**Translational Research in Kinesiology**

In 2013 falls by older adults accounted for over $34 million in health care costs [1]. By 2030, one out of every five adults will be an older adult and by 2050, the older adult population is estimated to be double what it was in 2010 [2]. Lower strength and rates of force development (RFD), as compared to a young adult population [3], [4] are associated with a slowing of movement, increased risk of falling, and functional decline.

As an exercise physiologist with over a dozen years designing and implementing exercise programs for older adults and special populations, I have a keen interest in methods to help these populations attain and maintain functional independence for as long as possible. A research agenda that focuses on improving function and mobility in special populations has several advantages. It opens doors for collaboration with other function and mobility researchers, health care professionals, and senior living centers within the community. It creates opportunities for the mentoring of students of all levels. Lastly, a research agenda based in function can include both interventional and mechanistic work.

***Past and Ongoing Research***

Working one-on-one with special populations, often exercise interventions I designed were geared towards strengthening of skilled movement. This included an application of the overload principle that focused on increasing both resistance levels and complexity of the exercises. Clients saw improvements in strength and skill, which enabled them to lead more active lifestyles. My initial foray into research took advantage of my prior experience and was an investigation of the task strengthening and complexity combinations and their effects on risk of falling. This project found combining increases in both resistance and complexity levels enabled older adults to decrease their risk of falling more than conventional strength training or stretching [5]. These results supported the theory of a functional ceiling [6] strength training has for older adults and indicates the need for greater depth of study of both interventions and mechanisms which cause dysfunction in special populations.

My current project is a step forward to examine the relationship between rate of neuromuscular activation and RFD in both isometric and dynamic movements and how it may translate to functional assessments for special populations. Early neurophysiology research shows, in a feline model, there is a strong relationship between an injected current (artificial neuromuscular activation) and rate of force development [7]. Movement velocity and neuromuscular activation co-vary [8] with higher rates of both strongly associated with function and mobility [9], [10]. The ability to activate muscles quickly is diminished in older adults [11] and people with PD [12]. The assessment of function in both populations is typically performed at a “preferred” speed [13], [14] which may not elicit neuromuscular activation levels high enough to properly determine functional abilities.

This is a multi-aimed project, which uses surface electromyography (sEMG) to investigate neuromuscular activation. Using sEMG, my current project looks to determine (Aim 1.1) which measure of neuromuscular activation best relates to RFD and (Aim 1.2) if this relationship follows early neurophysiology research [15] by showing a non-linear relationship. The next aspect (Aim 2) of this project exploits known differences in isometric RFD to determine if the rate of neuromuscular activation at increasing dynamic movement velocities varies across different populations (young adult, healthy older adult, and people with PD) during commonly used dynamic assessments. Finally, aim 3 is to determine if the relationship between rate of neuromuscular activation and dynamic movement velocity mirrors the non-linear relationship found in early neurophysiological research.

Preliminary results indicate that the peak rate of neuromuscular activation (RER) has the strongest relationship with movement velocity (aim 1.1, in preparation). The mathematical modeling, based on similar physiological relationships, at this state indicates there is a bi-linear (non-linear) relationship between isometric movement velocity and the rate of neuromuscular activation (aim 1.2, in preparation). I am also seeing that the 4-meter walk (NIH Toolbox) and the arm curl (Senior Fit Test) do not have the ability to elicit the desired rate of neural activation at the fastest velocity whereas recumbent bicycling and transverse plane elbow extension show a significant speed effect when performed as fast as possible.

***Future Research Goals***

I am interested in continuing to examine both interventions and the neural control of movement and function in older adults and special populations. I plan to investigate how both speed and complexity based interventions improve force production, function, and neuromuscular activation. This line of research is rife with opportunity for collaboration, mentoring, and helping many different populations. Older adults and special populations will benefit by the dissemination of this research to health care professionals and exercise physiologists. Students who participate in this research will have a better understanding not only research methodology but of the mechanisms behind loss of function and gain an appreciation for the role of exercise in health and functional independence, which will better prepare them for healthcare careers.

My short-term goals includes identifying norms for neural control of rapid movement (rate of force development scaling factor (RFD-sf)) [16]. Norms for neural control of rapid force production would allow health care professionals to understand the level of rapid movement control of an individual. This will allow them to appropriately determine an exercise program for the individual. A secondary short-term goal is to examine different antagonist surface EMG measures to determine which one has the greatest effect on rapid force production, through co-contraction, in older adults and people with PD.

I plan to pursue research funding for this research line through the NIH. I will also look towards the individual disease and disability foundations, such as the National Parkinson’s Foundation, the Michael J. Fox Foundation, more locally, the Shake it Off for PD Organization (West Chester, PA) for funding opportunities for this work. Ideally, a network of care can be created in the community in collaboration with exercise scientist researchers and students, and health care professionals. The goal would be to create a community where older adults and special populations seek out opportunities to exercise and help with research.

The dissemination of this information is key for the front line practitioners. Kinesiology and practitioner journals will be targeted for publications. Continuing education workshops will also be created for personal trainers, physical therapists, and medical professionals to teach them how to apply the new knowledge.

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