in absolute and relative values during the preseason although notably these improvements were not maintained in-season. The early season squat testing showed lower absolute strength when compared with other rugby codes. In contrast, these results were higher or comparable with relative lower-body strength scores reported in rugby union (1,3,9). When compared with backs in professional rugby union, rugby sevens forwards and backs have similar relative lower-body strength values whereas rugby sevens backs are 15% lower in absolute terms (1). Previous research reported an 8.5% increase in lower-body strength across a rugby union season (4). The inverse relationship in lower-body strength between the preseason gains and in-season losses may be attributed to a number of factors including changes in lower-body stimulus scheduling in-season, international travel requirements, increased tournament scheduling, and the ability to recover from high running loads (~20% higher-unpublished research) in-season, and impact collisions that are integral to rugby sevens (16,27,30), although it appears that maximal strength and power can be maintained at preseason levels for long in-season periods (6,19). There are 2 other possible explanations for this decay in lower-body strength. Firstly, forwards need superior lower-body strength to perform the skills of scrummaging, line outs, and restarts of play in both training and games. Measurement of force during an instrumented, individual player-simulated scrum session showed values ~52% less than a reported box squat measures and ~50% less than back squat (22,31). This additional lower-body load experienced exclusively by forwards would contribute to overall lower-body fatigue and should be considered when structuring the training week to optimize lower-body strength gains. Secondly, a box squat replaced the back squat exercise in-season (see Table 1) as a quality control measure to ensure players were maintaining a minimum squat depth. This action may also account for the decrease in reported back squat strength. Biomechanical differences such as a narrower stance, lower force values, and greater anterior displacement of the torso in a back squat when compared with a box squat could result in the reduced ability to perform maximal back squat (due to the absence of back squat specificity) during the training phase (31).

Upper-body strength gains in the combined cohort were small through the preseason and in-season with an overall moderate increase across the full season similar to previous reports in rugby league (6). This outcome is contrary to a decay of 1.2% in rugby union players across the season which was attributed to professional athletes having a greater strength training background and thus reducing the likelihood of further strength improvements in-season (4). In this study the players were ~3 years younger with a ~9% lower bench press, which may be due to an inherently shorter strength training background. The backs had a moderate increase in bench press strength for the preseason similar to a previous study in rugby union (5). Compared to professional rugby union and rugby league players the combined cohort had up to 8% lower absolute bench press values; however, in relative terms they were much closer to reported measures of 1.2–1.5 $w \cdot kg^{-1}$ (2,8,9). The group was relatively homogenous when upper-body strength was differentiated for forwards and backs. A 5% difference between rugby sevens playing positions has been reported (combined international and provincial level players), whereas international rugby sevens players had a 20% greater bench press than provincial level players (combined backs and forwards) (25). Although upper-body strength continually improved over the duration of the rugby sevens playing season, the combined cohort bench press scores were 2.4% less than previously reported in international level players (25). It is important to note the increase in upper-body strength across the season suggesting that running and skill training loads had minimal impact on upper-body strength development.

It is apparent that no single lower-body power measure showed consistent changes in the combined cohort or when differentiating between forwards and backs. The reported variance in power variables may have been magnified by using a linear position transducer (in place of a force plate). Peak power and relative peak power can be useful in assessing rugby sevens players (25,33). Combined players showed peak power measures 16% higher than provincial and 13% lower than international level rugby sevens players, and peak power measures were 29% higher than a recent report on elite rugby sevens players (25,33). The backs in the current study showed small to moderate increases over the full season. In a comparison of squatting techniques it was suggested that a box squat (due to the reported reduced forces and higher rate of force development) could be an effective exercise to develop explosive strength (31). The replacement of back squat with a box squat in-season (see Table 1) may account for the moderate increases shown by the backs in the absence of scrummaging, line outs, and restarts of play. The decrease in power identified in the forwards may be in part relate to the specific training loads associated with scrummaging, line outs, and restarts of play possibly compounding neuromuscular fatigue, resulting in a decreased adaptation to power training. Additionally, in-season training schedule changes reduced the ratio of lower- to upper-body strength training stimulus by ~20% (see Table 2). Given the strong relationship between strength and power, the reduction in the strength training stimulus may have facilitated a similar reduction in power output over time (7).

A longitudinal study comprising multiple seasons would be beneficial to address chronic adaptations to strength and power training. Future investigations could determine the effect of running loads and position-specific skills training on strength and power of positional groups during both preseason and in-season. Determining the optimal training week structure, whereby strength and power gains in-season are maximized would be advantageous. It appears that neuromuscular function may be significantly reduced for greater than 120 hours post tournaments (34). Given that there were 9 tournaments and 28 in-season training weeks this research effectively excludes 32% of productive training time in-season.

Conclusion

This study systematically quantified the changes in strength and power across an international rugby sevens season. It appears that rugby sevens players have similar physique and physical qualities to professional level backs in rugby union. Upper-body strength continually increased throughout an international rugby sevens season, whereas lower-body strength gains made in preseason training proved difficult to maintain in-season. The ability to maintain and improve power for forwards during the season may be affected by the additional set piece requirements of scrummaging, line outs, and restarts. Training loads need to be carefully prescribed for forwards and backs to account for the potential decay of strength and power qualities.

Practical Applications

Consideration should be given to the lower-body demands of rugby sevens forwards to ensure that lower-body improvements made in the preseason can be maintained throughout in-season. These outcomes could be achieved by ensuring the ratio of lower-body to upper-body programming remains consistent through the season, managing training time parity and recovery between positions. Use of the box squat in-season may be useful for maintaining and increasing lower-body explosive power; however, care should be exercised when assessing the back squat if the box squat has been the primary lower-body strength modality.

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