Human running during fatigue: Perspective from simple spring mechanics

- Fatigue is prevalent in running and further understanding of its impact on running mechanics helps in improving performance and injury reduction
- Spring-mass model is widely used to represent human running and fatigue was shown to induce perturbations in the spring-mass behaviour
- Studying fatigue from the spring-mass model perspective helps uncover how runners adjust global mechanics

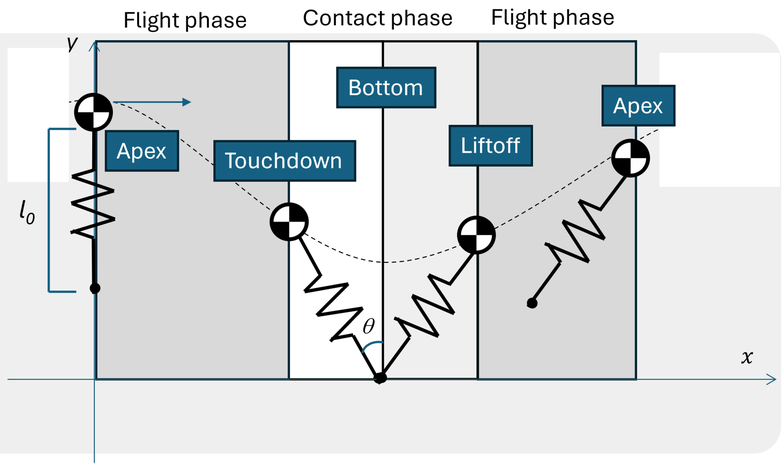


Figure 1: Simple diagram illustrating different key stages within the SLIP model framework

Research objectives

- **To examine the impact of task-level fatigue has on running mechanics from the perspective of spring-mass model at a high intensity, constant paced run on treadmill**
  - *Hypothesis 1: Generalized effects of task-level fatigue can be identified for both groups of runner*
  - *Hypothesis 2: Competitive runners would adopt a more consistent running mechanics despite the onset of fatigue*

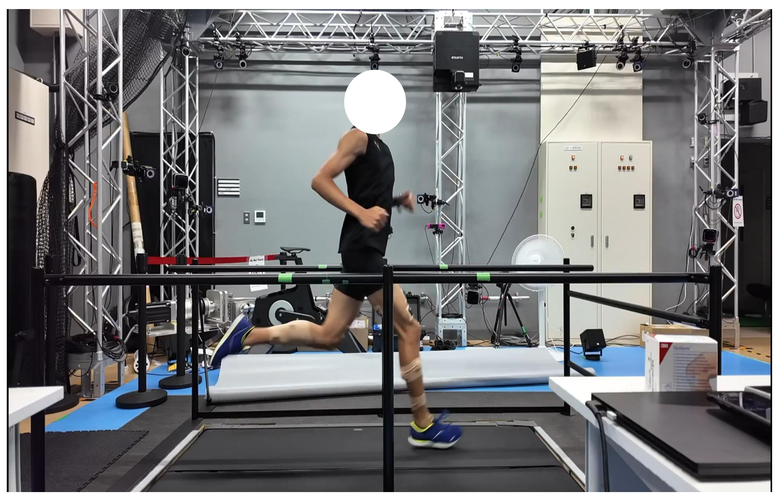


Figure 2: Experimental setup with the instrumented treadmill

Experiment protocol

Experimental Protocols
- vVO2max test
- Run to voluntary exhaustion at 90%vVO2max

Variables of interest:
- Leg stiffness (k_{leg}),
- Vertical stiffness (k_{vert}),
- Limb length (l_0),
- Attack angle (θ),
- Centre of mass position at touchdown (COMtd)

Participants
- 11 competitive runners (official running training with coaches)
- 13 non-competitive runners (no official running training with coaches)

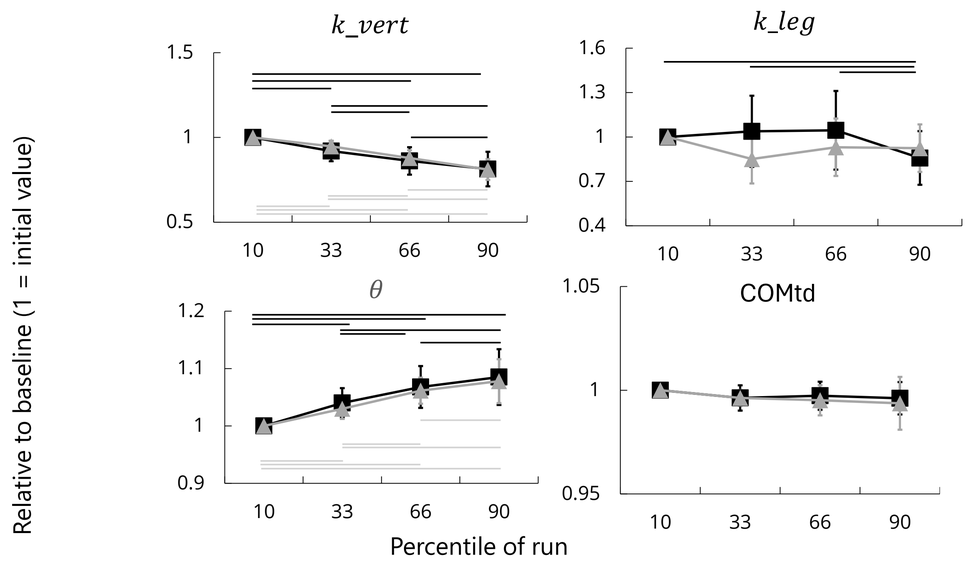


Figure 3: Average values of the variables across 4 different segments of the run. Black lines represent competitive runners and grey lines represent non-competitive runners. The horizontal solid lines indicate significant differences at p < 0.05.

Results & Discussions

Generalized effects of task-level fatigue
- **Increasing:** $\theta \rightarrow$ Proprioceptive deterioration
- **Decreasing:** $k_{vert} \rightarrow$ Reduced neuromuscular transmission

Group differences
- **Competitive:** Maintained COMtd → Better maintenance of important motor control objectives
- **Non-competitive:** Tended to lower COMtd

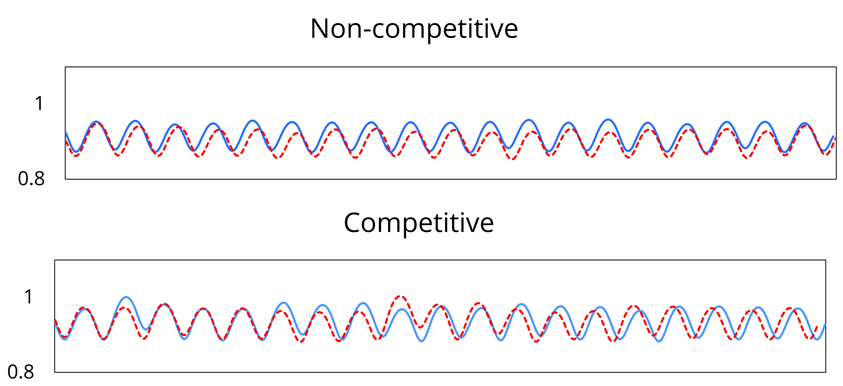


Figure 4: COM trajectories of a typical non-competitive and competitive runner. Solid lines represent the beginning (10th percentile) of the run and dotted lines represent the end (90th percentile) of the run. X-axis represents the duration of the run.

References
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ともに挑む。つぎを創る。