Detection of Fatigue Gait Patterns in Outdoor Marathon Runners Through Gait Symmetry Using Dual IMUs and Statistical parametric mapping

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Summary

Running is a regular exercise, while running-induced fatigue puts 40% of runners at risk of musculoskeletal injuries, and the injuries are concentrated in the lower limbs. This study aims to investigate how running-induced fatigue affects the gait symmetry of the foot throughout the entire stance phase and explores the mechanism of symmetry change. Three-dimensional rearfoot kinematics of 23 recreational runners during long-distance outdoor marathon were collected by dual inertial measurement units. Statistical parametric mapping is used to statistically analyze the changes in fatigue-induced 3D kinematics' symmetry of the rearfoot during the entire stance phase. Fatigue mainly altered the rearfoot symmetry of lateral acceleration and rotation speed in the transverse plane during the propulsion phase. Fatigue exacerbates asymmetry and functional differences, potentially increasing the risk of injury.

Introduction

Neuromuscular fatigue affects the individual's optimal running gait pattern, changes gait asymmetry, and increases the chances of injury. Considering that running-related injuries mainly occur in the lower extremities, especially the ankle-foot, it is crucial to study the changes in the symmetry of the rearfoot during running to explore the mechanism of fatigue interfering with optimal gait patterns.

Methods

Three-dimensional rearfoot kinematics of 23 recreational runners during long-distance outdoor marathon were collected by dual inertial measurement units (Xsens DOT 2nd Generation, Movella, Enschede, Netherlands). The normalized symmetry index (NSI) of rearfoot was calculated using statistical non-parametric mapping (SnPM) [1].

Results and Discussion

Prolonged running changes the rearfoot symmetry at rotation speed in the sagittal plane at initial contact, vertical acceleration during mid-stance, and medial-lateral acceleration and the rotation speed in the transverse plane during the propulsion phase (Figure 1).

Conclusions

Fatigue mainly altered the rearfoot symmetry of lateral acceleration and rotation speed in the transverse plane during the propulsion phase. Fatigue exacerbates asymmetry and functional differences, potentially increasing injury risk.

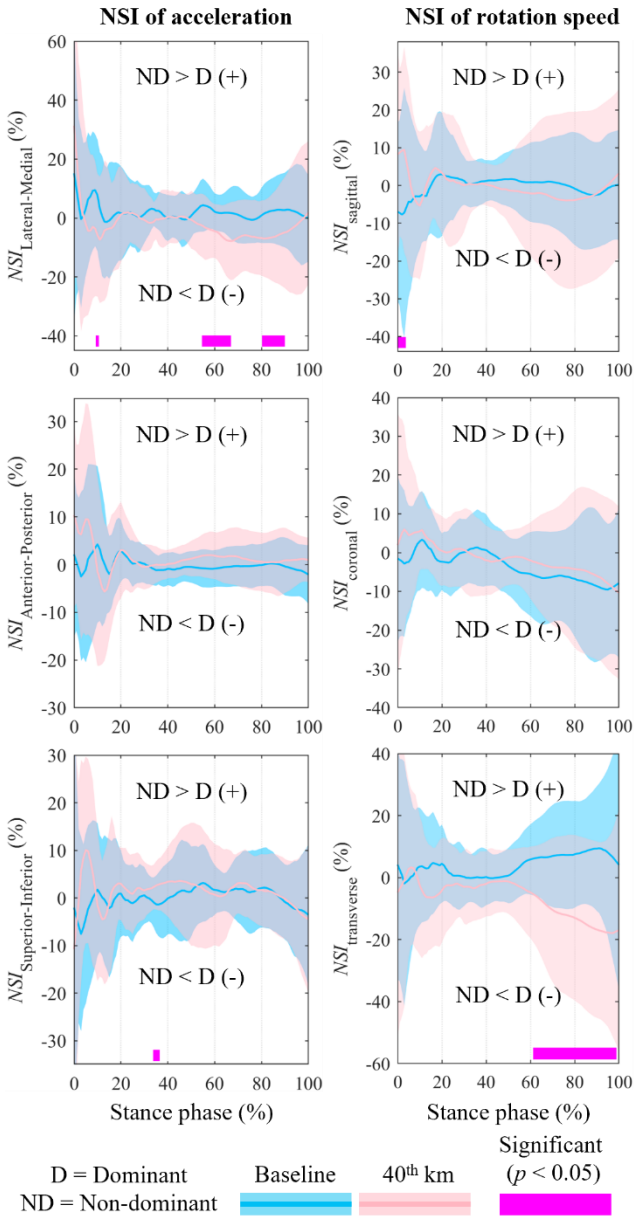

Figure 1: Normalized symmetry indexes (NSI) of the three-dimensional accelerations and angular velocities.

Acknowledgments

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References

[1] Trama R. et al. (2021). *J. Open Source Softw.*, **6**: 3159.