Joint kinematics during steep uphill walking

Calder Robbins[1], Adam Grimmitt[2], Wouter Hoogkamer[2]

[1]Department of Mechanical and Industrial Engineering, University of Massachusetts, Amherst, MA, USA
[2]Department of Kinesiology, University of Massachusetts, Amherst, MA, USA

INTRODUCTION

- Walking on steep inclines requires adaptations in joint kinematics for stability and efficiency.
- Extreme elevation ultra-trail races are gaining popularity [1].
- Athletes wonder if benefits of running in stiffer shoes on level ground extend to steep slopes [2].
- Previous studies have focused on joint kinematics in response to graded locomotion but had limitations [3,4]:
  - Limited slope ranges (< ± 10°)
  - Lack of joint-specific analysis
  - No consideration of metatarsal-phalangeal joints (MTP)
- There is still a gap in our understanding of leg joint kinematics on steep slopes.

Aim: To address the effects of increasing incline on MTP and ankle joint kinematics.

HYPOTHESIS

- As slope increases, there is a corresponding increase in MTP and ankle joint dorsiflexion angles.

METHODS

- 11 healthy participants (21.8 ± 2.9 years, 171.5 ± 7.8 cm, 63.9 ± 7.2 kg).
- 1-minute walking trials at inclines of 0°, 10°, 20°, or 30° and a constant speed of 0.6 m/s.
- Participants wore minimalist shoes (Vibram FiveFingers KSO EVO)
- Trials segmented into strides via anterior-posterior first head MTP joint marker and ankle and MTP joint angles were averaged across strides.

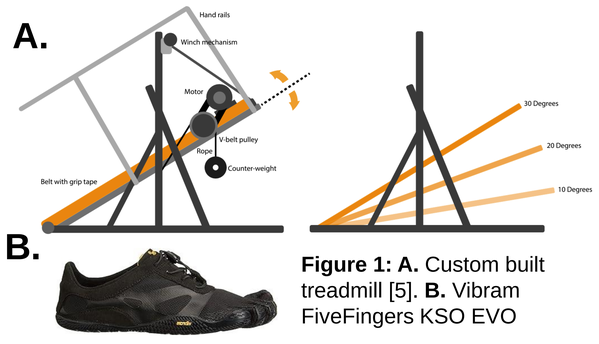
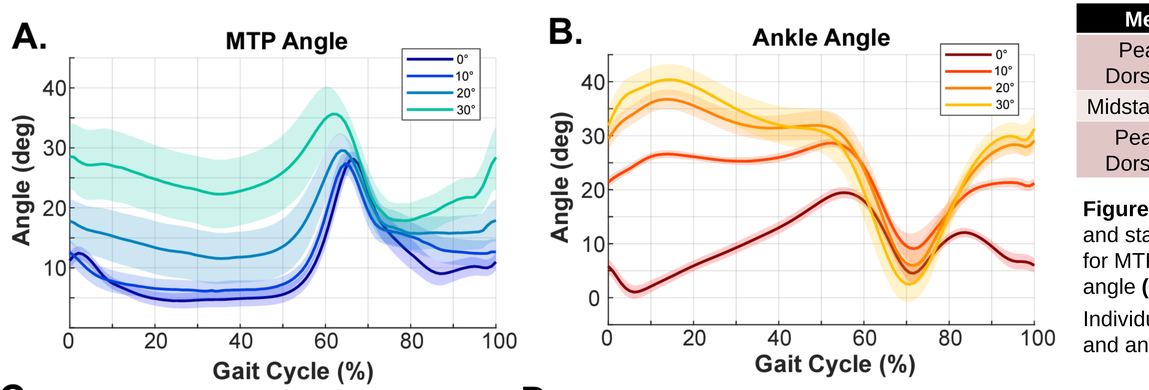
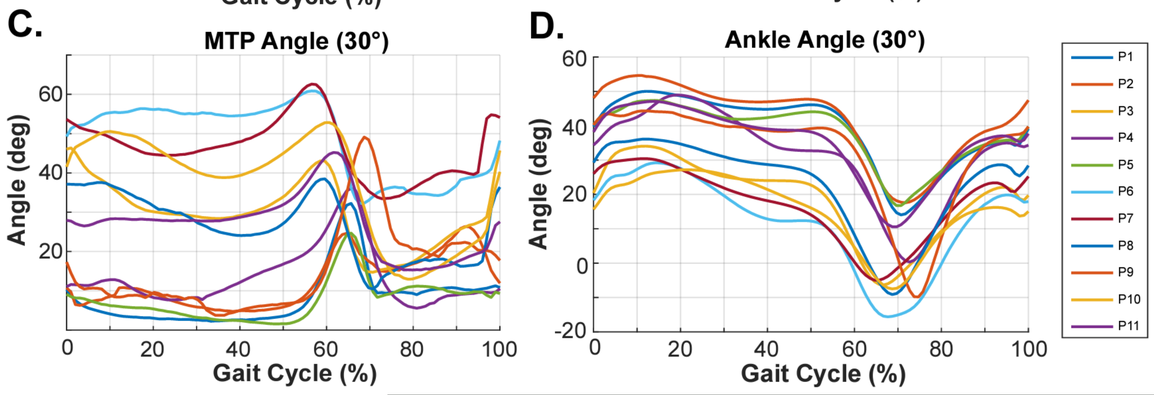


Figure 1: A. Custom built treadmill [5]. **B.** Vibram FiveFingers KSO EVO

RESULTS





Measure	*p* value
Peak MTP Dorsiflexion °	**0.005**
Midstance MTP °	**0.004**
Peak Ankle Dorsiflexion °	**< 0.001**

Figure 2: Group average (solid) and standard deviation (shaded) for MTP angle **(A)** and ankle angle **(B)**.

Individual average MTP angle **(C)** and ankle angle **(D)** for 30° trial.

- At 30°, midstance MTP dorsiflexion angle was negatively correlated to peak ankle dorsiflexion angle ($r^2 = 0.79$).
- All angles increased with increasing incline.

CONCLUSIONS

- Our results show that increasing incline results in significant increases in MTP and ankle joint dorsiflexion angles.
- Further investigation into how these findings vary when athletes choose shoes with different stiffness properties will help inform shoe design and deepen our understanding of locomotion on steep inclines.

ACKNOWLEDGEMENTS

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