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Match participation and movement demands in amateur domestic women's rugby union in New Zealand

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ABSTRACT

Objective

To describe the movement analysis and heart rate data of amateur domestic women's rugby union match activities.

Design

Prospective cohort study.

Methods

Data were collected from 69 amateur female club level rugby union players over two consecutive seasons, using heart rate and microtechnology devices. Total distance, maximum velocity, Player Load ([PL] accumulated accelerometer-derived load), and individual PL vectors (PL forward [PL_F], PL sideward [PL_S] and PL vertical (PL_V]), speed zones and heart rate variables were examined. Analysis by player position, player group, matches won and lost, and years of competition were conducted.

Results

Inside Backs recorded a significantly higher mean distance (3920.4 ±1,437.3 m) per-match than Front-Row-Forwards ($\chi^2_{(1)}$=12.6; *p*=0.0004 Friedman repeated measures ANOVA on ranks; *z*=-4.1; *p*<0.0001 Wilcoxon signed-rank post-hoc test; *d*=0.55 Cohen's effect size) and Outside-Backs ($\chi^2_{(1)}$=27.3; *p*<0.0001; *z*=-5.3; *p*<0.0001; *d*=0.36). As a result, backs recorded a significantly higher mean distance per-match (3,692.3 ±1,440.5 m) than forwards ($\chi^2_{(1)}$=4.9; *p*=0.0273; *z*=-2.5; *p*=0.0132; *d*=0.36). Players recorded a significantly higher max HR in 2018 per-match (192.6 ±34.7 b·min^{-1}) compared with 2019 ($\chi^2_{(1)}$=9.1; *p*=0.0025; *z*=-2.6; *p*=0.0087; *d*=0.20).

Conclusions

The results of this study suggest that the physical and physiological profiles of the playing positional groups at the amateur, domestic club level of women's rugby union were similar (but not the mean distance covered) and may be suggestive of generalised, rather than specialised, training regimes that fail to prepare players for higher levels of competition. Amateur women's rugby union may benefit from the incorporation of positional specific training that would provide forward playing positions with the opportunity to develop collision and contact abilities, while concurrently allowing backs a greater opportunity to train their high intensity running capacity.

INTRODUCTION

Rugby union is an intermittent contact invasion game, involving periods of high-intensity activity (i.e. running, collisions, scrummaging) interspersed with lower-intensity activities including periods of rest.[29] The incorporation of microtechnology (Global Positioning System [GPS] and integrated tri-axial accelerometer) devices has enabled researchers and practitioners to quantify the workloads experienced within team sports such as rugby union.[15, 29] Furthermore, the use of microtechnology has been reported to be a reliable indicator of the physical demands of team sports.[15] The knowledge attained from the incorporation of GPS microtechnology enables specialist coaching staff to monitor detailed sport-specific data and positional specific movement profiles.[15, 29] This is deemed to be invaluable[20] to coaching staff assisting with the facilitation of optimal player training programmes and therefore, match-play preparation.[9]

The physiological demands of male rugby union players have been reported at the international,[34] professional[9] and amateur[29] levels of participation. These studies have reported that the total mean distances vary per-match from 3,698 m[28] to 6,130 m[4] and that the majority of the game (83 to 86% of the total distance) is played at low intensity.[9, 28] Total match-play distance is however, dependent upon playing position, with back playing positions (e.g. halfback, stand-off, centres, wings and fullbacks) (7,227 m) covering more distance than forward playing positions (6,680 m).[16] Positional differences are also reported to exist in relation to the intensity of match-play, with back playing positions covering a greater relative distance than forward playing positions (71.9 versus 66.7 $m \cdot min^{-1}$, respectively).[16]

Contradictory literature has, however, been published stating that back playing positions covered slightly less high-speed distances (323 m vs 369 m) compared with the forward playing positions.[9] In addition to playing position, athletic calibre and age have been reported to impact on the distance covered throughout match-play with elite senior,[9] male amateur,[29] and junior[24] rugby union forwards covering 5,850 m, 4,260 m and 3,511 m, respectively.

Despite the ever increasing body of knowledge on male participation in rugby union, there is a paucity of published studies reporting on the physical and physiological demands of women's 15-a-side rugby union.[6, 8, 42, 43] The match demands of women's rugby union have utilised video data collection,[43] and GPS sampling rates at 5 Hz[42] and 10 Hz[6, 8] to obtain the data for respective studies. These studies[6, 8, 42] have reported a mean total distance per-match from 4,982 m[6] to 5,820 m,[42] with forwards covering a mean distance of 5,049 m[6] to 5,616 m[8] per-match, while backs covered a mean distance of 4,908 m[6] to 6,471 m[42] per-match. Of note, the study by Virr et al.[43] had limited numbers, with only four premier division club level players analysed per-match using video analysis and heart-rate monitors. The study by Suárez-Arrones et al.[42] utilised a 5 Hz GPS device on eight players during a single women's national rugby union match which may not be reflective of the demands occurring within the women's game or across a competition season. Only two studies[6, 8] utilised a GPS system at a greater sampling rate (10 Hz) in an effort to increase the validity and reliability of the data obtained.[40]

Although the movement demands of women's rugby union have started to be explained, these studies have been undertaken at either premier[6] or elite[8, 42] level of competitions. More recently, one study[8] reported the running demands of women's rugby union in New Zealand, covering seven matches of a provincial team, over one competition. As such, there is a paucity of studies reporting the physical and physiological demands at the amateur domestic level of women's rugby union. Therefore, the aim of this study was to quantify the match participation movement demands and physiological responses of senior amateur rugby union players by player roles and player positional groups over two consecutive seasons of domestic competition matches within New Zealand.

METHODS

A prospective cohort descriptive study was undertaken to record the movement demands and physiological responses of 69 (age: 26.5 ±7.4 years [range: 17.6 to 48.5 years]; Height: 1.67 m ±0.08m [range 1.50-1.80 m]; mass 87.1 kg ±18.9 [range 50-127 kgs] years playing experience 4.3 ±4.2 years [range 0-18 years]) amateur women 15-a-side rugby union players, in New Zealand, from the same team over two consecutive years participating in a domestic club level competition. A total of 34 players participated in the first season and 35 players competed in the second season. A total of 22 players participated in both competition seasons. All players were considered amateur, as they received no remuneration for participating in rugby union activities and derived their main source of income from other employment activities. Players competed in a single level competition where all teams (the number varied each year) played each other once before the top five were identified for a second-round top five and bottom six competition format. There were a total of 28 matches played under the rules and regulations of New Zealand Rugby, with matches comprising of two 40-minute halves, with a resulting match exposure of 558.6 match exposure hrs. Players were categorised according to their (1) playing group and (2) positional group.[9] These two groups were: (1a) Forwards (loose-head prop, hooker, tight-head prop, left lock, right lock, blind-side flanker, open-side flanker, and number eight) and (1b) Backs (halfback, first-five, left wing, second-five, centre, right wing, and full back); and (2a) Front-Row Forwards (loose-head prop, tight-head prop; left lock, right lock); (2b) Back-Row Forwards (hooker; blind-side flanker, open-side flanker, number eight); (2c) In-Side Backs (halfback; first-five, second-five, centre) and (2d) Out-Side Backs (left wing, right wing, full back). The hooker was included in the Back Row Forward's due to their roving style of play.[18] This would most accurately reflect the positions with similar match demands and enable comparisons to be undertaken. Utilising GPS and HR monitors, the players were measured during competition matches over the 2018 and 2019 competition seasons. Prior to the competition commencing, all players provided written consent to participate in the research and all procedures were approved by the institutional ethics committee prior to data collection.

Equipment and Procedures

Players heart rates (HR) were continuously monitored during match participation using a portable monitor (Team Heart Rate System, Polar, Kempele, Finland). Player movements were monitored using microtechnology devices (OptimEye S5 device; Catapult Innovations, Melbourne, Australia), worn in a custom designed pocket, within a vest supplied by the device manufacturer, between the shoulder blades. The devices produced a 10 Hz GPS sampling rate through the in-built GPS-chip. Additionally, the devices contained a tri-axial accelerometer, gyroscope, and magnetometer sampling at 100 Hz (firmware v.5.27). As such, the device could continuously monitor linear and rotational accelerations, direction, and orientation of the player during match-play. Post-match data were downloaded and trimmed (to include on-field match-play time only) using proprietary software (Openfield, Catapult Innovations, Melbourne, Australia). The use of GPS technology has been utilised for research in several sporting codes including soccer, rugby league, Australian football league[15] and rugby union[29, 34] and has been reported to be acceptable[35] and ecologically[22] valid when assessing contact-based team sports. The OptimEye S5 has been previously reported to have valid and reliable distance and speed measurements, with very high correlation (r=0.94) for distance covered and acceptable within- and between-device reliability for measuring acceleration forces.[2, 3]

Mean and peak HR for each match were calculated for each player. During each match, the following time and GPS-based variables were analysed: match time (min), total distance (m) and maximum velocity (Vel_{Max} in $m.s^{-1}$). Additionally, accumulated accelerometer-derived loads (arbitrary unit known as PlayerLoad (PL)) were calculated by the sum of accelerations in the mediolateral [x], anteroposterior [y] and vertical [z] directions to provide a measure of the total stress upon an athlete as a result of accelerations, decelerations, changes of direction and impacts.[3] The frequency, duration, and distance of locomotive activities were also obtained in six speed bands, as have been previously reported.[29]

Player Load (PL) is expressed as the square root of the sum of the squared instantaneous rate of change in each of the three vectors. The application of this variable as a marker of training load has been established against both internal[10] and external load[41] measures. PL has been shown to be reliable both between (1.02% Coefficient of Variation (CV)) and within devices (1.05% CV) for dynamic movements.[17] Further, within a team sport circuit, the reliability of PL was reported as having a CV of 4.9%. Additionally, PL demonstrates high inter-unit reliability within Australian Rules Football (1.94% CV).[17] There is a strong relationship between PL and total distance[5] and as such, the vertical vector of the PL equation can be removed, thereby providing a measure of acceleration in the medio-lateral and anterior-posterior planes only (Player Load Two-Dimensional (PL2D)).[27] Such 2D measures have recently been shown [31] to be more sensitive to collision load within contact based team sports such as rugby league. To report only low-speed activities (<2 $m{\cdot}s^{-1}$) the PL_{SLOW} was recorded. The PL_{SLOW} is accumulated through accelerations that are recorded in the three vectors of movement and is a proxy measure for the frequency and magnitude of low-speed exertions in rugby union (e.g., rucking and scrummaging)[37] that GPS or video analysis are unable to provide. The PL_{SLOW} is related (r^2=0.62) to collisions that occur during rugby union match-play.[39] The PL and 2DPL were recorded as well as the PL in each of the individual axes i.e. PL forward (PL_F), PL sideward (PL_S) and PL vertical (PL_V). Each PL variable were normalised for all match times (minutes) and reported in arbitrary units ($au{\cdot}min^{-1}$).

Statistical Analyses

All data were downloaded onto a Microsoft Excel spreadsheet and analysed with SPSS (IBM SPSS Statistics for Windows, Version 26.0.0 Armonk, NY: IBM Corp). Data were checked for normality and homogeneity of variance using a Shapiro-Wilk's test of normality. If tolerances were not met, equivalent non-parametric tests were utilised. Physical demands (i.e., PL, PL2D, PL_F, PL_S, PL_V, PL_{Slow}, Vel_{Max}) among player positions, and years of competition were compared using a 1-way analysis of variance (ANOVA) with a Tukey post-hoc test to determine the source of differences. Non-parametric data (Match duration, Distance, Relative Distance, HR_{Max} and HR_{Mean}, speed zones) were analysed with a Friedman repeated measures ANOVA on ranks. If notable differences were observed, a Wilcoxon signed-rank post-hoc test was conducted with a Bonferroni correction applied. A t-test was utilised to assess differences in player age. Cohen's effect size (d) were utilised to calculate practically meaningful differences between playing positions and for different levels of participation. Effect sizes of <0.19, 0.20-0.60, 0.61-1.20 and >1.20 were considered trivial, small, moderate, and large, respectively.[26] The level of significance was set at $p \leq 0.05$, and all data are expressed as means and standard deviations.

RESULTS

Players in the 2019 cohort were significantly older than the 2018 cohort (28.9 ±8.0 yr. vs. 24.2 ±6.0; $t_{(17)}$=-2.4; *p*=0.0289; *d*=0.66) (see Table 1). Players were involved in a total of 28 matches for an exposure of 558.6 match hrs. Although 2018 recorded a higher mean distance per-match (3,604.2 ±1,365.6 m), compared with 2019 (3,463.1 ±1,273.0 m; $\chi^2_{(1)}$=2.6; *p*=0.1088; *z*=-1.2; *p*=0.2355; *d*=0.11) this difference was not significant. There was a statistically significant difference that players recorded a higher Vel_{Max} in 2019 when compared with 2018 (5.78 ±1.02 vs. 5.77 ±1.27 m.s^{-1}; $F_{(139,84)}$2.04; *p*=0.002; *d*=0.01). Players recorded a significantly higher max HR in 2018 per-match (192.6 ±34.7 beats-per-minute) compared with 2019 (185.6 ±34.4 beats-per-minute; $\chi^2_{(1)}$=9.1; *p*=0.0025; *z*=-2.6; *p*=0.0087; *d*=0.20). Players recorded a significantly higher mean distance in the 1.2 to 2.5 m·s^{-1} velocity band in 2018 when compared with 2019 ($\chi^2_{(1)}$=4.0; *p*=0.0450; *z*=-2.4; *p*=0.0160; *d*=0.18).

Table 1: Summary of movement analysis and heart rate data for domestic amateur women's rugby union players in New Zealand by participation year and combined seasons of competition matches reported in distances and arbitrary units by means with standard deviation.

	2018	2019	Total
Players (n=)	34	35	69
Age (yr.)	24.2 ±6.0[b]	28.9 ±8.0[a]	26.5 ±7.4
Games (n=)	12	16	28
Match exposure (hr.)	239.4	319.2	558.6
Match time per player (min)	56.1 ±25.8	57.8 ±24.2	56.8 ±25.2
Match demands			
Distance (m)	3,604.2 ±1,365.6	3,463.1 ±1,273.0	3,546.6 ±1,329.2
Distance (m·min^{-1})	91.5 ±73.5	76.5 ±52.9	85.4 ±66.3
PL (au·min^{-1})	3.8 ±1.3	3.9 ±1.4	3.9 ±1.4
PL2D (au·min^{-1})	2.9 ±1.1	2.8 ±1.0	2.9 ±1.1
PL_F (au·min^{-1})	1.8 ±0.7	1.7 ±0.6	1.8 ±0.7
PL_S (au·min^{-1})	1.9 ±0.7	1.9 ±0.7	1.9 ±0.7
PL_V (au·min^{-1})	3.0 ±1.1	2.9 ±1.1	2.9 ±1.1
PLSlow (au·min^{-1})	2.7 ±0.8	2.6 ±0.8	2.6 ±0.8
Vel_{Max} (m.s^{-1})	5.8 ±1.3[b]	5.8 ±1.0[a]	5.8 ±1.2
Max HR (b·min^{-1})	192.6 ±34.7[b]	185.6 ±34.4[a]	189.5 ±34.8
Mean HR (b·min^{-1})	149.2 ±22.4	147.5 ±26.7	148.5 ±24.4
Running profile			
Band 1: 0.0 to 1.5 (m·s^{-1})	2,004.3 ±635.1	1,924.6 ±595.5	1,971.8 ±620.0
Band 2: 1.5 to 2.5 (m·s^{-1})	711.5 ±320.9[b]	654.6 ±295.5[a]	688.3 ±311.8
Band 3: 2.5 to 3.5 (m·s^{-1})	557.1 ±310.7	516.6 ±268.2	540.6 ±294.5
Band 4: 3.5 to 6.0 (m·s^{-1})	323.0 ±273.8	347.6 ±305.3	333.0 ±287.0
Band 5: 6.0 to 7.0 (m·s^{-1})	17.2 ±32.5	17.4 ±32.9	17.3 ±32.7
Band 6: 7.0 to 8.0 (m·s^{-1})	1.5 ±6.9	2.1 ±6.8	1.8 ±6.9

SD = standard deviation; min = minutes; m = metres; au·min^{-1} = arbitrary units per minute; PL = PlayerLoad; PL2D = PlayerLoad 2-dimension (frontal & sagittal); PL_F = player load in frontal plane; PL_S = PlayerLoad in sagittal plane; PL_V = PlayerLoad in transverse plane; PL_{SLOW} = Player Load <2 m·s^{-1} (metres per second); Vel_{Max} (m·s^{-1}) = Maximum Velocity (metres per second); HR = Heart rate; b·min^{-1} = beats-per-minute; Significantly different (*p*<0.05) than (a) = 2018; (b) = 2019.

Table 2: Summary of movement analysis and heart rate data for domestic amateur women's rugby union players in New Zealand for the 2018, 2019 and combined seasons of competition matches for player groups and player roles reported in distances and arbitrary units by means with standard deviation.

	Front-Row Forwards	Back-Row Forwards	Forwards	In-Side Backs	Out-Side Backs	Backs
Players (n=)	24	16	40	20	9	29
Age (yr.)	29.4 ±9.0[c]	27.5 ±6.5[c]	28.6 ±8.1[f]	23.0 ±4.5[ab]	24.0 ±5.7	23.3 ±4.8[e]
Games (n=)	28	28	28	28	28	28
Match exposure (hr.)	154.3	154.3	308.6	154.3	115.7	270.0
Match time per player (min)	57.9 ±24.3	57.3 ±25.0	57.6 ±24.6	55.5 ±25.8	56.3 ±25.8	55.9 ±25.8
Match Demands						
Distance (m)	3,189.2 ±1,195.7[bc]	3,669.2 ±1,161.1[a]	3,409.7 ±1,201.9[f]	3,920.4 ±1,437.3[ad]	3,410.5 ±1,399.5[c]	3,692.3 ±1,440.5[e]
Distance (m·min^{-1})	76.2 ±62.1[c]	88.4 ±66.2	81.8 ±64.1	93.4 ±68.3[a]	83.9 ±68.4	89.1 ±68.4
PL (au·min^{-1})	3.6 ±1.3[c]	4.1 ±1.3	3.8 ±1.3	4.2 ±1.5[a]	3.5 ±1.3	3.9 ±1.4
PL2D (au·min^{-1})	2.7 ±1.0	3.1 ±1.0[c]	2.9 ±1.0	3.1 ±1.1[b]	2.5 ±0.9	2.9 ±1.1
PL_F (au·min^{-1})	1.7 ±0.6[d]	1.9 ±0.7	1.8 ±0.7	1.9 ±0.7	1.6 ±0.6[a]	1.7 ±0.7
PL_S (au·min^{-1})	1.8 ±0.7	2.1 ±0.6[c]	1.9 ±0.7	2.1 ±0.8[b]	1.7 ±0.6	1.9 ±0.7
PL_V (au·min^{-1})	2.7 ±0.9	3.1 ±1.0[c]	2.9 ±1.0	3.2 ±1.2[b]	2.7 ±1.0	3.0 ±1.2
PLSlow (au·min^{-1})	2.7 ±0.9[d]	2.8 ±0.7[cd]	2.7 ±0.8	2.7 ±0.8[b]	2.3 ±0.7[ab]	2.5 ±0.7
Vel_{Max} (m.s^{-1})	5.2 ±0.9	5.5 ±0.8	5.3 ±0.8	6.2 ±1.0	6.3 ±1.6	6.2 ±1.3
Max HR (b·min^{-1})	191.1 ±38.1	190.1 ±29.5	190.6 ±34.3	188.5 ±39.1	188.3 ±29.8	188.4 ±35.3
Mean HR (b·min^{-1})	148.9 ±27.1	151.1 ±22.7	149.9 ±25.1	145.5 ±26.6	148.7 ±18.7	146.9 ±23.5
Running Profile						
Band 1: 0.0 to 1.5 (m·s^{-1})	1,867.4 ±621.4[c]	2,042.2 ±518.5	1,947.7 ±582.0	2,095.9 ±635.9[ad]	1,875.8 ±667.3[c]	1,997.4 ±658.1
Band 2: 1.5 to 2.5 (m·s^{-1})	678.4 ±314.8[b]	741.2 ±300.3[a]	707.3 ±309.3	718.7 ±311.5[d]	605.7 ±306.5[c]	668.1 ±313.7
Band 3: 2.5 to 3.5 (m·s^{-1})	470.1 ±259.1[b]	602.6 ±294.7[ac]	530.9 ±309.3	610.4 ±319.9[bd]	477.4 ±272.2[c]	550.9 ±306.2
Band 4: 3.5 to 6.0 (m·s^{-1})	189.2 ±166.9[bcd]	277.8 ±212.2[acd]	229.9 ±193.8[f]	466.2 ±357.7[abd]	413.6 ±283.4[abc]	442.7 ±327.0[e]
Band 5: 6.0 to 7.0 (m·s^{-1})	6.0 ±17.7[cd]	5.0 ±14.6[cd]	5.5 ±16.3[f]	26.6 ±38.9[ab]	33.7 ±41.7[ab]	29.8 ±40.3[e]
Band 6: 7.0 to 8.0 (m·s^{-1})	0.8 ±3.9[cd]	0.1 ±1.2[cd]	0.5 ±0.3[f]	2.3 ±7.7[ab]	4.2 ±10.8[ab]	3.1 ±9.2[e]

SD = standard deviation; min = minutes; m = metres; au·min^{-1} = arbitrary units per minute; PL = PlayerLoad; PL2D = PlayerLoad 2-dimension (frontal & sagittal); PL_F = player load in frontal plane; PL_S = PlayerLoad in sagittal plane; PL_V = PlayerLoad in transverse plane; PL_{SLOW} = Player Load <2 m·s^{-1} (metres per second); Vel_{Max} (ms) = Maximum Velocity (metres per second); HR = Heart rate; b·min^{-1} = beats per minute; Significantly different (*p*<0.05) than (a) = Front-Row Forwards; (b) = Back-Row Forwards; (c) = Inside Backs; (d) = Outside Backs; (e) = Forwards; (f) = Backs .

Front Row Forwards were significantly older (29.4 ±9.0 yrs.) than Inside Backs (23.0 ±4.5 yrs. $t_{(19)}$=3.2; p=0.0049) (see Table 2). As a result, forwards were significantly older than backs (28.6 ±8.1 vs. 23.3 ±4.5 yrs.; $t_{(29)}$=3.9; p=0.0005). Inside Backs recorded a significantly higher mean distance (3920.4 ±1,437.3 m) per-match than Front Row Forwards (3,189.2 ±1,195.7 m; $\chi^2_{(1)}$=12.6; p=0.0004; z=-4.1; p<0.0001; d=0.55) and Outside Backs (3,410.5 ±1,399.5 m; $\chi^2_{(1)}$=27.3; p<0.0001; z=-5.3; p<0.0001; d=0.36). As a result, Backs recorded a significantly higher mean distance per-match (3,692.3 ±1,440.5 m) than forwards (3,409.7 ±1,201.9 m; $\chi^2_{(1)}$=4.9; p=0.0273; z=-2.5; p=0.0132; d=0.36).

The Outside Backs recorded a significantly lower mean PL_{Slow} (2.3 ±0.7 au.min^{-1}) compared to Front Row Forwards ($F_{(112,6)}$=5.2; p=0.0211; d=0.50) and Back Row Forwards (2.7 ±0.9 au.min-1; $F_{(112,6)}$=8.2; p=0.0064; d=0.71) (see Table 6). The Inside Back's recorded a significantly mean higher distance in the 0.0 to 1.5 m·s^{-1} (2,095.9 ±635.9 m·s^{-1}) than Front Row Forwards (1,867.4 ±621.4 m·s^{-1}; $\chi^2_{(1)}$=5.7; p=0.0168; z=-2.8; p=0.0047; d=0.36) and Outside Backs (1,875.8 ±667.3 m·s^{-1}; $\chi^2_{(1)}$=19.5; p<0.0001; z=-4.7; p<0.0001; d=0.34). Forwards recorded a significantly lower mean distance per-match in the 3.5 to 6.0 m·s^{-1} (229.9 ±193.8 m·s^{-1}) velocity band than Backs (442.7 ±327.0 m·s^{-1}; $\chi^2_{(1)}$=36.1; p<0.0001; z=-7.9; p<0.0001; d=0.72).

DISCUSSION

This prospective study undertook to document the physical demands occurring in an amateur women's club rugby union team during match participation over two consecutive seasons. The results identified the physical and physiological profile of individual positional groups in amateur women's rugby union throughout match participation. Given the paucity of the availability of both GPS- and accelerometer-based variables in amateur women's rugby union, this study highlighted the importance of integrating microtechnology into the routine monitoring of amateur women's sports such as rugby union.

The reporting of total distance covered per-match in the current study revealed differences between the playing groups, but provides little comparison with other sporting studies.[15] However, by reporting the mean relative distance (m·min^{-1}) per-match, this provides a more accurate reflection of the intensity of the workload the player's undertake during the activity.[15] For example, by comparing the total distances in women's football (3,977 m to 9,997 m; mean: 7,797 ±1,976 m), women's hockey (5,541 to 6,154 m; mean: 5,824.5 ±329.5 m)[25] and other studies in women's rugby union (4,982 to 5,820 m, mean: 5,576.5 ±398.5 m),[6, 8, 42] it can be seen that the mean distance per-match in the current study was much lower by 40% (rugby) to 55% (football) of the total distances recorded. However, this does not account for the match duration. When comparing the relative distances in women's football (79.3 to 118.0 m·min^{-1}: mean 101.0 ±11.9 m·min^{-1}), hockey (79.0 to 115.0 m·min^{-1}: mean: 98.5 ±15.6 m·min^{-1})[25] and rugby (54.8 to 68.0 m·min^{-1}; mean: 61.4 ±9.3 m·min^{-1}),[6, 8, 42] the relative distance per-match in the current study was less (38.3 ±13.7 m·min^{-1}) by 38% (rugby) to 62% (football) of the relative distances covered per match. The differences between the current cohort and other studies indicated that the total and relative distances covered at the amateur club level were much lower and may be attributed to a difference in player fitness, playing style, match intensity, and player preparedness at the higher levels of participation.[28] Other aspects that should be considered are characteristics of the different sporting activities, number of physical contacts/impacts, body composition of participants, field size, player numbers, match duration and substitution rules.

Throughout the matches, the back-playing positions travelled greater total distances, including distances above 6.0 m·s^{-1} and accumulated PL and PL_V values, compared with the forward playing positions. This finding was not surprising, given the vertical component of running as this accelerometer-based metric accounts for between 50% to 60% of the overall three-dimensional load.[3] Interestingly, back playing positions accumulated a similar mean PL2D throughout match-play. This finding was highlighted in a previous study where players with a similar PL2D were likely to undertake comparable collisions and tackles.[14] A possible suggestion for this finding is that backs have both short bursts of changes in direction and are more often being tackled in open space. Conversely, the PL and PL_V for forwards is comprised predominantly of collision and tackle events in confined spaces, such as rucks and mauls, at a lower velocity. Although there were some subtle differences for a number of metrics (PL, PL_V and PL2D), the variance between positions was somewhat trivial from a practical perspective, suggesting that minimal differences were apparent in the physical demands of match-play at this level of competition. Further, such findings highlight the importance of incorporating a variety of external load metrics into the routine monitoring of collision-based sports such as women's rugby union, in order to adequately quantify the workload across different playing positions.

Although differences were noted between positional groups in regard to PL_{Slow}, from a practical perspective it appears that both forward and back playing positions accumulate similar loads from low velocity activities, such as physical collisions and tackles. This was contrary to previous work reporting that forwards attained greater PL_{Slow} than their back playing counterparts.[36] Such discrepancies may, however, be attributed to altered physical capacities and game play strategies between the examined cohorts.

The use of heart rate monitors have been previously utilised as an indicator for determining the physiological demands of the players[13] and can be a useful index of the overall physiological strain and quantification of the total work performed during match activities.[13] Although heart rate may be an effective way to measure the intensity of activities,[21] other factors may also influence the heart rate of players, such as the level of fatigue the player is experiencing. The maximum heart rates reported in this study may be an indication of the fatigue the players experienced during match participation and further studies may consider a fatigue monitoring scale to be incorporated into the study parameters.

The results of this study suggested that the physical and physiological profiles of the playing group at the amateur domestic club level of women's rugby union were quite similar and may be suggestive of generalised, rather than specialised, training regimes that fail to prepare players for higher levels of competition. Amateur women's rugby union may benefit from the incorporation of positional specific training that would provide forward playing positions with the opportunity to develop collision and contact abilities, while concurrently allowing backs a greater opportunity to train their high intensity running capacity. Although the use of microtechnology may not be available to the majority of amateur women's rugby union teams, measurements such as heart rate measurement and the use of scales such as the Borg Rating of Perceived Exertion (RPE)[11] may be useful in monitoring player loads. The various RPE scales have been reported[1, 7, 30] to be a valid measure of exercise intensity independent of participant sex[7, 19, 23] and age.[33, 38] These scales may provide the coaching and management team with an alternative means of assessing and monitoring exercise intensity[12, 32] in women's rugby union.

LIMITATIONS

The current study followed a domestic women's rugby union team during two years of competition matches. Therefore, the results reported in this study should be interpreted with caution and may not be transferable to other levels of rugby union participation. Additional information such as the number of tackles, contact events and scrums were not obtained and future studies would benefit from the inclusion of this information to assist with PL assessment.

CONCLUSIONS

The game participation physical demands in an amateur domestic women's rugby union team in New Zealand measured using heart rate and movement analysis indicated there was very little difference between positional groups. It was also apparent that the physiological profiles gathered from using microtechnology were much lower in rugby union when compared with other women's sports. Given the limited availability of microtechnology data at this level of competition, the study highlights the importance of integrating a variety of external load metrics into the routine monitoring of collision-based sports such as rugby union.

Practical Applications

- The findings of this study can be utilised to assist with the training and preparation for specific tactical strategies that are used in match environments for women's rugby union.
- Training for these roles should focus on the development of the aerobic capacity for both attack and defending roles as well as skill development and the development of anaerobic capacities.

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