ABSTRACT
COORDINATION STRATEGIES AND NEUROMUSCULAR RESERVE DURING THE SIT-TO-STAND TASK IN OLDER AND YOUNG ADULTS

Nayun Ahn, M.A., A.T.C.
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The sit-to-stand (STS) task is often performed more than 50-60 times a day by non-impaired older adults. Although typically considered simple, the STS movement becomes notably more difficult as older adults become affected by age-related functional declines or neuromuscular impairments. Since one's ability to perform the STS task significantly impacts their independent mobility, safety, and quality of life, it is an important task for older adults. Reduced neuromuscular capacity (i.e., muscle strength) and reserve (i.e., difference between capacity and task demand) in lower limb causes older adults to adopt different STS coordination strategies which is often inefficient and unsafe. Although many studies investigated older adults achieve STS task in certain movement strategies compared to young adults, the underlying mechanisms of why they use different movement strategies compared to young adults is not well established. It is therefore crucial to examine the mechanisms that older adults use to accomplish the STS task and identify which are limiting factors to determine altered STS coordination strategies. The purpose of this dissertation was to investigate coordination strategies, neuromuscular capacities, and reserves in older and young adults during the STS task.

Healthy older and young adults performed self-selected speed STS task, while three-dimensional movement, ground reaction forces were collected with motion capture cameras, force plates, respectively. Additionally, isometric muscle strength was measured with a Biodex. In the first study, induced acceleration analysis was used to identify the lower limb net joint moment contributions to the horizontal and vertical velocity of the body’s center-of-mass. In the second study, joint torques from maximum voluntary isometric contraction (MVIC) were used as an input for a regression-based model to estimate maximum potential net joint moment (NJM) capacities during STS task. The relative muscular efforts (RME) were calculated as the ratio between the inverse dynamics NJMs and the maximal potential NJMs. In the third study, hierarchical clustering analysis was applied to biomechanical STS and muscle strength data from older and young adults to identify subgroups with distinct movement strategies.

The primary findings of this dissertation were that, regardless of joints, the contribution of NJMs to the vertical COM differed in older adults compared to young adults, using different control strategies to compensate for age-related declines. While knee and hip extensors RME were not significantly differ, older adults adopted altered strategies to reduce mechanical demand on the knee and hip extensors to compensate for their limited ability to generate maximum moment producing capacity. Four unique STS coordination strategies were classified. Strength, anthropometrics, and preferred movement speed as well as joint dominance distinguished STS strategies within and between healthy older and young adults.