

Background

Downhill running (DR) induces exercise-induced muscle damage (EIMD) due to high eccentric loading. However, its impact on running biomechanics remains unclear, with inconsistent findings across studies. Moreover, most research has focused on male participants, limiting the understanding of potential sex-specific responses to eccentric exercise. This gap is particularly relevant given evidence of differences in muscle damage, neuromuscular function and fatigue between sexes.

Aim

To investigate changes in running pattern during a 30-min DR test and the subsequent development of EIMD in female runners.

Results

- Mean **VO₂max** and **MAS** were 46.4 ± 4.6 mlO₂/min/kg and 15.3 ± 0.7 km/h, respectively. Participants ran the DR test at a mean speed of 13.8 ± 0.7 km/h (90% of MAS).

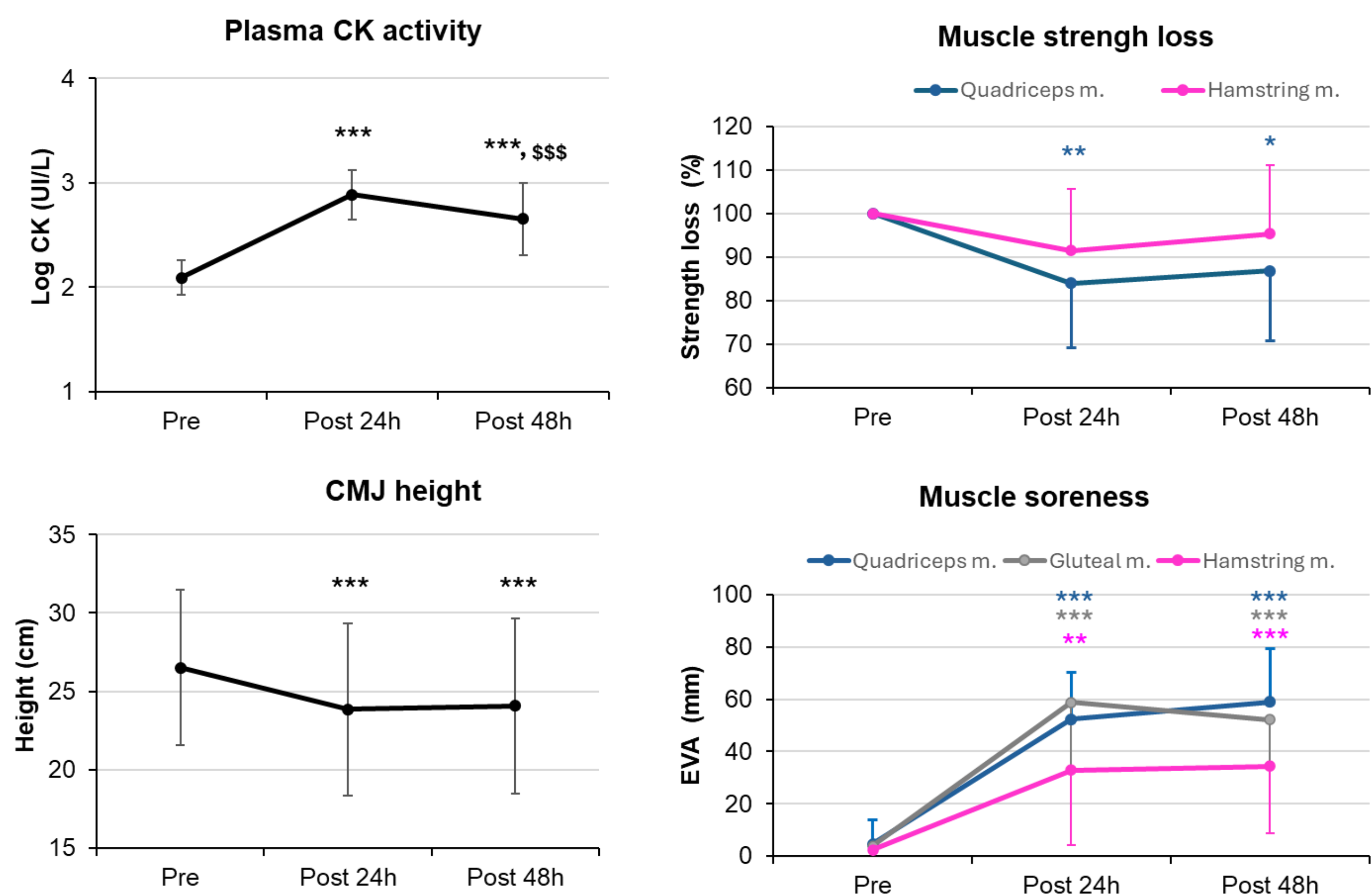


Fig 1. Changes in muscle damage indirect markers. One-way repeated measured ANOVA, Means $\pm$ SD; Significant differences were indicated by *p<0.05; **p<0.01; ***p<0.001 (compared to « Pre »); \$\$\$p<0.001 (compared to « Post 24 h »).

Material and methods

- Female road runners (n=15, VMA ≥ 14) were recruited in this study.
 - Age 23.3 ± 3.0 years
 - Height 165.9 ± 5.0 cm
 - Body mass 57.2 ± 5.4 kg
 - Body fat 21.3 ± 3.5 %
- At *Visit 1*, participants performed **an incremental treadmill test** to determine maximal oxygen uptake (VO₂max) and maximal aerobic speed (MAS).
- At *Visit 2*, they performed a 5-min warm-up consisting of level running at 60% of MAS, followed by 3 min of level running at 90% of MAS. The DR test then consisted of **30-min of downhill running (-15% gradient) at 90% of MAS**.

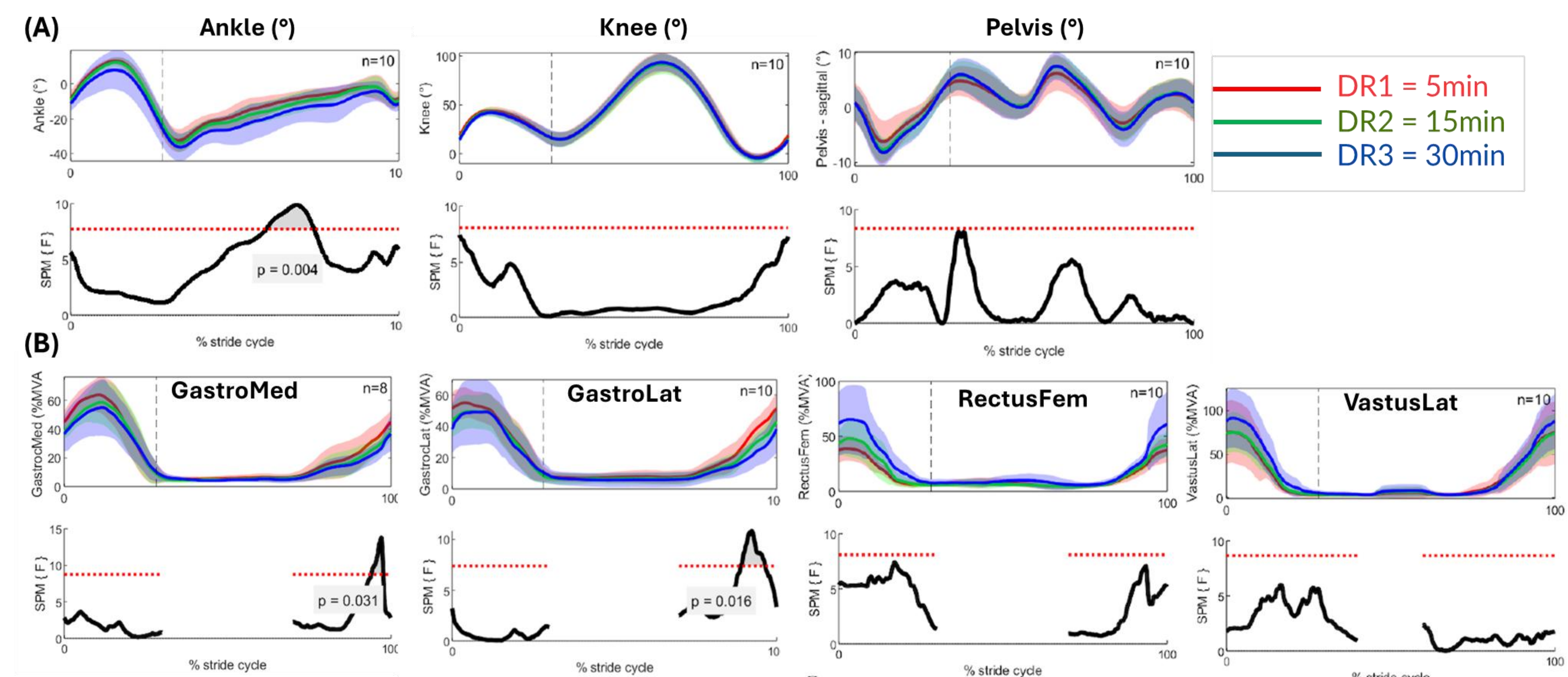


Table 1. Stride spatiotemporal parameters recorded at 5, 15 and 30 min of DR (DR1, DR2, DR3; respectively). Repeated measures ANOVA (Means $\pm$ SD).

	DR 1	DR 2	DR 3	p value
Stance time (ms)	211.33 $\pm$ 12.81	214.40 $\pm$ 15.10	214.24 $\pm$ 15.70	0.314
Swing time (ms)	486.48 $\pm$ 18.81	485.47 $\pm$ 17.05	487.75 $\pm$ 25.67	0.871
Stance percent (%)	30.28 $\pm$ 1.22	30.61 $\pm$ 1.16	30.51 $\pm$ 1.42	0.578
Stride frequency (Hz)	1.44 $\pm$ 0.05	1.43 $\pm$ 0.06	1.43 $\pm$ 0.07	0.698
Stride length (m)	2.64 $\pm$ 0.08	2.65 $\pm$ 0.09	2.66 $\pm$ 0.10	0.642



- Indirect markers of EIMD** were measured before the DR test (“pre”, *visit 2*), 24 h and 48 h post-exercise (*visits 3 and 4*).
- Biomechanical measures** were recorded using a 3D optoelectronic system (Qualisys). Lower-limb muscle activity (rectus femoris, vastus medialis, vastus lateralis, biceps femoris, and gastrocnemius) was assessed by surface electromyography (sEMG) at 5, 15 and 30min during the DR test.

Fig 2. (A) Kinematic data (B) Surface EMG activity (normalized to maximal activation) during the stride cycle across the DR. Analysis was performed using MATLAB® software and a 1D statistical parametric mapping approach, as described in Pataky (2012)¹. Dashed red lines indicate critical threshold ($\alpha = 0.05$). Gray shaded area indicates regions with statistically significant differences between the three DR time points.

Conclusions and Perspectives

- The DR test induced marked changes in EIMD markers, with similar responses at 24 and 48 h, suggesting the occurrence of muscle damage in road-running athletes.
- The decrease in gastrocnemius sEMG activity and the reduced ankle dorsiflexion observed during the swing phase may reflect the presence of fatigue-induced alterations at the ankle. Despite these local adaptations at the ankle joint, spatiotemporal parameters remained unchanged, indicating that runners were able to preserve global running biomechanics.
- Further analyses are needed to determine whether the observed fatigue-induced alterations in running biomechanics are associated with the magnitude of EIMD.

Reference

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