

SIMULATION OF LOWER LIMB MUSCLE ACTIVATION USING RUNNING SHOES WITH DIFFERENT HEEL-TO-TOE DROPS USING OPENSIM

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Introduction:

Although numerous studies have been conducted to investigate the acute effects of shoe drops on running kinematics and kinetic variables, the muscle force consequences remain unknown. Thus, the primary goal of this study was to compare the muscle force, kinematics, and kinetic variables of habitually rear-foot runners with the heel-to-toe drop of negative 8mm shoes (minimalist shoes) and the heel-to-toe drop of positive 9mm shoes (normal shoes) during the running stance phase using musculoskeletal modelling and simulation techniques.

Methods:

Experimental data of 16 healthy rearfoot strike pattern runners for a standard lower limb kinematic, ground reaction force and muscle activation were collected. The data were used OpenSim for musculoskeletal modeling simulation. In Matlab, the statistical parameter mapping paired t-test was used to compare the joint angle, moment, and muscle force waveform. Results: The results revealed differences in the sagittal ankle and hip angles and sagittal knee moments between the different heel-to-toe drops of running shoes.

Results:

The results found that with the negative 8mm running shoes, the ankle dorsiflexion angle, ankle eversion angle, knee flexion angle, hip flexion angle, hip internal rotation, and hip external rotation angle were significantly smaller than the positive 9mm running shoes. While the lateral gastrocnemius, Achilles tendon and extensor hallucis longus muscles were significantly greater in the minimal shoe compared to normal shoes. The vastus medialis, vastus lateralis and extensor digitorum longus muscles force were smaller in the minimalist shoes.

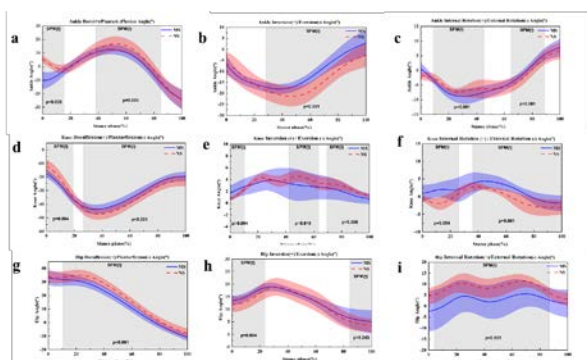


Figure 1: Illustration of the MS and NS lower limb results showing the statistical parametric mapping outputs for the moment of the ankle, knee, and hip

during the running stance phase. MS, minimalist shoes, NS, normal shoes.

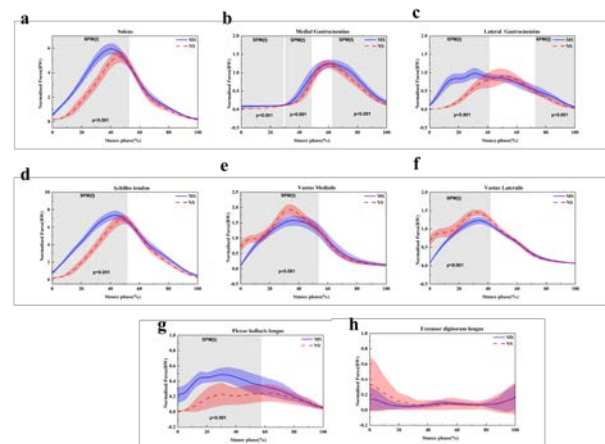


Figure 2: Illustration of the results between the MS and NS lower limb showing the statistical parametric mapping outputs for the muscle force during the running stance phase. MS, minimalist shoes, NS, normal shoes.

Discussion:

Negative running shoes may cause runners to use a midfoot strike pattern. High muscle force in the gastrocnemius lateral, Achilles tendon, and flexor hallucis longus muscles demonstrated that increases the potential for Achilles tendonitis and ankle flexor injuries.

Reference:

1. Yu et al. *Front. Bioeng. Biotechnol.*, 2021, 9.
2. Sun et al. *J. Sports. Sci. Med.* 2020, 19, 20.
3. Xiang et al. *J. Appl. Biomech.* 2022, 132, 110941.

