# Study of biomechanical and muscle activity patterns during a 30min downhill running test and subsequent muscle damage in male trailers.

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## INTRODUCTION

- Downhill running (DR) sections, a common component in off-road races, can lead to exercise-induced muscle damage (EIMD) due to the greater eccentric work of some lower limb muscles.
- Running biomechanics and muscle activation may change during prolonged DR but these adjustments have not been clearly identified in trailers yet. A better understanding of the running pattern modifications appears essential for performance optimization and injuries prevention.

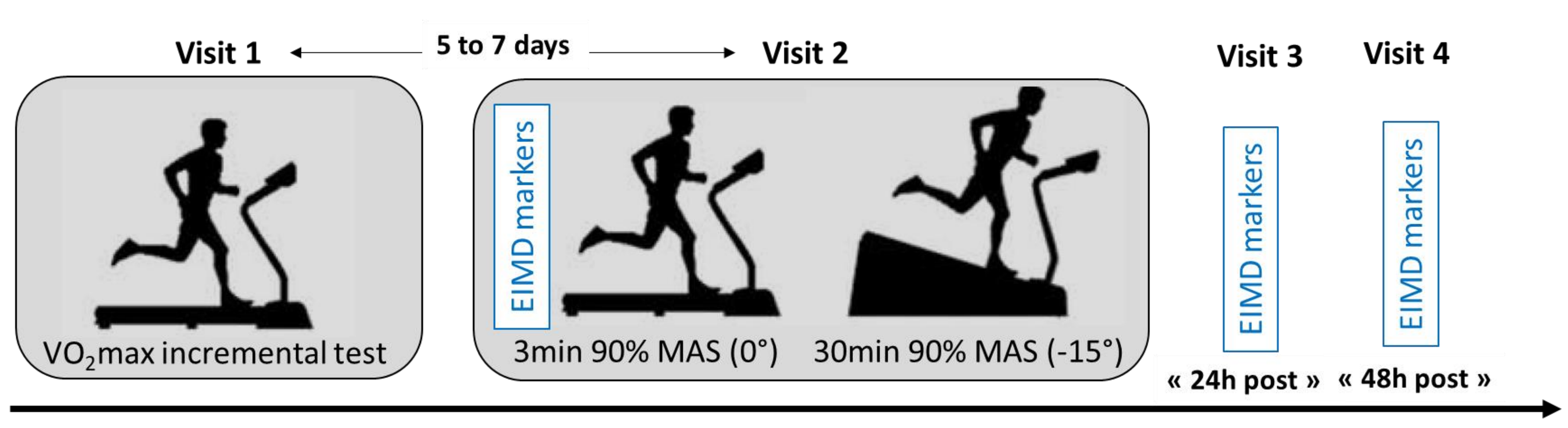
**Therefore, the present study aimed**

**(1) to characterize the running pattern over a 30min downhill running test ;**

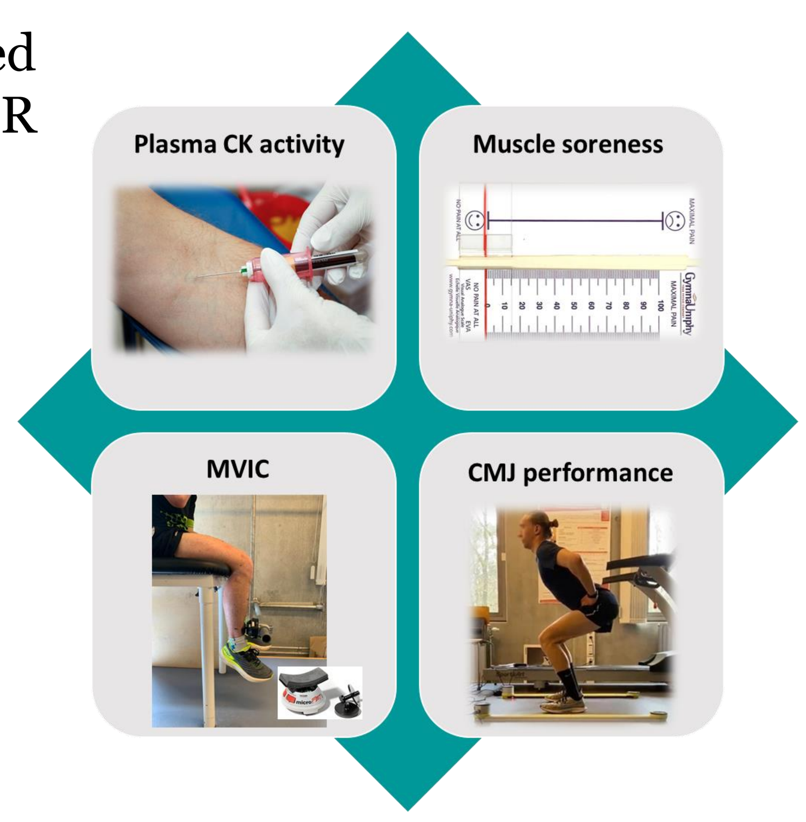
**(2) to investigate the DR-induced muscle damage.**

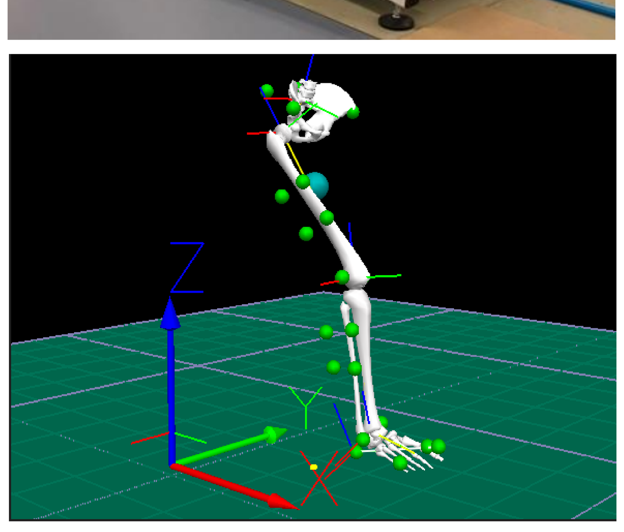
## PROTOCOLS

- Recreational male trailers (n=12, VMA ≥ 15) were recruited in this study.
  - Age 27.9 ± 8.9 years
  - Height 178.3 ± 8.1 cm
  - Weight 71.8 ± 10 kg
  - Fat mass 14.6 ± 4.5 %
- At **visit 1**, participants completed a standard $VO_2$max test on a treadmill to determine physiological parameters, notably their maximal aerobic speed (MAS).
- At **visit 2**, they performed a warm-up of 5min level running at 60% MAS followed by 3min level running at 90% MAS. Then, the DR protocol consisted of 30min downhill running (-15% grade) at 90% MAS.




- The EIMD indirect markers were measured before ("pre", **visit 2**), 24h and 48h post DR session (**visits 3 and 4**, respectively).



- Biomechanical measures were recorded using the 3D Codamotion® system. Muscle activity of the lower limb muscles (*rectus femoris, medial and vastus lateralis, femoral biceps* and *gastrocnemius* muscles) was assessed at the start, middle and end of the DR (at 5min, 15min and 30min; respectively).

## CONCLUSIONS

- The DR induced **muscle damage** as reflected by significant changes in EIMD indirect markers **24** and **48h post-exercise**.
- The kinematic data did not change except the **stance phase** (in % of the running gait) which increased significantly over the 30min DR.
- While some changes in **muscle activity** of lower limb muscles (*vastus lateralis* and *biceps femoris)* were observed over 30min-DR, further investigations are warranted to identify the intermuscular compensations that can occur during prolonged DR and its relationship with the subsequent EIMD.

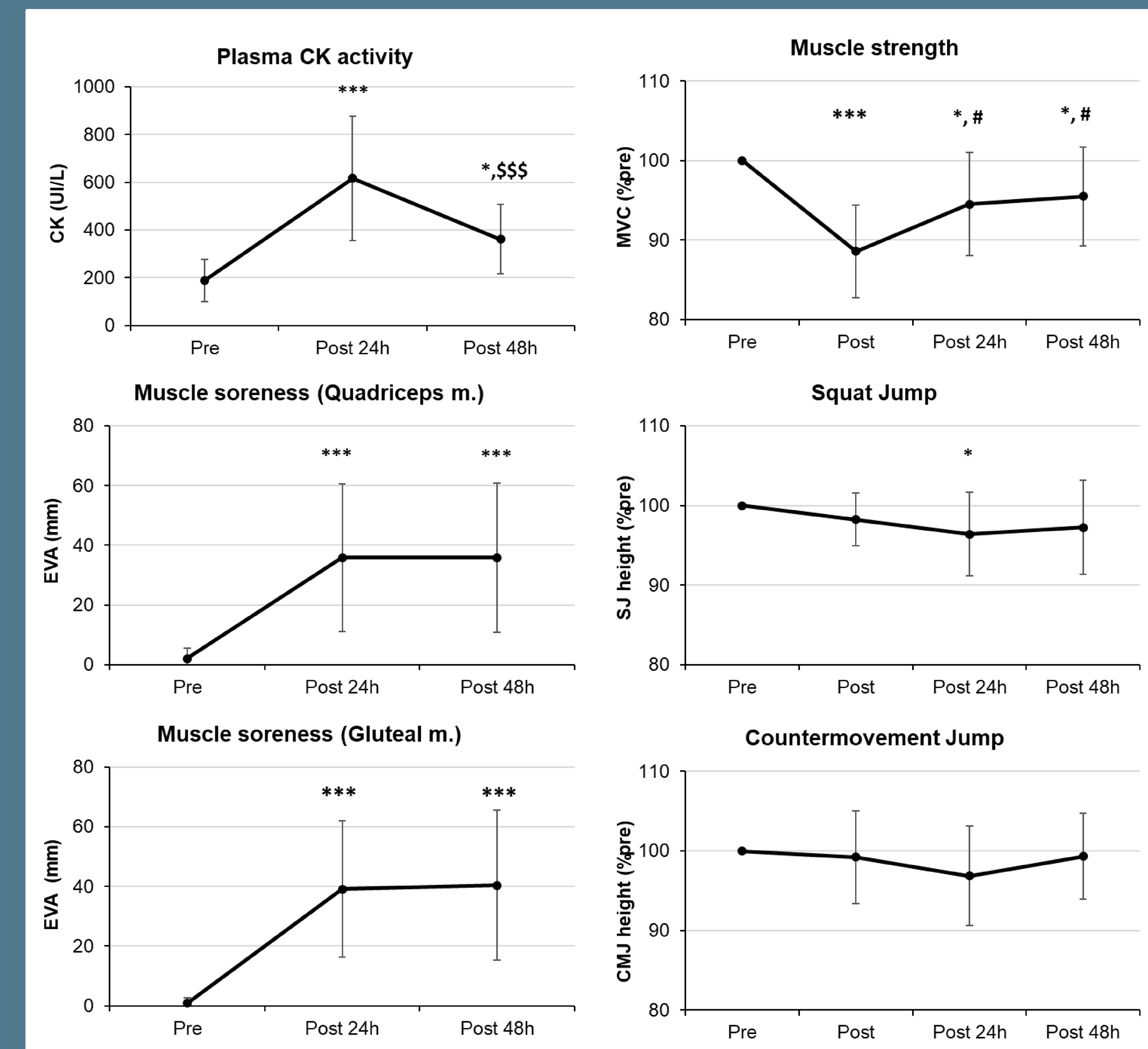
## RESULTS

### DOWNHILL RUNNING PROTOCOL

Subjects were able to complete a 30min DR (-15%) at 90% of their MAS.

- Speed (90% of MAS) 14.11 ± 1,58 km/h
- RPE (cardiovascular aspect) 11.92 ± 1.44
- RPE (muscular aspect) 13.17 ± 2.62
- Running distance 7095.8 ± 705.97 m
- Lactatemia « pre DR » 2.56 ± 0.43 mmol/l
- Lactatemia « post DR » 3.99 ± 0.98 mmol/l

### INDIRECT MARKERS OF MUSCLE DAMAGE




Plasma CK activity, maximal isometric strength and muscle soreness showed significant changes at 24 and 48h after 30min-DR.

Jump performance appeared less affected. SJ height, but not CMJ, was decreased at 24h post-exercise compared to « Pre ».

**Fig 1. Changes in muscle damage indirect markers.** One-way repeated measured ANOVA; Means ± SD; Significant differences were denoted by *p<0.05; ***p<0.001 (compared to « Pre »); $p<0.01 (compared to « Post 24h »); #p<0.05 (compared to « Post »).

### SPATIOTEMPORAL PARAMETERS

| | DR 1 | DR 2 | DR 3 | *p value* |
|---|---|---|---|---|
| Stance time (ms) | 216.07 ± 23.98 | 223.36 ± 21.33 | 223.95 ± 19.70 | 0.107 |
| Swing time (ms) | 501.90 ± 25.70 | 495.27 ± 23.75 | 496.79 ± 29.47 | 0.610 |
| Stance percent (%) | 30.06 ± 2.73 | 31.04 ± 2.07 | 31.06 ± 2.06 | ***0.046**** |
| Stride frequency (n/min) | 83.77 ± 4.03 | 83.72 ± 4.44 | 83.47 ± 4.76 | 0.947 |
| Stride length (m) | 2.88 ± 0.17 | 2.88 ± 0.13 | 2.89 ± 0.12 | 0.960 |

**Table 1. Stride spatiotemporal parameters recorded at 5min, 15min and 30min of downhill running** (DR1, DR2, DR3; respectively). Repeated measures ANOVA (means ± SD).

### 3D BIOMECHANICAL ANALYSIS

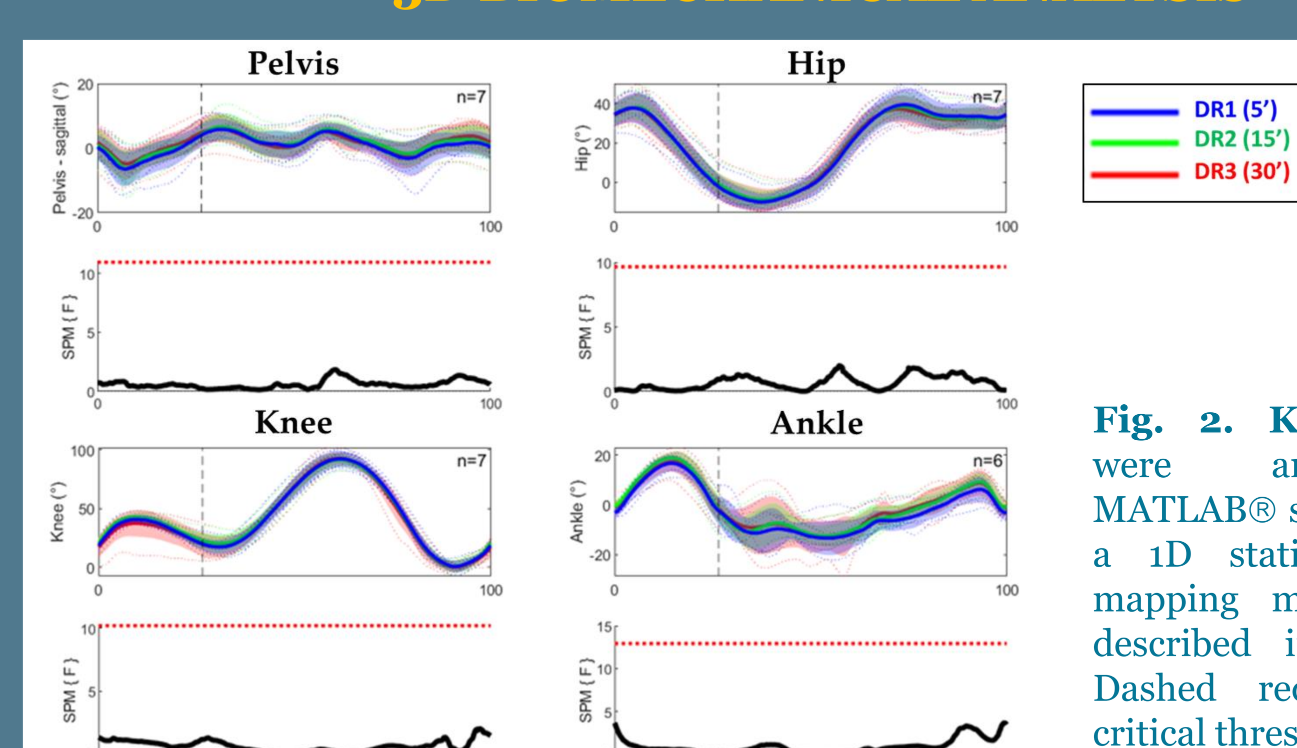



**Fig. 2. Kinematics data** were analysed using MATLAB® software and using a 1D statistical parametric mapping method (SPM) as described in Pataki et *al.*[1] Dashed red lines indicate critical threshold (α = 0.05).

### SURFACE EMG ACTIVITY OF LOWER LIMB MUSCLES

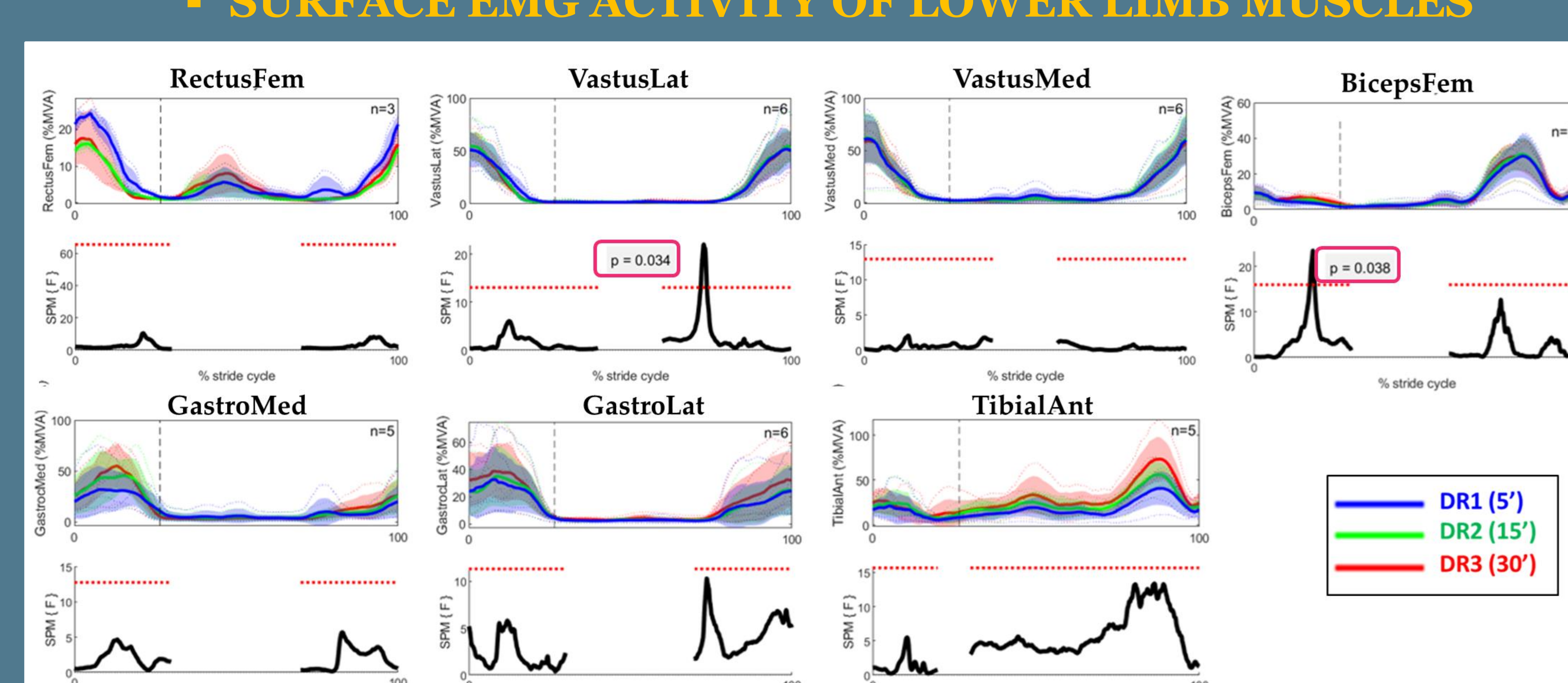



**Fig. 3. Surface EMG activity** (normalized to maximal activation) during the stride cycle (analysis using MATLAB® software and using SPM method). Gray shaded area indicates regions with statistically significant differences between the time points.

[1] Pataki TC, Vanrenterghem J, Robinson MA (2005). *Journal of Biomechanics*, **48** (7): 1277–1285.