

# AN EVALUATION OF THE PHYSIOLOGICAL DEMANDS OF ELITE RUGBY UNION USING GLOBAL POSITIONING SYSTEM TRACKING SOFTWARE

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## Abstract

The current case study attempted to document the contemporary demands of elite rugby union. Players (n = 2) were tracked continuously during a competitive team selection game using Global Positioning System (GPS) software. Data revealed that players covered on average 6,953 m during play (83 minutes). Of this distance, 37% (2,800 m) was spent standing and walking, 27% (1,900 m) jogging, 10% (700 m) cruising, 14% (990 m) striding, 5% (320 m) high-intensity running, and 6% (420 m) sprinting. Greater running distances were observed for both players (6.7% back; 10% forward) in the second half of the game. Positional data revealed that the back performed a greater number of sprints (>20 km/h) than the forward (34 vs. 19) during the game. Conversely, the forward entered the lower speed zone (6-12 km/h) on a greater number of occasions than the back (315 vs. 229) but spent less time standing and walking (66.5 vs. 77.8%). Players were found to perform 87 moderate-intensity runs (>14km/h) covering an average distance of 19.7 m (SD =14.6). Average distances of 15.3 m (back) and 17.3 m (forward) were recorded for each sprint burst (>20 km/h), respectively. Players exercised at ~80 to 85%  $VO_{2max}$  during the course of the game with a mean heart rate of 172 b/min (~88% HR max). This corresponded to an estimated energy expenditure of 6.9 and 8.2 MJ, back and forward, respectively. The current study provides insight into the intense and physical nature of elite rugby using “on the field” assessment of physical exertion. Future use of this technology may help practitioners in design and implementation of individual position-specific training programs with appropriate management of player exercise load.

はじめて、ラグビー選手のGPS測定を行った論文→しかし、被験者は2名のみのCase Study

【目的】パイロットスタディーとして、エリートラグビー選手のBKとFW別の試合中の運動様式をGPSを用いて測定する事  
→将来の研究のためのきっかけになる事を目的にしている

## 【方法】

被験者：2名（BK：SO、FW：FL）、25.0±3.6歳、104.6±10.4kg、193.3±9.7cm、 $VO_2$  max 53.3±2.1ml/kg/min  
→もともとの被験者は3名だった（LOの選手が前半のみで交替したため、データを採用せず）  
→被験者はセルティックスリーグとギネスプレミアシップ（プロリーグ）をプレイしている選手  
→ $VO_2$ maxは事前に研究室で測定

試合：プレシーズン最後の試合（シーズン前直前の試合）

機材：GPS（SPI Elite：GPSports）→1Hz(GPS)と100Hzの3軸の加速度計

統計：被験者が少ないため統計分析は実施せず

## 【結果】

### 心拍数

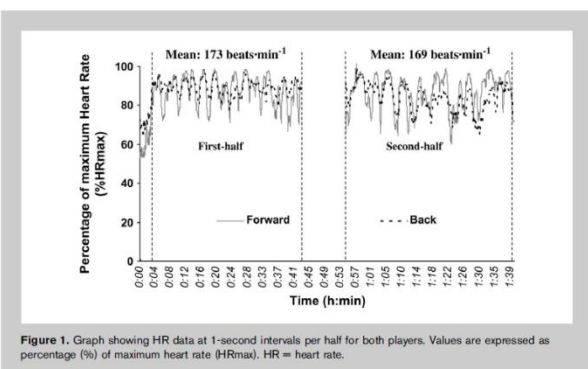


TABLE 1. Percent (%) time spent in each HR zone.\*†

Percent time per HR zone	Player position	
	Back	Forward
Zone 1: 0–60% HRmax	0 (0; 0)	1.8 (3.4; 0.1)
Zone 2: 60–70% HRmax	2.5 (2.0; 2.8)	3.7 (3.2; 4.9)
Zone 3: 70–80% HRmax	13.9 (5.3; 25.2)	15.7 (16.2; 18.3)
Zone 4: 80–90% HRmax	42.2 (45.6; 50.1)	27.7 (33.7; 30.6)
Zone 5: 90–95% HRmax	36.7 (38.4; 19.4)	35.7 (27.2; 28.0)
Zone 6: 95–100% HRmax	4.7 (8.7; 2.5)	15.4 (16.4; 18.1)

\*HR = heart rate.

†Values inside parentheses are values representative for first and second halves, respectively.

Zone4以上(80%HR以上)がBKが83.6%、FWが78.8%にも及ぶ

最大心拍数は172拍と200拍であった。平均心拍数はBK169拍、FW173拍

走行距離、平均速度、Speed Zone、Max Speed、加速

平均スピード : BK 1.19m/sec(71.9m/min)

FW 1.11m/sec(66.7m/min)

Speed Zone 設定はTable3の通り

Zone1:0-1.7m/sec (0-6km/h)

Zone2:1.7-3.3m/sec (6-12km/h)

Zone3:3.3-3.9m/sec (12-14km/h)

Zone4:3.9-5.0m/sec (14-18km/h)

Zone5:5.0-5.5m/sec (18-20km/h)

Zone6:5.5m/sec< (20km/h<)

High Intensity Running Distance: BK 816m、FW 655m、

HI Run Rate: BK 11.3%、FW 9.8%

TABLE 2. Game data per position and half.\*†

Work variable	Player position	
	Back	Forward
Total distance (m)	7,227 (3,318; 3,542)	6,680 (2,931; 3,236)
Distance/min	71.9 (78.9; 84.9)	66.7 (69.7; 77.5)
Total time (min)	83.49 (42.0; 41.4)	83.49 (42.0; 41.4)
Total HR exertion (AU)	25,762 (11,273; 9,855)	26,388 (10,785; 10,913)
HR exertion/min	309 (268; 238)	316 (256; 263)
Maximum HR (b·min <sup>-1</sup> )	199 (second half)	200 (second half)
Mean HR (b·min <sup>-1</sup> )	172 (177; 167)	170 (170; 171)
Mean work to rest ratio	1.5.7 (1:5.1; 1:4.7)	1.5.8 (1:5.7; 1:4.8)

\*AU = arbitrary units; HR = heart rate.

†Values inside parentheses are those for first and second halves, respectively.

TABLE 3. Distance (meters) covered by each player in designated speed zones.\*

Distance (m) within speed zone	Player position	
	Back	Forward
Standing and walking; 0-6 km·h <sup>-1</sup>	2,802 (1,247; 1,314)	2,409 (1,124; 1,110)
Jogging: 6-12 km·h <sup>-1</sup>	1,956 (794; 1,054)	1,856 (722; 948)
Cruising: 12-14 km·h <sup>-1</sup>	673 (332; 330)	746 (310; 362)
Striding: 14-18 km·h <sup>-1</sup>	978 (532; 439)	1,011 (479; 481)
High-intensity running; 18-20 km·h <sup>-1</sup>	292 (172; 120)	342 (138; 177)
Sprinting: >20 km·h <sup>-1</sup>	524 (241; 283)	313 (157; 159)

\*Values inside parentheses are those for first and second halves, respectively.

TABLE 4. Game acceleration and speed data per position and half.\*

Work variable	Player position	
	Back	Forward
Average speed (km·h <sup>-1</sup> )	4.3 (4.7; 5.1)	4.0 (4.2; 4.7)
Maximum speed (km·h <sup>-1</sup> )	28.7 (second half)	26.3 (second half)
No. of accelerations over 1.5 m·s <sup>-1</sup> in 1 s	85 (39; 46)	89 (43; 41)
No. of accelerations over 2.0 m·s <sup>-1</sup> in 1 s	41 (22; 18)	43 (19; 22)
No. of accelerations over 2.5 m·s <sup>-1</sup> in 1 s	10 (5; 5)	9 (7; 2)
No. of accelerations over 2.75 m·s <sup>-1</sup> in 1 s	5 (3; 2)	6 (6; 0)

\*Values inside parentheses are those for first and second halves, respectively.

Max Speed

BK: 7.97m/sec (28.7km/h)

FW: 7.30m/sec (26.3km/h)

加速 (Speed Change)

2.5m/s/s以上 FWとBKともに15回

TABLE 5. Number of entries/surges by players into each speed zone.\*

No. of surges within speed zone*	Player position	
	Back	Forward
Surges below 6 km·h <sup>-1</sup>	207 (88; 111)	220 (91; 112)
Surges between 6 and 12 km·h <sup>-1</sup>	229 (133; 158)	315 (132; 159)
Surges between 12 and 14 km·h <sup>-1</sup>	123 (54; 66)	125 (57; 61)
Surges between 14 and 18 km·h <sup>-1</sup>	116 (63; 51)	109 (53; 51)
Surges between 18 and 20 km·h <sup>-1</sup>	43 (26; 17)	46 (20; 24)
Surges above 20 km·h <sup>-1</sup>	34 (20; 14)	19 (10; 9)

\*Numbers of surges per speed zone are not exclusive locomotor efforts but rather the number of times players reached speeds above designated speed interval.

1.5m/s/sとは止まった状態から1秒に5.4m

2.0m/s/sとは止まった状態から1秒に7.2m

2.5m/s/sとは止まった状態から1秒に9.0m

2.7m/s/sとは止まった状態から1秒に10m

Table5 Speed Zone別の回数

インパクト”g” force

5-6g: 強い加速や減速、方向チェンジの衝撃

6-6.5g:グラウンドに倒れた程度の衝撃

6.5-7g:タックル程度の衝撃

7-8g:強いタックルの衝撃

8-10g:強烈なタックル、スクラムのエンゲージ

10g以上:さらに強いタックルや衝突の衝撃

TABLE 6. Game impact and body load data per position and half.\*†

Variable	Player position	
	Back	Forward
Light impact (5-6g)	349 (168; 169)	563 (201; 317)
Light-moderate (6-6.5g)	328 (152; 171)	398 (174; 188)
Moderate-heavy (6.5-7g)	55 (25; 30)	143 (37; 97)
Heavy (7-8g)	38 (15; 23)	101 (24; 71)
Very heavy (8-10g)	24 (15; 9)	56 (19; 35)
Severe (10 <sup>+</sup> g)	4 (2; 2)	13 (6; 7)
Total no. of impacts	798 (377; 401)	1,274 (461; 715)
Total body load (AU)	31,402 (16,483; 14,372)	119,103 (35,477; 78,058)
Body load/min	376 (392; 344)	1,426 (843; 1,883)

\*AU = arbitrary units.

†Values inside parentheses are those for first and second halves, respectively.

TABLE 7. Percent (%) time spent by players in each speed zone.\*

Percent time within speed zone	Player position	
	Back	Forward
Standing and walking; 0-6 km·h <sup>-1</sup>	77.8 (76; 72.6)	66.5 (78.3; 73.5)
Jogging: 6-12 km·h <sup>-1</sup>	13 (12.8; 16.9)	24.3 (11.9; 15.7)
Cruising: 12-14 km·h <sup>-1</sup>	3.1 (3.6; 3.7)	3.4 (3.4; 4)
Striding: 14-18 km·h <sup>-1</sup>	3.7 (4.8; 4.0)	3.8 (4.3; 4.4)
High-intensity running; 18-20 km·h <sup>-1</sup>	0.9 (1.3; 0.9)	1.1 (1.1; 1.4)
Sprinting: >20 km·h <sup>-1</sup>	1.4 (1.6; 1.8)	0.8 (1.0; 1.0)

\*Values inside parentheses are those for first and second halves, respectively.

TABLE 8. Estimated values for energy expenditure, oxygen consumption, and percentage of maximal oxygen consumption (VO<sub>2</sub>max) between position and half.\*

	Estimated oxygen consumption (ml·kg <sup>-1</sup> ·min <sup>-1</sup> )		VO <sub>2</sub> max		EE (MJ)	
	Back	Forward	Back	Forward	Back	Forward
First half	47	46	85	85	3.6	4.1
Second half	43	46	78	85	3.3	4.1
Total game	45	46	82	85	6.9	8.2

\*EE = estimation of energy expenditure.

【まとめ】

ラグビーユニオン(83.7m/min)はプロサッカー(118±7.5m/min)に比べると平均スピードは遅い(Alvarez JCB & Castagna C 2007)

ラグビーユニオンのエリート選手の試合時の運動様式をGPSを用いて測定し、上記のような結果が得られた