

## THE EFFECT OF EXERCISE ON BALANCE AND PERIPHERAL NEUROPATHY IN OLDER ADULTS WITH TYPE 2 DIABETES

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### INTRODUCTION

According to the most recent 2009 World Health Organization (WHO) estimates, more than 220 million people worldwide have diabetes. It is expected that this number will double in 20 years, and that most individuals with diabetes living in developed countries will be 65 years and older, whereas those living in developing countries will be between 45 and 64 years of age. A common complication of diabetes is peripheral neuropathy, which plays a substantial role on morbidity and mortality (Duby et al., 2004). The disorder is characterized by a progressive loss of nerve fibers and sensation, which affects foot sensation, innervations of the small muscles of the foot, and fine vasomotor control of the pedal circulation (Jeffcoate & Harding, 2003).

While a minority of people experience symptoms that manifest as a burning sensation, sharp pain, numbness, and pain to normal touch, the majority have silent symptoms such as the inability to feel, assess temperature, or sense even painful stimuli, particularly in the feet. As a result of their loss of protective sensation, individuals with peripheral neuropathy are at an increased risk for microtrauma and hidden injury to the foot, which can cause infections, calluses, and ultimately foot ulceration (Pinzur, 2002; Vinik et al., 2000). Diabetic foot ulcerations are a major public health concern, because they are one of the primary reasons for hospitalization among the diabetic population as well as the leading cause of non-traumatic foot amputations.

Diabetic complications greatly affect fall risk. According to Park, et al., (2007), older adults with diabetes have a two- to three-fold higher risk for injurious falls and physical disability than their non-diabetic counterparts. To decrease the fall risk in this population, intervention programs including resistance, endurance, balance, and flexibility

exercises have traditionally been used. More recently, Tai Chi has been recognized as an effective alternative for fall prevention among older adults in Western societies. While the interest in Tai Chi's benefits for the elderly is growing, the benefits for older adults with diabetes, specifically for those with peripheral neuropathy, are unknown. Therefore, the purpose of this study is to investigate the effects of Tai Chi in comparison to traditional training on balance and peripheral neuropathy in older adults with type 2 diabetes.

### METHODS

**Participants:** Forty-five adults with type 2 diabetes between the ages of 60 and 80 years will be recruited for this project. Inclusion criteria include not partaking in regular exercise, ability to walk independently, no chronic medical problems (other than diabetes) that limit participation, not taking blood pressure medication, having a body mass index (BMI) of less than 40 kg/m<sup>2</sup>, and no cognitive impairments. Fifteen healthy adults without diabetes but with the same inclusion criteria will serve as a healthy control.

**Study Design and Protocol:** Individuals meeting the study criteria will be scheduled for a baseline testing appointment. After the baseline assessment for all 60 participants, the 45 diabetic participants will be randomized into a Tai Chi, a traditional exercise, and a non-exercising control group. The two exercising groups will meet three times per week for 16 consecutive weeks. The assessments will occur at baseline (start), 2 months (midterm), and 4 months (termination), and will include tests for balance and peripheral neuropathy as well as tests for overall fitness.

**Interventions:** *Tai Chi* – The lessons will be taught by an experienced instructor who follows the classic Yang style emphasizing multidirectional

weight shifting, awareness of body alignment, and coordination of movement. The participants will practice three times a week for 1 hour. *Traditional exercise* – The training sessions will be conducted by a qualified trainer. The weekly training routine will consist of three 1-hour sessions of combined strength, flexibility, endurance, and balance exercises. *Control* – The control groups will be instructed to continue with their daily physical routine during the 16-week intervention period.

**Outcome Measures:** The primary outcome measures will include an assessment of balance and peripheral neuropathy, which includes foot tactile sense and ankle proprioception. The secondary outcome measures will include the SF-36 health questionnaire, and an assessment of overall fitness.

Balance will be measured using the Tekscan pressure mat, foot tactile sense will be determined with the Semmes-Weinstein Monofilament test (Figure 1), and ankle proprioception will be assessed with the Biodex Advantage 33.3. Information gathered from the Tekscan can establish the risk of falling as well as provide insight into how an individual loads his or her foot, which – combined with the monofilament foot tactile sensory test – can reveal sites that are at risk for foot ulcerations. Data obtained from the Biodex can provide information about an individual's ability to detect motion within the ankle joint, which is important in maintaining balance and stability.



**Figure 1:** Sites for the Semmes-Weinstein monofilament test

The overall fitness level will be assessed with the Senior Fitness Test (SFT), a standard fitness test for adults 60 years and older. The SFT includes tests, such as the chair stand, arm curl, chair sit and reach, back scratch, 8-foot up and go, and 6-minute walk test, which assess an individual's strength, flexibility, mobility, and aerobic capacity. The SF-36 will be used to measure health-related quality of life.

**Data Analysis:** A 3x3 factorial repeated ANOVA will be conducted to calculate the differences between and within the diabetic groups. If significance is found in group or time effects for the between or group differences, a multiple comparison post-hoc analysis will be performed. A two-sample *t*-test will be used to compare the baseline assessments between the 15 healthy control and the 45 diabetic participants, and a Bonferroni correction will be used to compare the means of the final assessment between the 15 healthy controls and those of the 3 diabetic groups. The level of significance will be set at  $p < 0.05$ .

## IMPORTANCE OF STUDY

Given the estimated increases in the number of diabetic older adults, there is a need for increased research in treatment strategies and therapeutic interventions. Although the number of studies on the effects of Tai Chi on balance control and fall prevention has increased over the last 15 years, the available data is still limited. The results from this study can provide insights into the changes that occur in balance and peripheral nerve sense with exercise in older adults with type 2 diabetes. Specifically, the findings may provide an answer to the question whether both strength training and Tai Chi exercise are appropriate treatment strategies to address foot ailments and the associated high fall risk in this population.

## ACKNOWLEDGEMENTS

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