Background and Significance: Humans hopping on different elastic surfaces in series (Fig. 1), adjust leg stiffness \( k_{\text{leg}} \) to maintain system stiffness \( k_{\text{system}} \), primarily by modulating ankle joint stiffness \( k_{\text{ankle}} \). When a parallel elastic element is applied at the ankle to assist plantarflexion (Fig. 2), \( k_{\text{leg}} \) and total \( k_{\text{ankle}} \) (ankle+spring) is conserved. Moreover, biological \( k_{\text{ankle}} \) decreases to offset the added stiffness of the spring. We studied the effects of adding a resistive plantarflexion torque in parallel with the ankle. We hypothesized \( k_{\text{leg}} \) and total \( k_{\text{ankle}} \) would remain invariant and that biological \( k_{\text{ankle}} \) would increase to compensate.

Research Design: We ran a repeated measures study on 10 subjects hopping in place under three conditions: AFO (control), plantarflexion assist spring-loaded AFO (PA-SLAFO), and a plantarflexion resist SLAFO (PR-SLAFO). We collected kinematic, kinetic, and EMG data at each condition for three frequencies (2.2, 2.4, 2.8 Hz). We analyzed statistics using a Three-Way ANOVA (subject, condition, frequency) with a Bonferroni Post-Hoc test.

Results & Tentative Conclusions: Different AFO conditions had no effect on \( k_{\text{leg}} \) \( (P > .103) \). Total \( k_{\text{ankle}} \) was maintained for PA-SLAFO, with biological \( k_{\text{ankle}} \) decreasing to perfectly compensate. In the PR-SLAFO condition, total \( k_{\text{ankle}} \) was greater than expected \( (P<0.05) \). Biological \( k_{\text{ankle}} \) increased with PR SL-AFO, but was unable to completely compensate for the added resistance. This implies that despite adequate global compensation to maintain \( k_{\text{leg}} \), subjects could not completely compensate for added resistive torque solely at the ankle and had to enlist a multi-joint compensation strategy. We are currently investigating these multi-joint compensation strategies.
REFERENCES:


