LOAD RATIOS DURING A CYCLING GRAND TOUR: DETECTING FATIGUE?

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Training monitoring

Evaluate the effect of a particular dose of training (*training load*) on fitness, fatigue and performance

Optimize performance

Prevent overtraining & injuries

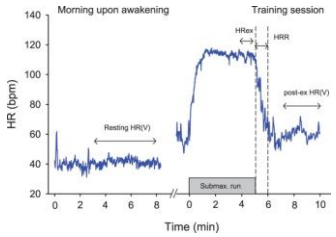
Training plan

Internal training load

Training dose

External training load

Response



Fitness (+)

Fatigue (-)

Performance

Buchheit, 2014; Coutts, 2016

Comparison of Heart Rate and Session Rating of Perceived Exertion Methods of Defining Exercise Load in Cyclists

Jose A. Rodríguez-Marroyo,[1] Gerardo Villa,[1] Juan García-López,[1] and Carl Foster[2]

Table 3. Session RPE, HR, and daily time spent in the 3 intensity zones analyzed in the different weeks of 21-day races.*†

	First week	Second week	Third week
RPE	5.1 ± 0.2‡	5.7 ± 0.2	6.5 ± 0.2
Maximal HR (b·min^{-1})	188 ± 1‡§	181 ± 1	180 ± 1
Mean HR (b·min^{-1})	143 ± 2§	140 ± 1	138 ± 1
Zone 1 (min)	98.9 ± 6.1	100.6 ± 6.2	118.3 ± 4.8
Zone 2 (min)	87.7 ± 5.5‡§	117.7 ± 5.1	132.1 ± 5.9
Zone 3 (min)	22.3 ± 2.8‡	10.9 ± 1.5	7.2 ± 1.0

*Zone 1 = exercise intensity below VT; zone 2 = exercise intensity between VT and RCT); zone 3 = exercise intensity above RCT; RPE = rating of perceived exertion; HR = heart rate; RCT = respiratory compensation threshold; VT = ventilatory threshold.
†Values are mean ± *SEM*.
‡Significantly different from the third week ($p < 0.05$).
§Significantly different from the second week ($p < 0.05$).

- Increase in weekly RPE
- Decrease in maximal HR
- Slight decrease in mean HR

- Use of subjective:objective load ratios to detect fatigue state?

Aim

This study evaluated the changes in integrated ratios of subjective and objective load measures of professional cyclists during baseline training and during a Grand Tour.

Can integrated load ratios provide additional monitoring information compared to solitary load measures?

Participants

- Twelve professional cyclists from a World-Tour cycling team
  - Age : 29 ± 4.5
  - Body mass : 72.2 ± 5.3 kg
  - VO_{2max} : 75 ± 6 ml·min·kg^{-1} / 5.38 ± 0.51 L ·min^{-1}

- ***Physiological Assessment***
  Laboratory incremental test tarting at 2.50 W/kg and increasing by 0.5 W/kg every 3 min

- ***Datacollection***
  RPE, power output and HR data collected during the 2016 Giro d'Italia and Vuelta a España and during baseline training in the two weeks preceding the Grand Tours

Exercise Load

Session-RPE (sRPE)

Post-exercise RPE: "How hard was this workout/stage?"

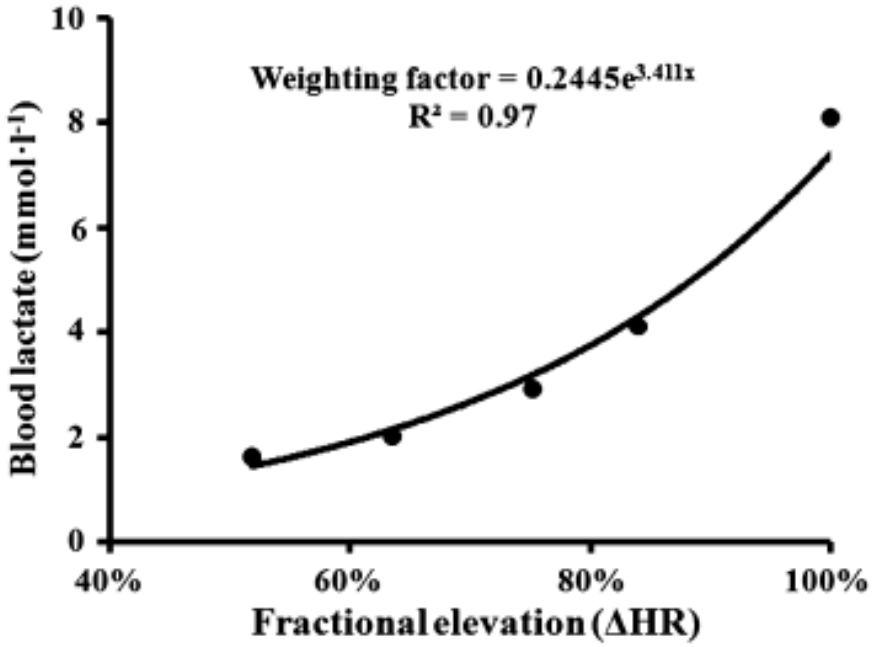
Session-RPE = RPE (CR-10 scale) x duration

1 - 10 Borg Rating of Perceived Exertion Scale	
0	Rest
1	Really Easy
2	Easy
3	Moderate
4	Sort of Hard
5	Hard
6	
7	Really Hard
8	
9	Really, Really, Hard
10	Maximal: Just like my hardest race

Exercise Load

Individualized TRIMP (iTRIMP)

1) Individual HR – Blood Lactate profile in response to incremental exercise
2) Best fit exponential model based with fractional elevation in HR
3) Every HR reading an individual specific weighting factor
4) Every HR reading from exercise bout weighted
→ summation provides total iTRIMP score



√ Strong dose-response relationships observed with changes in aerobic fitness (Sanders et al. 2017)

Exercise Load

Training Stress Score™ (TSS)

TSS = [(t x NP x IF) / (FTP x 3600)] x 100

whereas t is the time, NP™ is normalized power IF™ is intensity factor and FTP is the individual's functional threshold power.

√ Strong dose-response relationships observed with changes in aerobic fitness (Sanders et al. 2017)

Design

sRPE:iTRIMP
sRPE:TSS
TSS:iTRIMP

→ *Expected:*
Increasing fatigue →
Increasing ratio

Post-exercise RPE
Heart rate
Power Output

~2 weeks

Baseline

Week 1

Week 2

Week 3

Grand Tour

Results

	Baseline training (n = 51)	First week GT (n = 84)	Second week GT (n= 98)	Third week GT (n = 82)
RPE	3.5 ± 1.9	6.0 ± 1.6[1]	7.0 ± 1.9[1]	7.4 ± 2.0[1,2]
Mean PO (W)	201 ± 30	208 ± 24	237 ± 41[1,2]	241 ± 56[1,2]
NP (W)	241 ± 45	271 ± 25[1]	291 ± 38[1,2]	281 ± 43[1,2]
Mean HR (beats·min^{-1})	124 ± 13	130 ± 9	130 ± 11	127 ± 16
Mean HR %HR_{max}	65 ± 7	66 ± 4	67 ± 6	65 ± 8
Maximal HR (beats·min^{-1})	167 ± 20	181 ± 7[1]	177 ± 9[1]	174 ± 9[1]
% PO zone 1 (min)	86.8 ± 12.2	75.9 ± 6.5[1]	68.1 ± 13.9[1,2]	67.8 ± 21.5[1,2]
% PO zone 2 (min)	5.9 ± 5.6	9.5 ± 4.1	11.2 ± 5.0[1]	12.9 ± 11.7[1,2]
% PO zone 3 (min)	7.4 ± 7.7	14.7 ± 4.0[1]	20.7 ± 11.1[1,2]	20.2 ± 16.4[1]
Mean training load				
sRPE (AU)	786 ± 673	1773 ± 505[1]	2147 ± 972[1]	1958 ± 992[1]
iTRIMP (AU)	208 ± 180	292 ± 105[1]	372 ± 138[1]	270 ± 185[1]
TSS (AU)	155 ± 104	261 ± 49[1]	300 ± 104[1]	223 ± 111[1]

Abbreviations: RPE, rating of perceived exertion; PO, power output; NP, Normalized Power™, HR, heart rate; HR_{max}, maximal heart rate; sRPE, session rating of perceived exertion; iTRIMP, individualized TRIMP; TSS, Training Stress Score™.

[1] Significantly difference compared to baseline training data ($p < 0.05$)

[2] Significant difference compared to first week grand tour data ($p < 0.05$)

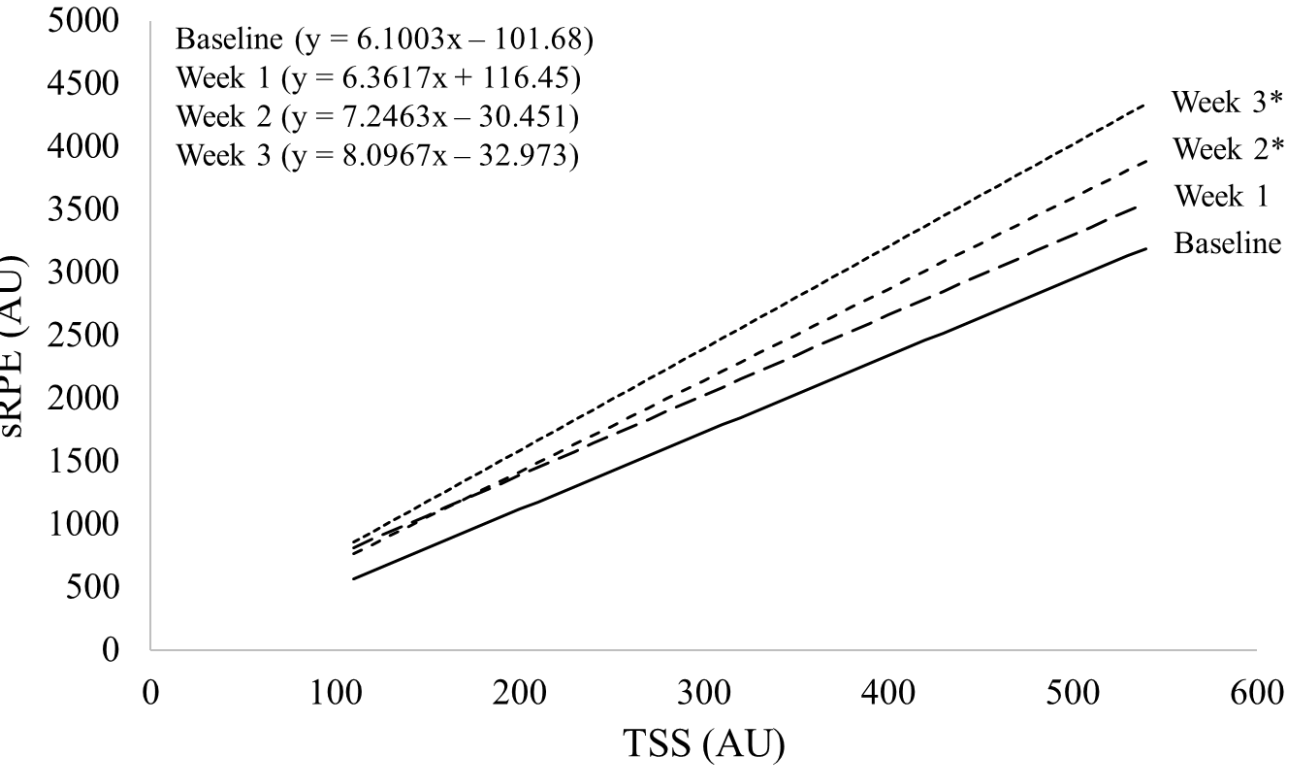
[3] Significant difference compared to second week grand tour data ($p < 0.05$)

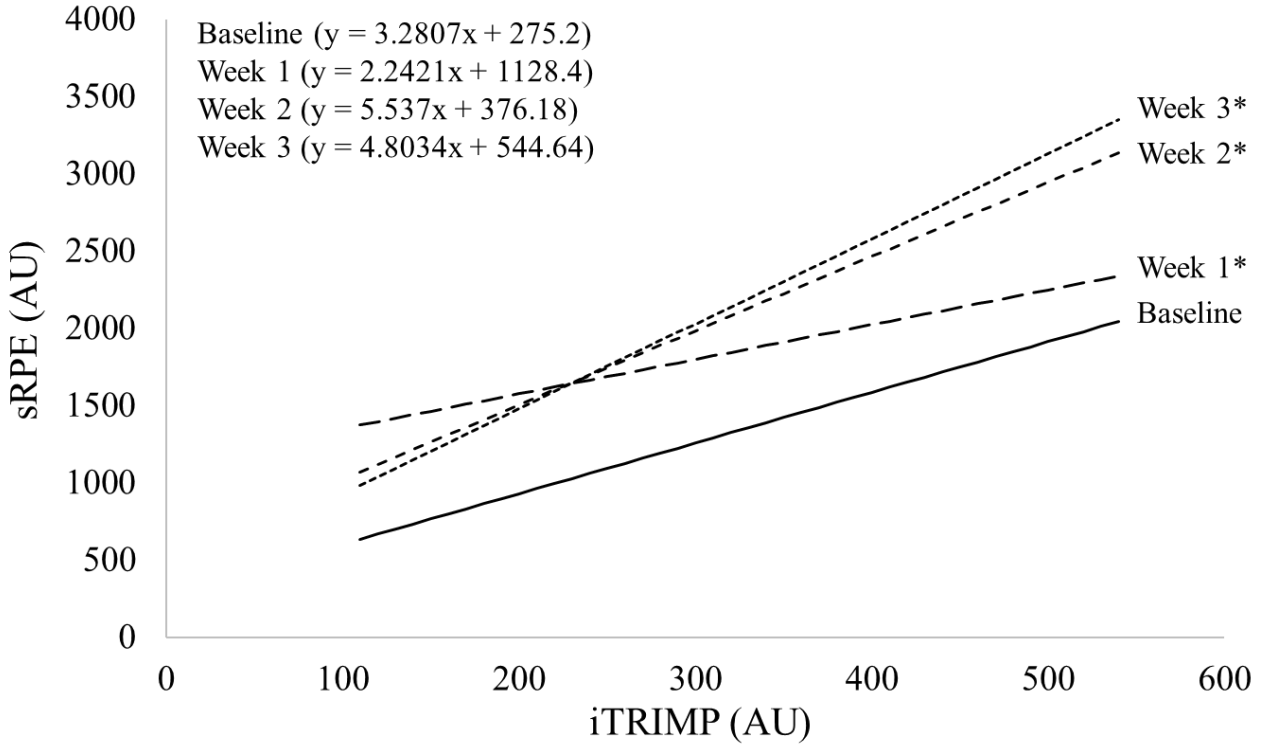
- Week-to-week increase in RPE & mean power output

- Week-to-week decreases in mean & max HR

- Training load highest in second week

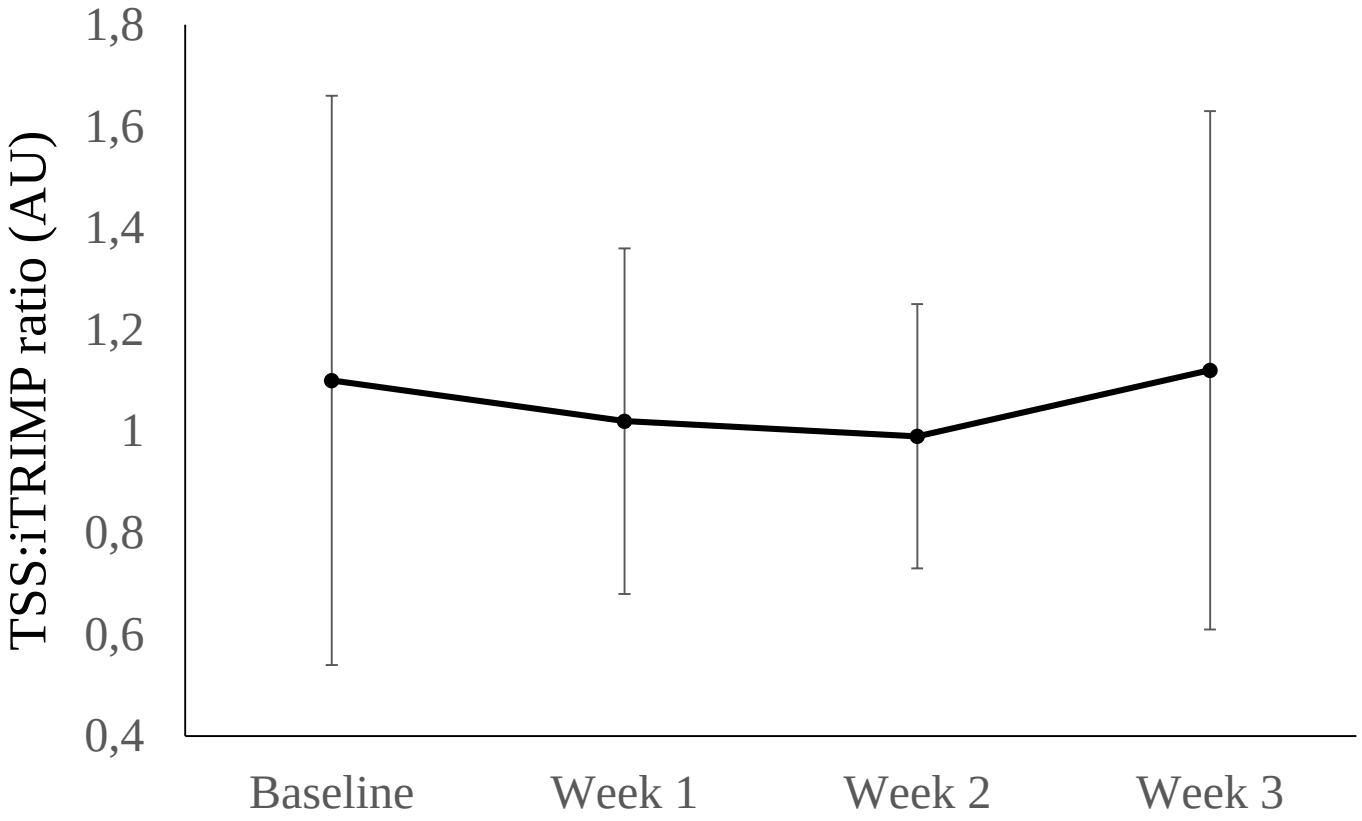
* Course profile (e.g. elevation gain)
* Race tactics



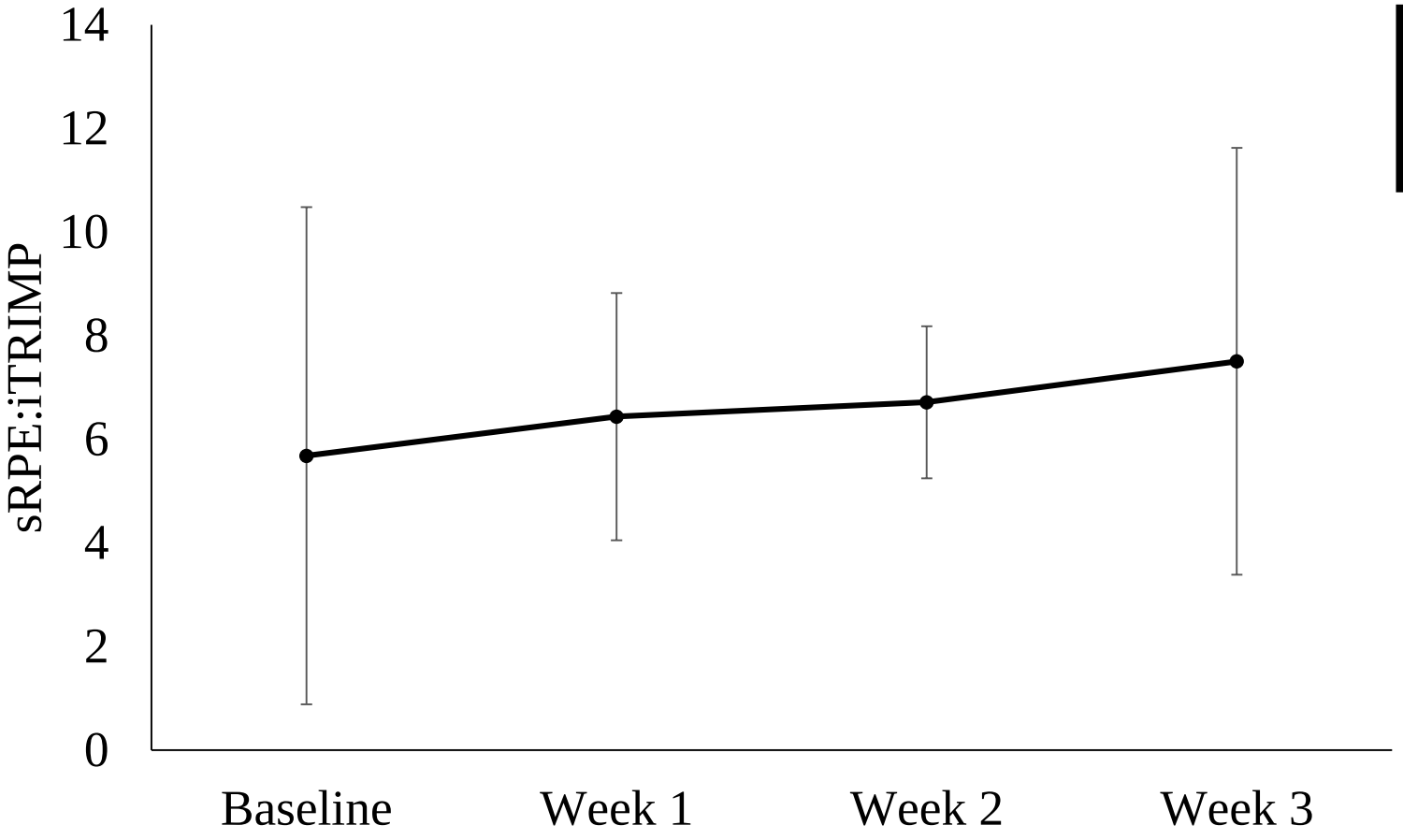


*TSS score of 300 AU in the third week of a Grand Tour will result in a sRPE that is **370 units** higher compared to sRPE in week 1!*

	Baseline	GT week 1	GT week 2	GT week 3
TSS: iTRIMP	1.10 ± 0.56	1.02 ± 0.34	0.99 ± 0.26	1.12 ± 0.51

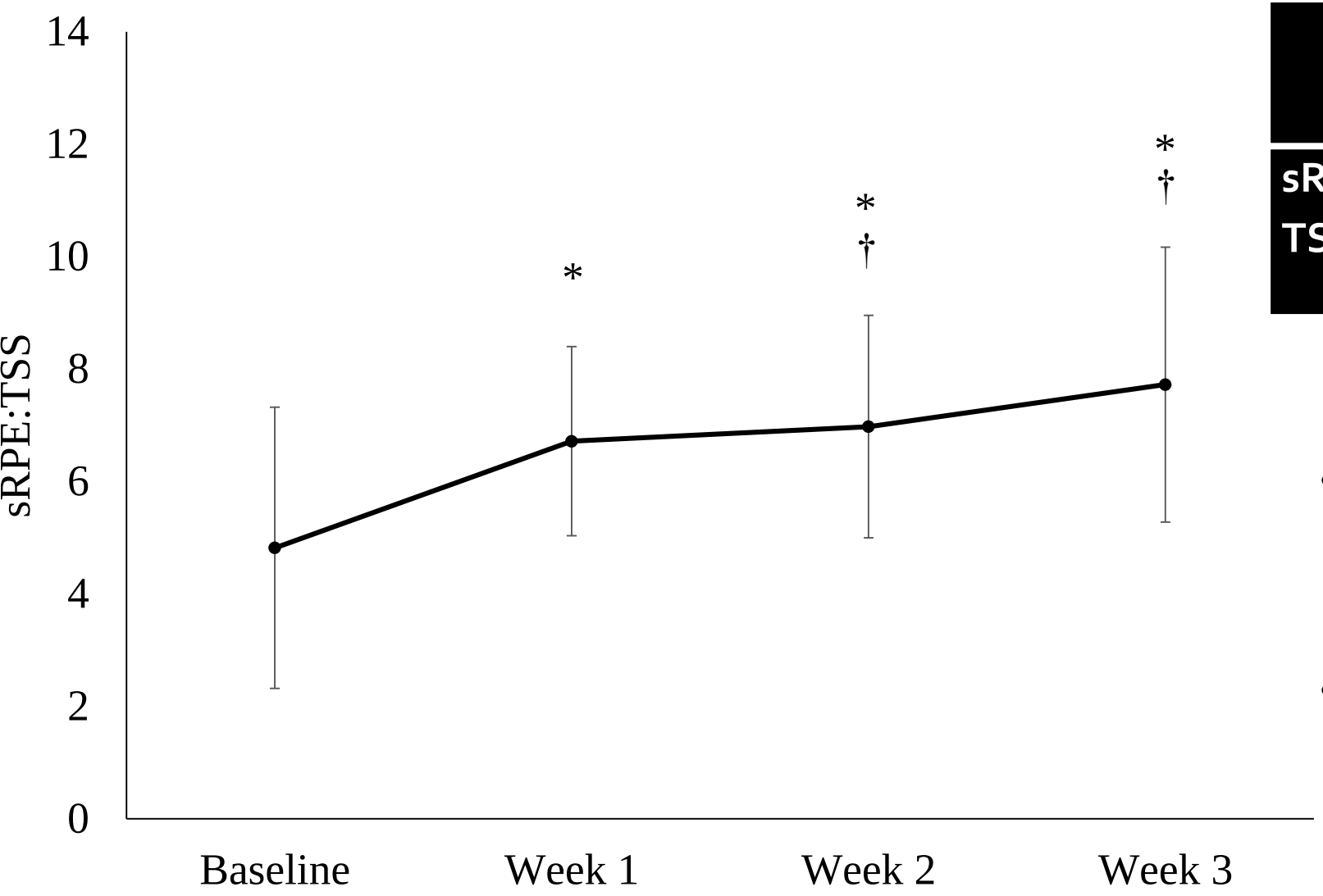


- Decreasing trend towards week 2, increase comparing week 2 to week 3
- Trivial to small (d = 0.03 – 0.27) compared to baseline
- Variation



	Baseline	GT week 1	GT week 2	GT week 3
sRPE: iTRIMP	5.68 ± 4.80	6.44 ± 2.39	6.72 ± 1.47	7.51 ± 4.12

- Small increases in the Grand Tour compared to baseline training data (*d* = 0.21 – 0.41)
- Trivial increase in the second week compared to the first week (*d* = 0.14) and small increase when comparing the third to second week (*d* = 0.28).
- Variation



	Baseline	GT week 1	GT week 2	GT week 3
sRPE: TSS	4.82 ± 2.50	6.72 ± 1.68	6.98 ± 1.98	7.72 ± 2.45

- The sRPE:TSS ratio was moderately higher (*d* = 0.91 – 1.17) during the Grand Tour compared to baseline training
- Small week-to-week increases when comparing week 3 with week 1 (*d* = 0.49) and week 2 (*d* = 0.34) of the Grand Tour.
- Larger effect sizes, lower variation and statistical significance

* Significantly different from baseline (P < 0.05)
† Significantly different from GT week 1 (P < 0.05)

Discussion

- **Solitary load measures:** no clear decreasing or increasing trends observed over the course of the Grand Tours with load being highest in the second week for all three measures (sRPE, iTRIMP, TSS)
  → Race tactics
  → Course profile

- However, when expressed as a ratio, small to moderate week-to-week continuous increases in the **sRPE:TSS** and **sRPE:iTRIMP** ratios were observed during the Grand Tours.

- The gradual increase in **subjective:objective load ratios** could indicate increasing fatigue that is not necessarily reflected by changes in solitary load measures.

Limitations

- No additional physiological or psychological indicators of fatigue were measured

- Taper strategies → reduced load

  Remains questionable how and if the proposed ratios of this study change during other training phases (e.g. preparatory phases without competitions).

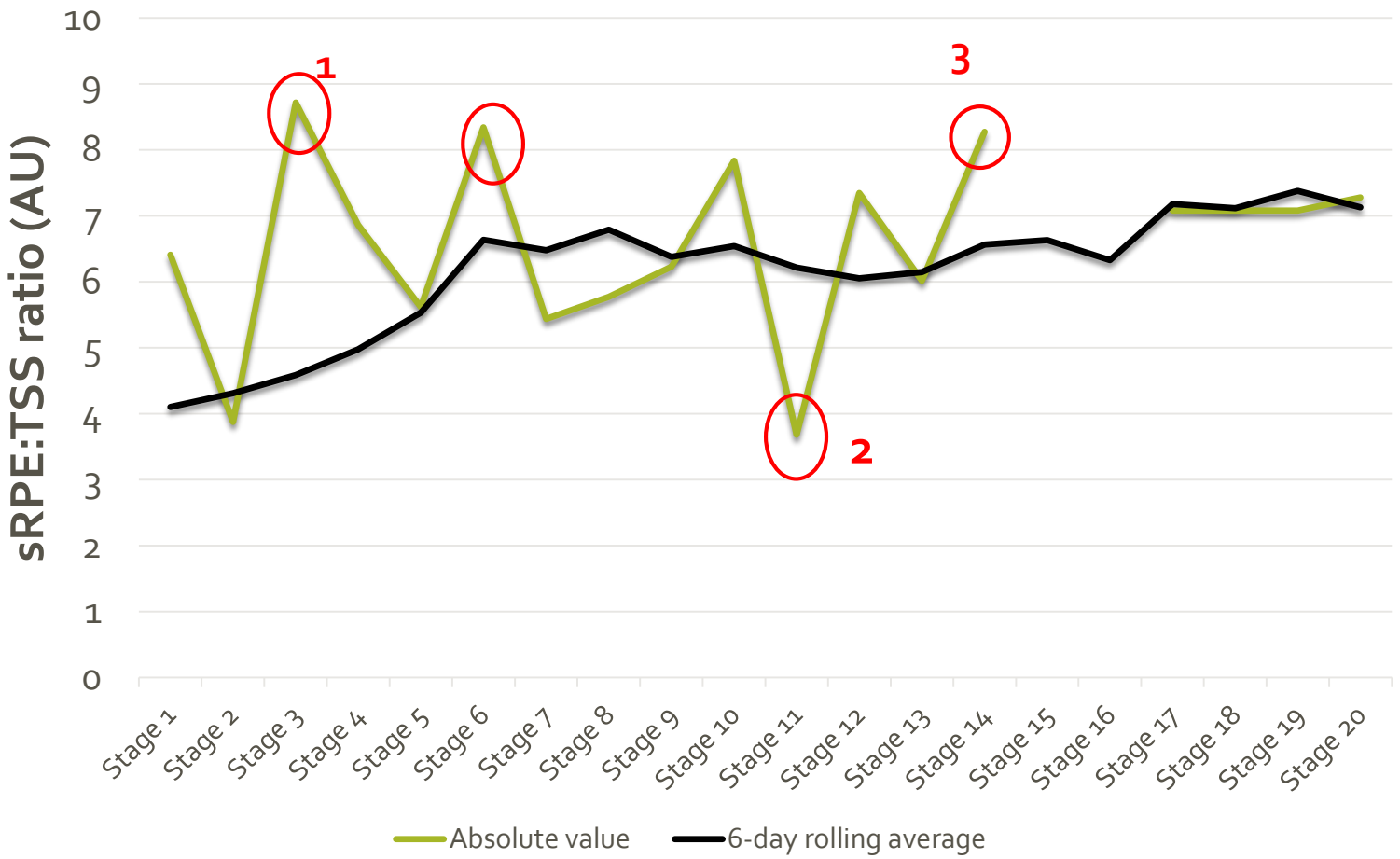
Conclusion

- This study is the first to show the changes in integrated load ratios during a Grand Tour in professional cyclists.

- Changes observed in ratios were not reflected in solitary load measures suggesting that ratios can provide valuable additional information when monitoring athletes.

- The integration of a subjective (sRPE) and objective (iTRIMP, TSS) should be considered favourable to monitor fatigue compared to ratios solely based on objective measures

Practical Implications



1. **Stages 3 and 6,** summit finish
 High 'acute' fatigue?

2. **Stage 11,** took it 'easy' and did not pushed on to follow leaders

3. **Stage 14,** went in the attack early, hard day.

- Absolute ratio as an indicator of **acute fatigue**?
- Rolling average as indicator of **accumulated fatigue**?

Thank you for your attention!

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