

Rugby union movement patterns: The impact of fatigue and substitute players

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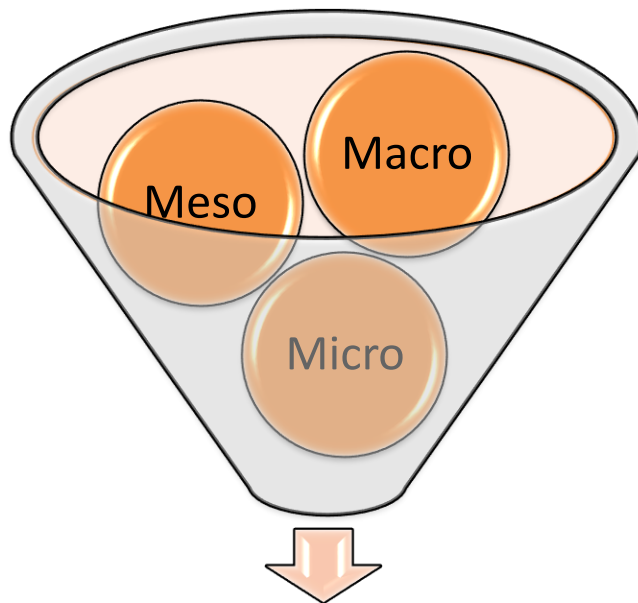


Fatigue in team sports

Fatigue = ↓ in total and high-intensity running distance

(Waldron and Highton, 2014, Sports Med 44:12)

Distribution of energy resources



Pacing schema

Macro-pacing (pre-match)

- hydration, fuel availability, motivation, temperature, opposition, whole-game/substitute

Meso-pacing (half time)

- homeostatic disturbance, opposition, scoreline

Micro-pacing (continuous)

- homeostatic disturbance, opposition, scoreline

Edwards and Noakes, 2009, Sports Med 39:1

Professional Rugby Union

Rugby union is characterised by short-duration, high-intensity efforts during which players collide, often while running at full speed; interspersed by longer low-intensity periods of standing, walking and jogging.

(Austin *et al.*, 2011, J Sci Med Sport 14:3)



Diversity of Physical Requirements



The game demands differ for players in different positions.

(Deutsch *et al.*, 2007, J Sport Sci 25:4)

Research Aim

Understand the nature of fatigue in professional rugby union

- What is the influence of match period and position on movement patterns?
- What is the influence of substitutes on movement patterns?

Methods – Global Positioning System (GPS)

Variables measured

- Playing time
- Relative distance ($\text{m}\cdot\text{min}^{-1}$) in speed zones

Speed bands		
Walking	$0-2\text{m}\cdot\text{s}^{-1}$	Low intensity running $0-4\text{m}\cdot\text{s}^{-1}$
Jogging	$2-4\text{m}\cdot\text{s}^{-1}$	
Striding	$4-6\text{m}\cdot\text{s}^{-1}$	High intensity running $>4\text{m}\cdot\text{s}^{-1}$
Sprinting	$>6\text{m}\cdot\text{s}^{-1}$	

- Sprint ($>6\text{m}\cdot\text{s}^{-1}$) frequency
- Acceleration ($>2.75\text{m}\cdot\text{s}^{-2}$) frequency
- Accelerometer
 - Total impacts $>5\text{G}\cdot\text{min}^{-1}$
 - High-intensity impacts $>8\text{G}\cdot\text{min}^{-1}$

SPI Pro GPS unit

(GPSports, Canberra)
mass = 76g;
size = 87 x 48 x 20 mm
5Hz GPS Tracking
100Hz Tri-axial
Accelerometer



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Methods



Player characteristics

Age 25.5 ± 2.4 years

Body mass 101.5 ± 12.2 kg

Stature 1.86 ± 0.07 m

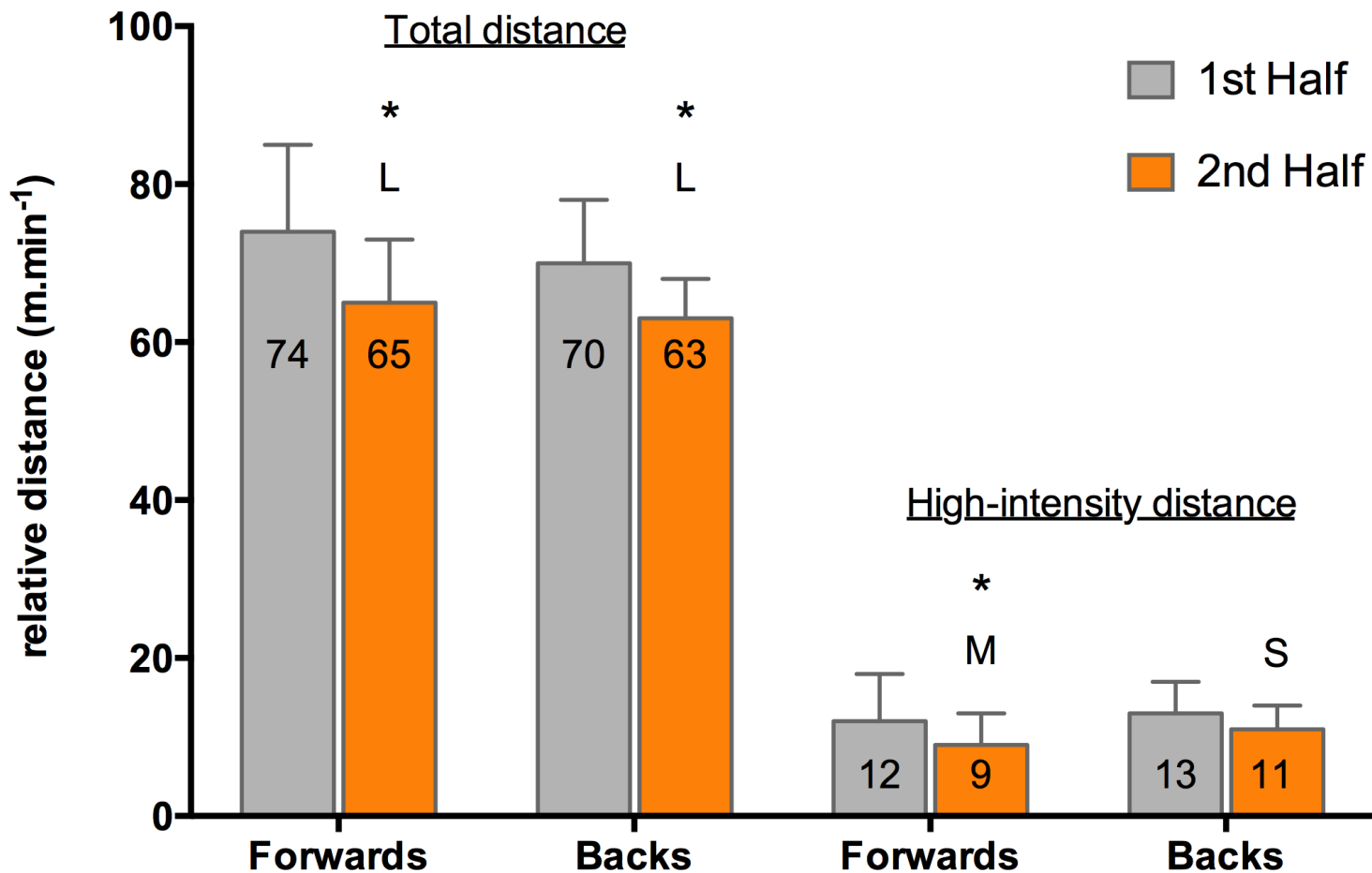
- Whole game players – start game and complete >35 min in 2nd half
- Substitute players – 2nd half replacements

Statistics

- Factorial ANOVA
- Paired and independent sample t-tests
- Cohen's effect size

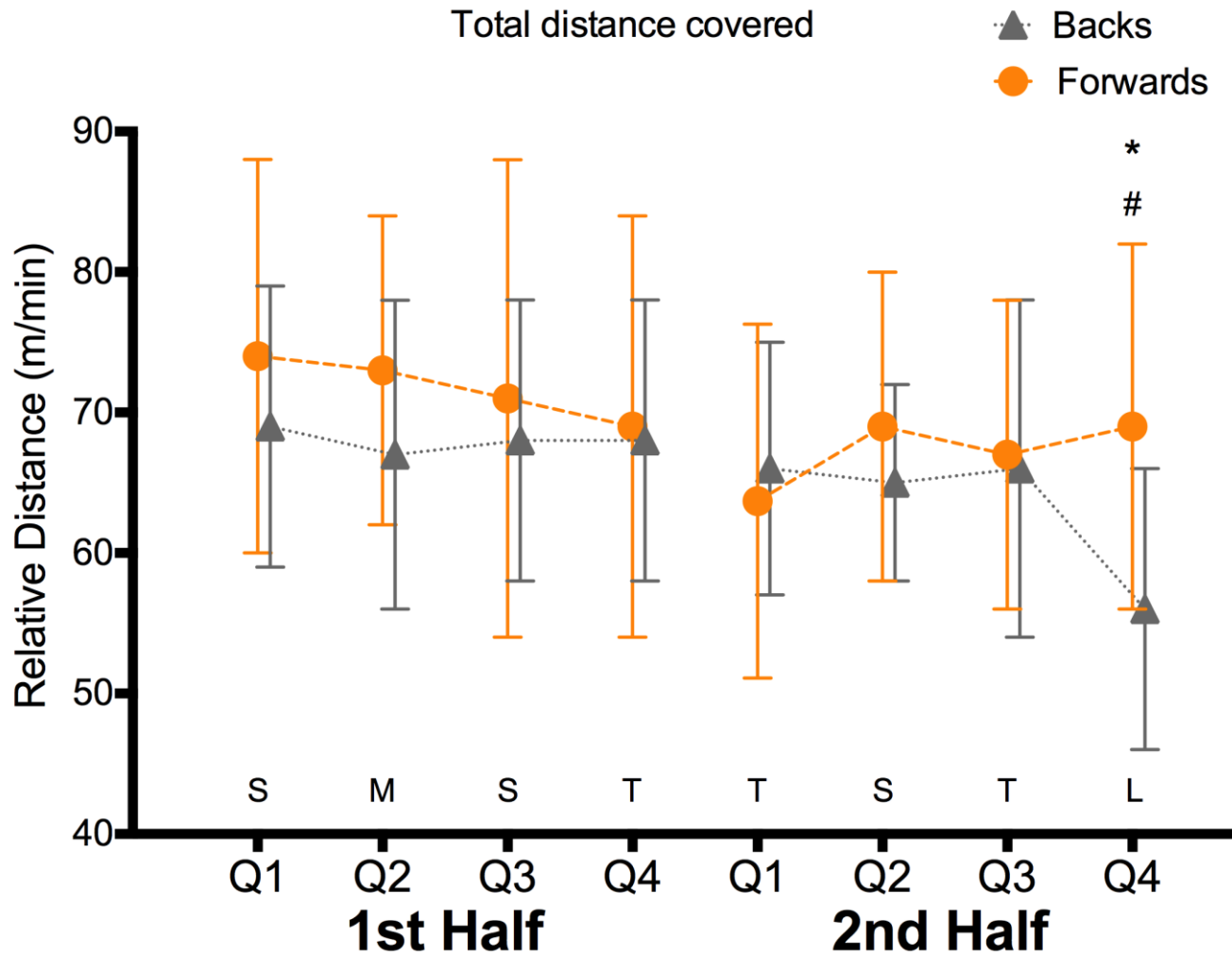


Results – Effect of half on total and high-intensity distance



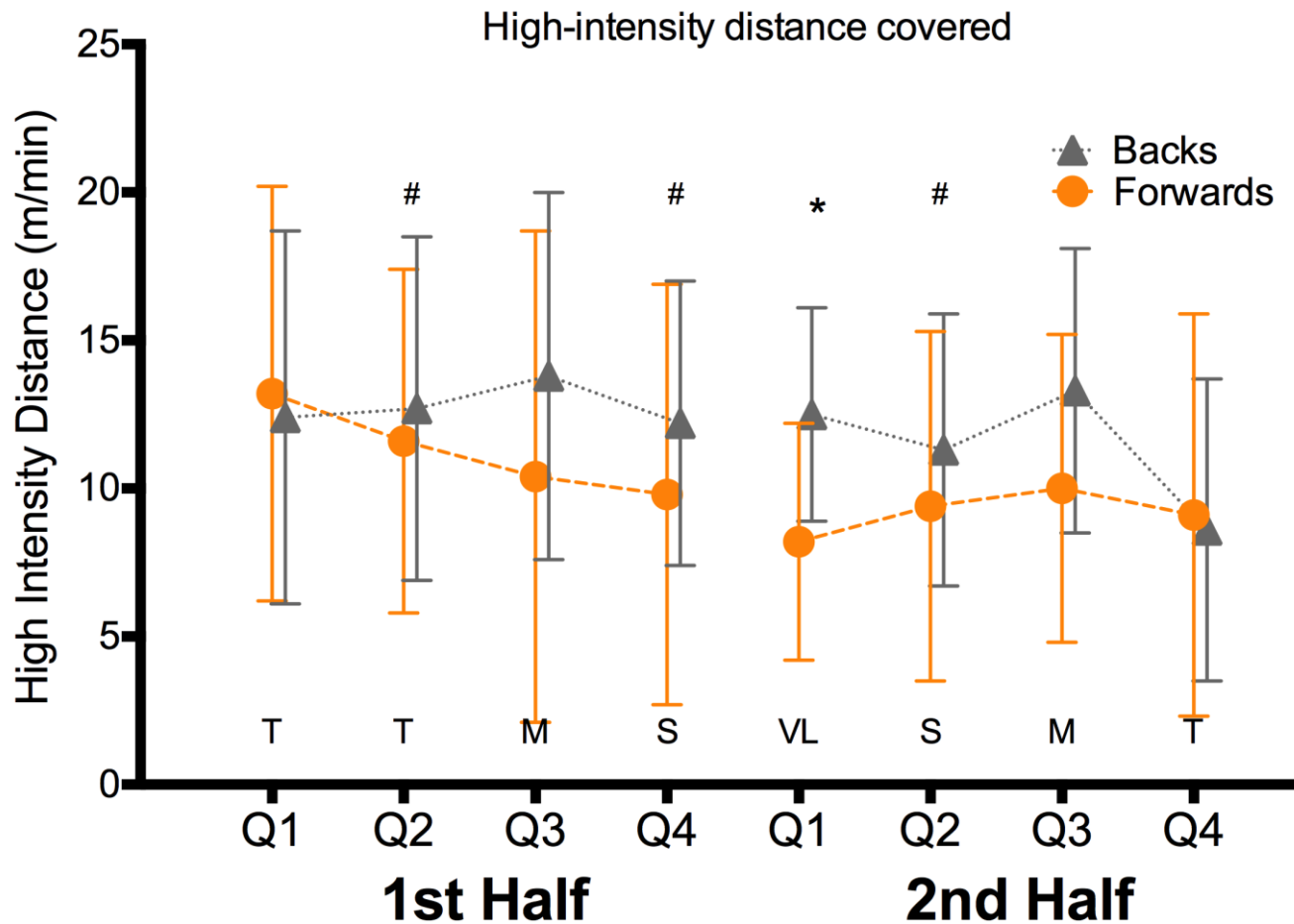
* indicates significant difference from 1st half. S, M, L and VL indicate effect sizes small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) respectively.

Results – Total distance per match period



* indicates significant difference between backs and forwards, # indicated significant different from all other match periods. T, S, M, L and VL indicate effect sizes trivial (<0.2), small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) respectively.

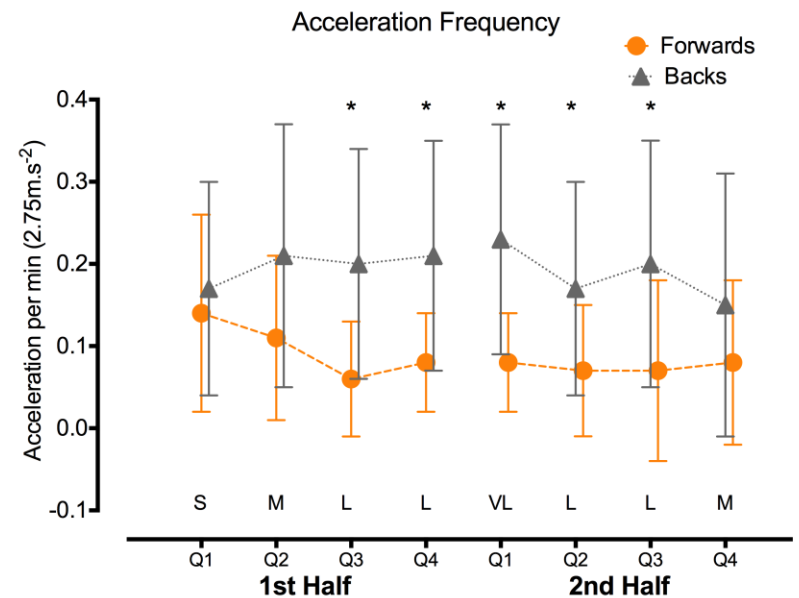
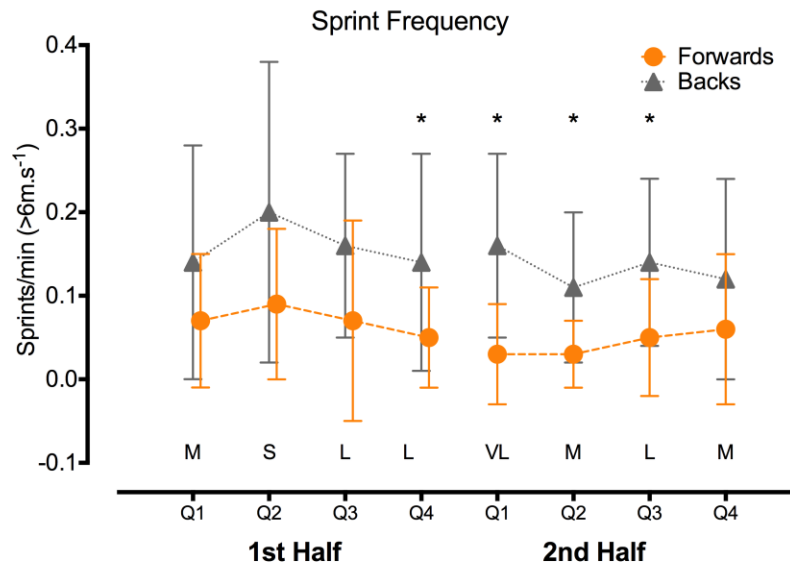
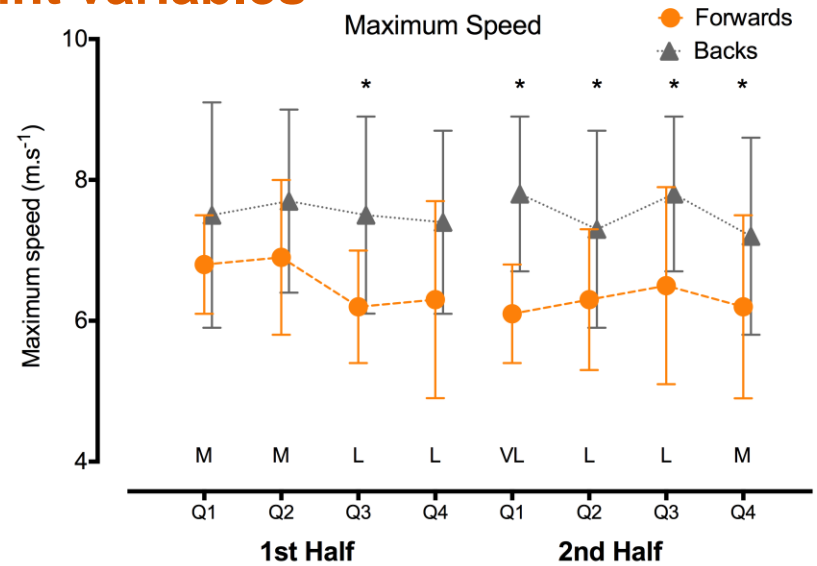
Results – High-intensity distance per match period



* indicates significant difference between backs and forwards, # indicates significant different from match period 2nd half Q4. T, S, M, L and VL indicate effect sizes trivial (<0.2), small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) respectively.

Results – Match period effects sprint variables

Sprint and acceleration frequency are reduced in the 2nd half for forwards, but not for backs.



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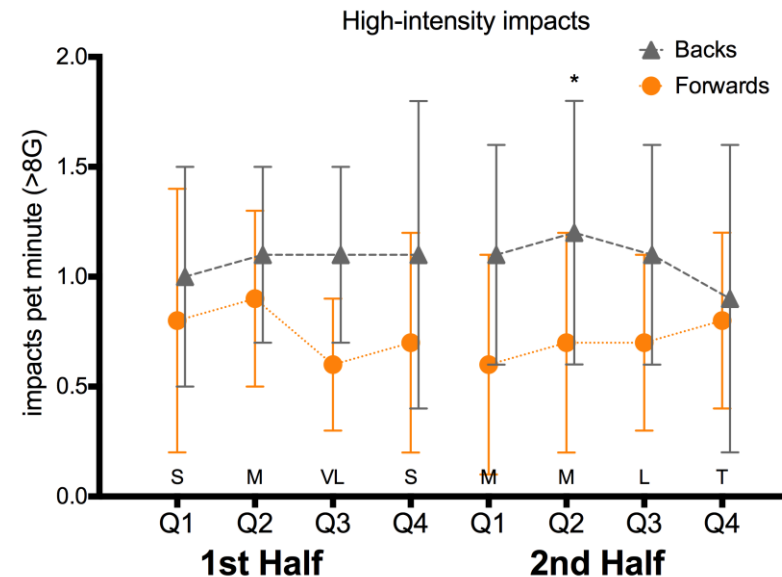
The effect of physical contact

↑ physical contact = ↓ total
↓ high-intensity running
distance (Johnston et al., 2014, Int J Sports Physiol Perform, Epub)

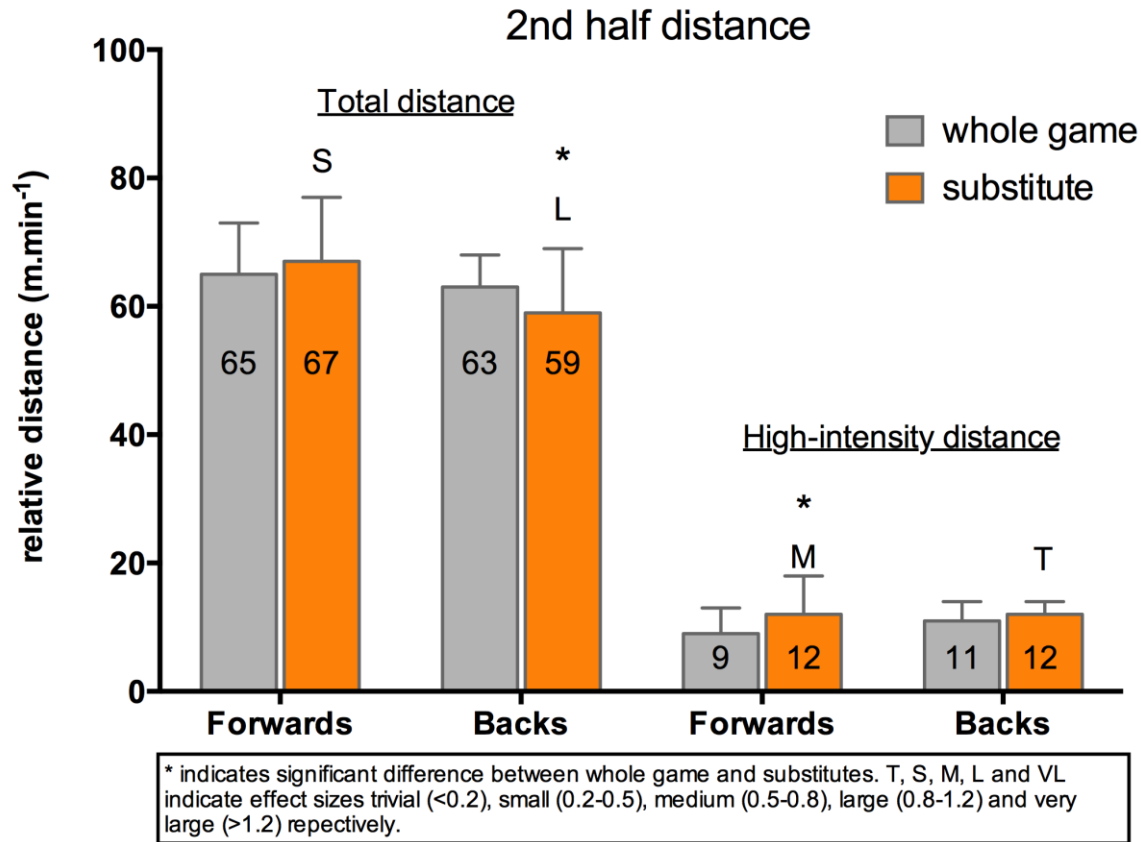
Forwards experience ↑ contact
involvements than backs
(Deutsch et al., 2007, J Sport Sci 25:4)


Accelerometer data – backs
experience ↑ total (>5G) and
high-intensity (>8G) “impacts”
than forwards


Data doesn't fit fatigue model



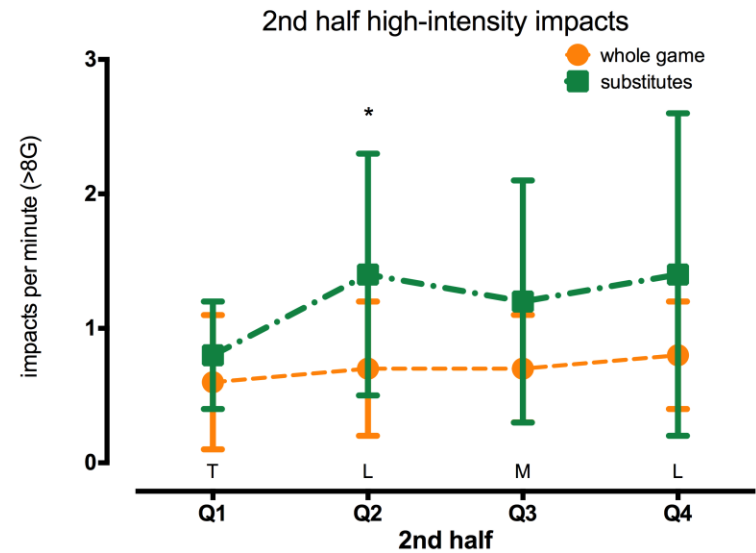
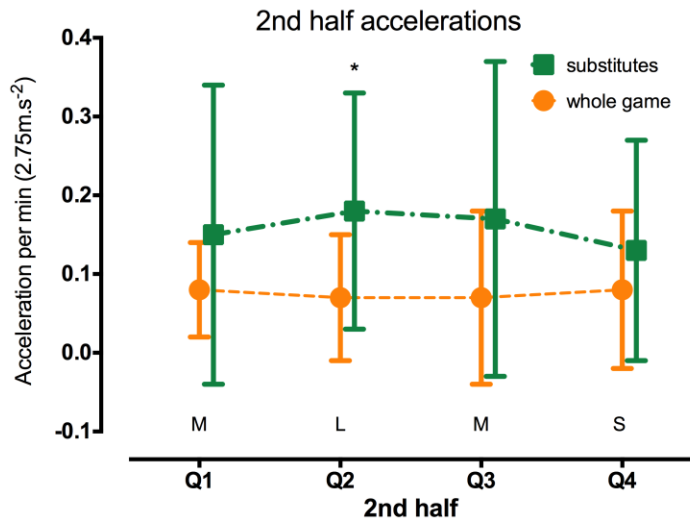
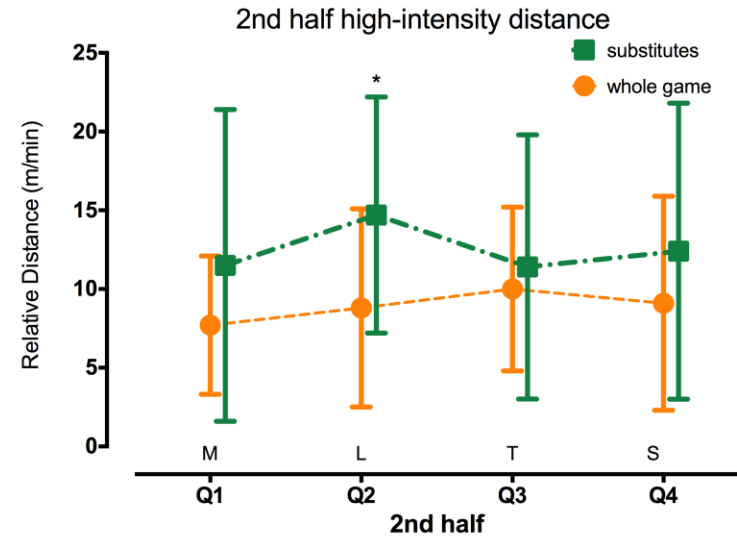
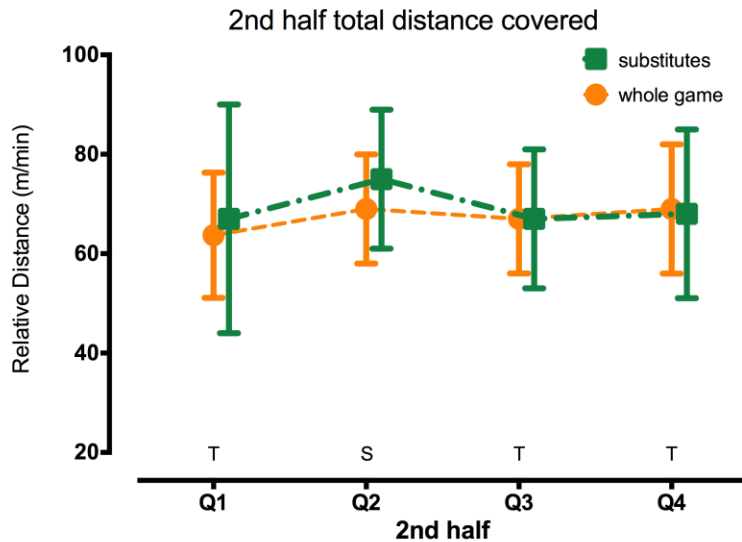
Results – Effect of substitutes



Forward substitutes  sprint and acceleration frequency and high-intensity impacts


Back substitutes  sprint and acceleration frequency, but n = 3

Results – effect of forward substitutes



* indicates significant difference between whole game players and substitutes. T, S, M, L and VL indicate effect sizes trivial (<0.2), small (0.2-0.5), medium (0.5-0.8), large (0.8-1.2) and very large (>1.2) respectively.

Conclusions – running distance

Rugby union players  total (10%) and high-intensity (18%) running in 2nd half.

Similar results in soccer¹, rugby league² and rugby sevens³.

BUT

Rugby union work rates are much lower than other sports (~ 70 vs. $\sim 100 \text{m}\cdot\text{min}^{-1}$)^{1,2,3}

1. Bradley and Noakes, 2013, J Sport Sci 31:15

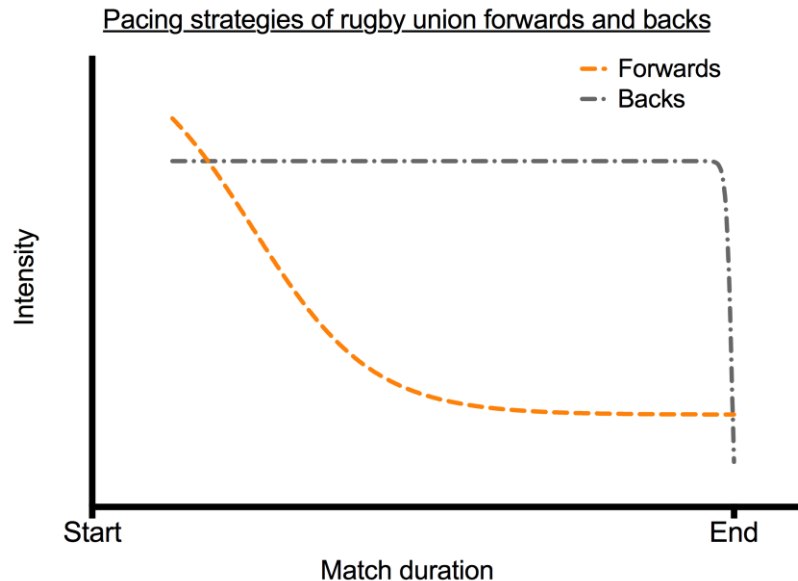
2. Waldron et al., 2013, Int J Sports Physiol Perform 8:2

3. Higham et al., 2011, J Sci Med Sport 15




Conclusions – fatigue profile

Backs and forwards demonstrate differing fatigue profiles.



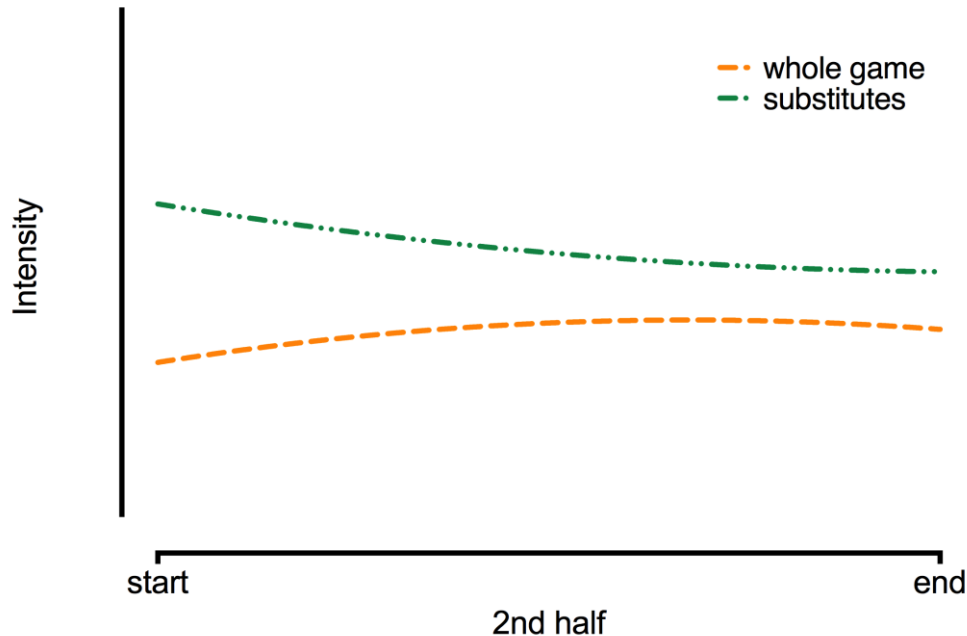
Pacing profile	
Forwards	Backs
“Slow positive”	“Flat”



Forwards progressively  total and high-intensity distance, maximum speed, sprint and acceleration frequency

Backs maintain total and high-intensity distance, maximum speed, sprint and acceleration frequency for majority of match

Conclusions – Impact of substitutes

substitute pacing strategy



Substitutes  match intensity by  high-intensity distance, acceleration frequency and high-intensity impacts.

Substitutes set a higher pacing strategy in the early part of their exercise bout

– a **“one bout, all out”** strategy

For the coach - Take home message

- Fatigue is evidenced by reductions in total and high intensity running distance and sprint and acceleration frequencies.
- Fatigue profile of forwards and backs is different
- Monitor high-intensity running distance to determine onset of fatigue
- Replacing fatigued players with substitutes is an effective method of maintaining playing intensity



**Goodbye and thank you
for listening!**

Acknowledgements

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