

## HIP EXTENSOR FATIGUE ALTERS COUPLED HIP AND KNEE COORDINATION DURING SINGLE-LIMB STEP-DOWNS: A RANDOMIZED CONTROLLED TRIAL

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**BACKGROUND AND PURPOSE:** Impaired hip muscle function may contribute to movement coordination deficits such as altered femoral adduction or knee valgus that increase risk of lower extremity injuries. We examined whether hip and knee coordination is altered during single-limb step-downs following a hip extensor fatigue protocol.

**METHODS AND MATERIALS:** In this randomized controlled trial, 21 participants performed 20 repeated single-limb step-downs before and after completing either a Biering-Sorensen fatigue protocol or a sham fatigue protocol. Hip and knee kinematics were measured with 3D motion analysis and hip and thigh muscle recruitment was measured with surface electromyography (EMG).

**ANALYSES:** Means and SDs of sagittal and frontal plane hip and knee kinematics and muscle recruitment from EMG were calculated. Nonlinear measurements of coupled hip and knee coordination were examined with cross recurrence quantification analyses. Pre-to-post fatigue change scores were analyzed inferentially with independent t-tests ( $\alpha = 05$ ).

**RESULTS:** Neither the magnitude nor variability in sagittal and frontal plane hip and knee kinematics changed following the fatiguing exercise ( $p > .05$ ), though gluteus maximus recruitment during the step-down tests increased in the fatigue group. Based on cross recurrence quantification analyses, Shannon entropies of coupled sagittal plane hip and frontal plane knee displacement trajectories increased ( $p < .05$ ) in the fatigue group. Likewise, Lyapunov exponents of the coupled hip and knee trajectories decreased ( $p < .05$ ) in the fatigue group.

**CONCLUSIONS:** The increased Shannon entropies and decreased Lyapunov exponents emanating from the coupled hip and knee displacement trajectory patterns provide similar interpretations. Namely, participants performed the step-down tests with greater irregularity in the fatigued state. Future work is needed to understand how these changes in coupled motion patterns influence injury risk.

**IMPLICATIONS:** Fatiguing the hip extensors alters coupled hip and knee motion patterns, suggesting that inter-joint coordination is impaired. This may have implications for pathomechanics that elevate lower extremity injury risks.