Project Title: Optimizing Ankle Exoskeleton Assistance for Walking Across the Life Span

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Statistical Analysis Plan

The goal of the study is to evaluate the effects of bilateral ankle exoskeleton assistance on both young and older participants' metabolic energy cost during walking.

We seek to test three hypotheses:

H1. Bilateral ankle exoskeletons that provide 'motor-like' assistance will result in lower net metabolic power than those providing 'spring-like' assistance for young adults.

H2. Bilateral ankle exoskeletons that provide 'motor-like' assistance will result in lower net metabolic power than those providing 'spring-like' assistance for older adults.

H3. Bilateral ankle exoskeletons will result in lower net metabolic power for older versus young adults regardless of assistance strategy (i.e., for 'motor-like' or 'spring-like' assistance).

To test these hypotheses we will execute a repeated measures study design.

We will compute means of the primary outcome measure:

Net Metabolic Power (watts/kg)

for 6 bilateral ankle exoskeleton conditions:

C1. Without ankle exoskeletons (NoExo) across
C2. Bilateral ankle exoskeletons without assistance (NoTorque)
C3. Bilateral ankle exoskeletons with spring-like assistance (Spring)
C4. Bilateral exoskeletons with low-level motor-like assistance (10 Nm) (MotorLow)
C5. Bilateral exoskeletons with medium-level motor-like assistance (20 Nm) (MotorMed)
C6. Bilateral exoskeletons with high-level motor-like assistance (30 Nm) (MotorHigh)

for participants in two age categories:

X young adults (18-45 yrs)
Y older adults (>65 yrs).

To address H1 we will perform a two-way ANOVA on the young adult data (factors: participant (random) = X levels; exoskeleton condition = 6 levels) to test for a significant effect of exoskeleton condition on net metabolic power (watts/kg) ($p < \alpha = 0.05$; SPSS 21, IBM, USA). If exoskeleton condition is significant, we will perform post-hoc pairwise comparisons with a Bonferroni correction to test whether net metabolic power (watts/kg) is lower for MotorHigh vs. Spring; MotorMed vs. Spring; and MotorLow vs. Spring.

To address H2 we will repeat the analysis used for H1 on the older adult data.

To address H3 we will compute mean differences with respect to NoTorque for spring-like (C4-C2) and motor-like (C6-C2; C5-C2; C4-C2) assistance conditions for both young and old adults. Then we will perform four independent t-tests with a Bonferroni

correction to test whether the difference in net metabolic power (watts/kg) is greater for older versus young adults for Spring, MotorLow, MotorMed, and MotorHigh bilateral exoskeleton assistance.