MUSCULOSKELETAL ADAPTATIONS IN YOUNGER AND OLDER ADULTS IN RESPONSE TO CHALLENGING CONDITIONS

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INTRODUCTION

The Centers for Disease Control estimates that one out of four adults over the age of 65 experiences an accidental fall each year and that by the year 2030, there will be an estimated seven deaths per hour due to accidental falls. Previous research has identified some of the most significant risk factors for falls as being environmental conditions, cognitive distractions, and physical impairments. However, little is known about how the musculoskeletal system responds to these factors. Our current research is aimed at gaining an improved understanding of musculoskeletal adaptation by comparing the biomechanics of younger healthy subjects and older subjects who have experienced an accidental fall within the last year.

HYPOTHESIS: We hypothesize that older adults who have experienced an accidental fall will have altered biomechanics during activities of daily living resulting in a stiffer knee and higher compressive load across the knee joint.

APPROACH

- **Neuromechanical Data Collection**
  - Surface Type: Normal, Slick, Unlevel
  - Activities: Walk, Pivot
  - Additional Challenges: Weighted vest, Cognitive distraction

- **Computational Modeling**
  - Collaboration with Boise State University Center for Orthopaedic & Biomechanics Research Lab
  - 36 Activity/surface/challenge experimental setups
  - Three “good” trials per combination
  - 108 total trials per participant

Creating computational models of subjects allows for a greater understanding of how the musculoskeletal system responds to walking with challenging conditions. Via these models, we can determine the degree of rotation and/or translation of joints, what muscles are activated during kinematics, and the corresponding net forces and moments associated with kinematics. The three main steps for creating a computational model are:

  - **Scale**
  - Imports experimental marker data (Figure 1) from the CORR lab to create a computational model of the subject (Figure 2)

  - **Inverse Kinematics**
  - Places the computational model in a position that best matches the experimental marker data for each timeframe of each trial
  - Creates a file for each trial containing the joint angles and translations for each frame of the trial to be used for analysis

  - **Inverse Dynamics**
  - Determines the residual forces and moments for each trial (Figure 3) which are used to validate the accuracy of the computational model
  - Creates a file for each trial containing the net forces and moments for each timeframe of the trial to be used for analysis

- **Analysis**
  - Subject Specific Data
  - Young Adults (Walk-Unweighted-Normal)
  - Young Adult (YA) vs Older Adult (OA)

  - Currently, all subject data has been collected
  - 2 subjects need computational models constructed
  - Upon completion of analysis of all 28 subjects, correlation between knee stability and musculoskeletal function will be quantified
  - Subject-specific joint stability models will be created using OpenSim data, MRI imaging, and finite element software

  - Average the 3 trials per experimental setup & plot kinematics for each subject (Figure 4)
  - Combine the subject specific data with the other younger adult (YA) or older adult (OA) subject data (Figure 5)
  - Compare YA and OA data with respect to corresponding experimental setup (Figure 6)
  - Extract metrics from joint kinematic data and run mixed model ANOVA (analysis of variance) to identify potential interaction effects

- **Future Direction**
  - Findings may lead to musculoskeletal rehabilitation and injury prevention recommendations, orthotic development, or surgery intervention for subjects at risk from accidental falls
  - Possible future research directed towards incorporating material properties of the articular cartilage of the knee joint to create further tailored subject-specific joint stability models

References:
https://www.cdc.gov/homeandrec安全生产falls/adultfalls.html

Acknowledgments:
This project is supported by the National Institutes of Health (NIH R15AG059605 and NIA AG123803). I would like to thank the Southwestern Idaho Bridges to Baccalaureate Program for providing the opportunity for my first collegiate research experience. I would also like to thank the Computational Biosciences Laboratory for their guidance, support, and the opportunity to participate in their research project.