

# **The Effects of Neuromuscular Activity and Muscle Structure on Stepping Performance in Older Adults**

**Math 539 - Exam 1**

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## **Introduction**

Falls pose a significant threat to older adults, with nearly one in four individuals aged 65 and older experiencing a fall each year that often results in severe injuries and a loss of independence. In response our topic is "The Effects of Neuromuscular Activity and Muscle Structure on Stepping Performance in Older Adults". This study examines age-related differences in stepping performance and muscular structure: a critical component of balance recovery by evaluating factors such as stepping speed, weight transfer speed, and neuromuscular activation, while also investigating how muscle structure including muscle size, stiffness, and intramuscular fat content influences movement ability in both younger and older populations. The research integrates detailed assessments from electromyography and ultrasound imaging with clinical evaluations including the Stair Climb Power Test, Timed Up-and-Go Test, Four Square Step Test, and Handgrip Strength Test to control for confounding factors and provide comprehensive insights. Ultimately, these findings aim to inform targeted fall prevention strategies and mobility interventions designed to enhance stability and maintain independence among older adults.

## **Goals and Objectives**

### **Goals**

This study aims to examine age-related differences in stepping performance and investigate how muscle structure influences movement ability in younger and older adults. Specifically, it analyzes stepping speed, weight transfer speed, and neuromuscular activity to identify potential differences between age groups. By exploring these factors, this research seeks to provide valuable insights that can inform fall prevention strategies and mobility interventions for older adults.

### **Objectives**

To achieve these goals, the study will measure stepping speed and weight transfer speed in both younger and older adults. It will also analyze lateral, forward, and backward stepping performance to detect potential age-related impairments. Additionally, the research will assess the relationship between muscle structure—specifically muscle size, stiffness, and fat content—and stepping ability. By comparing stepping performance factors across age groups, the study aims to uncover neuromuscular differences that may contribute to balance and mobility challenges in aging populations.

Ultimately, the findings from this research will enhance understanding of how aging affects stepping performance and how muscle composition and function influence movement ability.

This knowledge may guide the development of targeted fall prevention strategies and mobility interventions to support older adults in maintaining stability and independence.

## **Literature Review**

### **Scope of the Problem**

Older adults are at a significantly higher risk of falling compared to younger adults, with approximately one in four adults aged 65 and older experiencing a fall each year (National Council on Aging 2024). Age-related declines in sensory perception, motor control, and cognitive processing contribute to impaired balance, increasing susceptibility to falls (National Safety Council 2024). The vestibular, visual, and proprioceptive systems, which are critical for maintaining postural stability, deteriorate with age, leading to slower reaction times and reduced coordination (Fitzpatrick and McCloskey 1994; Kandel et al. 2021). As a result, older adults struggle to recover from sudden balance disturbances. In addition, muscle function and strength decline with age. Together, these factors make older adults more prone to falls.

The consequences of falls are severe, as they are the leading cause of injury-related deaths among older adults (Centers for Disease Control and Prevention 2024b). Falls frequently result in hip fractures, head trauma, and other serious injuries, leading to long-term disability, loss of independence, and increased healthcare costs (National Safety Council 2024). In 2022 alone, over 3.5 million older adults required emergency medical attention due to falls (Centers for Disease Control and Prevention 2024a). These incidents contribute to a substantial burden on the healthcare system and significantly impact the quality of life for aging individuals. Given the high prevalence and serious consequences of falls, fall prevention strategies are essential to reduce injury risks and improve overall well-being in older adults.

### **Physiology of Balance Recovery**

One key component of fall prevention is understanding balance recovery—the process in which a person who loses balance avoids falling by using strategies like stepping. The physiology of balance recovery involves the coordinated interaction of the brain, nerves, and muscles to maintain or restore postural stability after a disturbance in balance. This relies on sensory input to detect imbalance and provide real-time updates, central processing to integrate sensory information and initiate action, and motor output, which is the execution of a balance recovery response.