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The Effects of Walking Poles and Training on Gait Characteristics and Fear of Falling in Community Dwelling Older Adults

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ABSTRACT

BACKGROUND & PURPOSE: Walking poles are becoming popular not only in younger populations, but also with older adults. Manufacturers are promoting the health benefits of walking poles and claim that they facilitate a more normal gait pattern and increase confidence with walking in older adults. There is a lack of evidence to support these claims. The purpose of this double-blinded randomized controlled trial involving community dwelling older adults is twofold: 1) to measure the impact of walking poles on gait speed, stride length, and fear of falling; and 2) to compare the impact of walking pole use between a structured pole training group and an unstructured pole training group.

METHODS: Dynamic gait analysis was performed on 12 healthy subjects (mean age 84.5 +/- 9.5 years; 8 female/4 males) using a GAITRite® mat. To determine baseline, subjects performed three walking trials without walking poles. Subjects were then randomly assigned to one of two groups, either structured or unstructured, for training in the use of walking poles. The subjects then repeated three walking trials on the GAITRite® mat utilizing the walking poles. Gait speed, stride length, fear of falling, and global rating of change within and between groups was analyzed using paired t-tests, independent 2 sample t-tests, Spearman correlations and Pearson correlations.

RESULTS: When comparing walking with and without walking poles, significant differences ($p<0.05$) were found within the unstructured training group with gait speed and stride length while no significant differences were found within the structured training group. No significant differences were found between training groups when comparing the amount of change in gait speed and stride length. A moderate inverse correlation was found between change scores of gait speed and fear of falling.

CONCLUSION: Results did not support the hypothesis that the use of walking poles would impact gait speed, stride length, and fear of falling differently in subjects who participated in structured training as compared to those who did not participate in structured training. Regardless of the type of training, our research did not support advertisers' claims that walking poles improve gait speed, stride length, or confidence with walking.

RESEARCH ADVISOR FINAL APPROVAL FORM

The undersigned certify that they have read, and recommended approval of the research project entitled…

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CHAPTER I: INTRODUCTION

There is a growing number of older adults living in the United States. Between the 2000 and the 2010 Census, the percentage of older adults increased at a rate of 15.1 percent compared to the entire United States population which increased at a rate of 9.7 percent. As a result, older adults currently account for more than 13 percent of the population living in the United States.[1] With the growing number of older adults, there is a heightened potential for fall related injuries, as the prevalence of falls increases with advanced age. One in three older adults experiences a fall each year in United States.[2] With age, older adults become increasingly dependent on the use of assistive devices in order to promote or maintain independence.

Walking poles are often promoted as an alternative gait assistive device for older adults. Marketing materials claim that walking poles promote a more normal gait pattern, improve balance, and increase one's confidence with walking.[3] It is also asserted that they are more effective and more accepted than canes, crutches, and walkers for those with orthopedic problems, including those undergoing post-surgical rehabilitation. Physical therapists and physicians are recommending walking poles for people with a variety of conditions.

Despite such marketing claims and promotions, there exists to date very limited evidence showing the impact of walking pole use in the older adult population. Current evidence is aimed primarily at the young, healthy population where the use of walking poles has been shown to increase exercise capacity,[4] increase stride length[5] and increase gait speed.[5] This leads to the questions of whether or not walking poles are advisable for older adults and whether or not education is necessary for safe and appropriate use.

The purpose of this study involving community dwelling older adults was to analyze the impact of walking poles on gait speed, stride length, and fear of falling and compare the impact of walking pole use between one group of subjects that completed a structured pole training program and another group that completed an unstructured pole training program. It was hypothesized that the use of walking poles would impact gait speed, stride length, and fear of falling differently in subjects who participated in a structured training session compared to those who participated in an unstructured training session.

CHAPTER II: LITERATURE REVIEW

Physiological Effects

A commonly researched topic to support the use of walking poles is the impact on physiological function. A 2011 randomized control trial examined the effects of walking pole use on functional capacity in sedentary older adults. This research found statistically significant improvements in function by improved chair stand test, arm curls, two minute step test, the chair sit and reach, and the Timed Up and Go (TUG).[6] Debriefing of this study's experimental group also revealed verbal confirmation of positive changes in overall health, functional capacity, physical fitness, and mental well-being. Early research by Rodgers et al. also revealed significant improvement in physiologic function such as oxygen consumption and heart rate when walking with walking poles compared to normal walking when tested using a randomized control trial.[7] This study also revealed significant increases in respiratory exchange ratio and caloric expenditure for the walking poles group when compared to a regular walking group. However, rate of perceived exertion was not found to change significantly with the use of walking poles. This study utilized female subjects aged 23.6 +/- 4.0 years.[7]

More recently, Kocur et al. confirmed this previous research by completing a control trial that concluded there was a greater increase in exercise capacity in the walking pole group when compared to the control group.[4] The study consisted of middle-aged male subjects (mean age 52.4 +/- 7.6 years). Furthermore, upper body endurance, lower body endurance and dynamic balance were also significantly improved in the walking pole group when compared with both the walking training and control groups.

This helps to support claims of physiologic benefits associated with the use of walking poles.[4] Similarly, Kukkonen-Harjula et al. conducted a randomized controlled study to compare physiological differences between brisk walking and walking with the use of walking poles in non-obese sedentary women.[8] It concluded that whether walking with or without poles, cardiorespiratory and neuromuscular components for health-related physical fitness in middle-aged women revealed similar benefits.[8]

A controlled study specific to elderly women (mean age 58.5+-6.9 years) found that when compared to a sedentary group of women with similar characteristics, a walking pole program performed three times per week significantly reduced pulse rate, diastolic blood pressure and systolic blood pressure after three months of training.[9] Maximal oxygen consumption and fitness index scores improved significantly in the walking pole group as well. Further, these measurements were all found to be better in the walking pole experimental group than the control group.[9]

Joint Loading

Another claimed benefit of walking poles is the reduced joint loading of the knees and hips. Early research supported this theory and concluded that walking poles ultimately allowed subjects to walk at faster speeds with reduced vertical ground reaction forces, reduced vertical knee joint reaction forces, and reduced knee extensor angular impulse and support moment, depending on the condition.[5] However, more recently, cross-over design studies have concluded that the first vertical ground reaction forces (landing forces) are not decreased with the use of walking poles.[10,11,12] Some research is actually finding that first vertical ground reaction forces are higher when using walking poles.[11,12] Further, Jensen et al. confirmed that even with increased pole force (x2.4), first vertical ground reaction forces are still not reduced.[13] It is hypothesized that this increase of loading during landing phase is due to an increase in hip range of motion and stride length with the use of walking poles.[10] Research, however, consistently shows that the second force peak (push off) does reduce ground reaction forces in the knee with the use of walking poles[5,10,12] and further reduced when increasing the amount of force placed on the walking poles.[13]

Gait Speed and Stride Length

Gait speed declines with age. Normal gait speed for younger populations is 1.4 meters per second where average gait speed in individuals ages 60-87 is reported to be 1.31 meters/second.[14] Walking pole manufactures advertise minimizing this decrease in gait speed as one potential benefit of using walking poles. Therefore, while assessing impact of walking pole use, it is important to note effects on gait speed.

Early research by Wilson et. al found significant differences in gait speed with the use of walking poles($p<0.0001$-0.0023), though this research was done on healthy adults with a mean age of 29.51 years.[5] With an older population, Hansen et al. completed a crossover study, which revealed no significant difference between gait speed when walking with walking poles or without. Participants were middle aged (mean age 51) women who were walking pole instructors.[11] Due to participant demographics, neither of these studies provide insight into effect of walking pole use on gait speed in older adults.

One way to help hypothesize what this effect may be is looking at the relationship between gait speed and dual tasking across age populations. A crossover study by

Springer et. al. included young adults and community dwelling older adults classified as either fallers or non-fallers.[15] A cognitive assessment was performed to assess executive function and memory, and subjects were then evaluated while walking at a normal pace under three conditions; simple task, complex task and arithmetic task. Average gait speed and swing time were measured, and data revealed all three groups had a significantly decreased gait speed when performing dual tasks.[15] This is important as walking with walking poles is considered a dual task. Further, this same study hypothesized that the decline with dual-task functioning may be associated with a decline in executive function.[15] Analysis of older adult education and task performance will be discussed later in this review.

Just as gait speed is an important element of gait that should be assessed when analyzing the use of walking poles, so is stride length. Wilson et. al reported a significant increase in stride length while using walking poles ($p<0.0001$), but again, it is important to keep in mind that this research was done on healthy adults, mean age 29.51.[5] Hansen et. al again concluded there was a small, but significant increase in stride length with walking poles ($p<0.003$) when working with middle-aged women who were trained walking pole instructors.[11] These studies lack information about how stride length would be affected in older adults utilizing walking poles.

A review of the literature on the use of walking poles in the older adult population (65 years of age or older) in the area of gait speed and stride length clearly identifies a lack of research. Though there are reports on the use of walking poles and the effect they have on gait speed and stride length, none of this research is focused on the older adult population. This clear gap in research further supports the purpose behind our research topic.

Injury Risk

Due to increased wrist velocities at higher walking speeds, walking pole use increases the risk for upper extremity injury due to high wrist shocks of up to 7.6 times gravitational acceleration.[12] A 2006 prospective study by Knobloch et al examined data on the overall injury rates of Nordic pole walking in 137 athletes with a mean age of 53 years.[16] The athletes had an average walking pole use experience of 212.8 weeks. The overall injury rate was found to be 0.926/1000 hours of exposure. The upper extremity was more likely to be involved and the most common injury was distortion of the ulnar collateral ligament of the thumb after a fall. The authors concluded that the use of walking poles is safe due to the small percentage of injuries that occur.[16]

The risk of injury while using walking poles has also been researched in different patient populations. A randomized control trial by Malicka et al examined the effects of walking pole use on upper extremity strength and lymphedema in women who received breast cancer treatment.[17] Thirty-eight women with a mean age of 62.8 years were involved in the study. The intervention group underwent eight weeks of walking pole training while the control group did not participate in any physical activity. Results found a significant difference in upper extremity muscle strength and no significant differences in volume of lymphedema. It was concluded that walking pole use was a safe form of rehabilitation in patients following breast cancer treatment.[17] Lastly, one researcher performed a biomechanical analysis of walking pole use in patients with fractured vertebra due to osteoporosis. The author found decreased force on the vertebra when using walking poles as a portion of the force is transferred into the walking poles. A slightly different method of walking with the poles was recommended by the author to maintain the lower forces on the vertebra. The author suggested walking with an reciprocal arm swing but keeping the arms outstretched and slightly bent to reduce the force of gravity of the head and trunk on the spine. Utilizing this method of Nordic walking is considered a safe form of exercise for patients with osteoporotic fractures.[18]

Assistive Devices

In order to identify the potential of walking poles as an effective walking device, we first must analyze the benefits and shortcomings of more traditional forms of assistive devices. In a review article by Bateni and Maki, benefits and possible disadvantages of single point canes and pickup walkers was collected and generalized from a group of previous studies.[19] Several general clinical benefits were identified. Most often, walkers and canes are prescribed to help improve mobility and maintain balance during ambulation and other activities. [19] Like mentioned previously, walking poles have been found to help improve mobility and therefore show consistent use with other ambulatory assistive devices.[6] Assistive devices also help diminish pain, compensate for weakness and increase motor control by reducing or eliminating weight bearing on one or both lower extremities. This un-weighting also helps to reduce the vertical ground force on the lower extremities.[19] The effectiveness of walking poles to help reduce vertical ground force is still a highly researched topic, as previously mentioned. The addition of a mobility aid adds a propulsive and/or braking force during the gait cycle, giving an individual greater functional efficiency. Assistive devices simultaneously increase confidence in gait by reducing fear of falling while also improving physiologic benefits such as: osteoporosis prevention, improved cardiopulmonary function, and better circulation. By increasing the base of support and range of center of mass, assistive devices improve balance and biomechanical stabilization. Reaction forces generated in the hands improve stabilization. The addition of an assistive device also gives additional somatosensory information to an individual by adding another point of contact to the ground that increases awareness of body position and movement of body segments. The review also concluded that, in general, canes are recommended for those with moderate level of impairment, whereas walkers are prescribed for those with more severe weakness, pain, and instability.[19]

The relationship between falls risk and assistive device use has some discrepancies in research. It is unclear and argued whether one of two theories is most accurate. One theme suggests the use of a mobility aid predicts/indicates increase of impaired balance, risk of falling, falls, decline in function, and injury. While, reversely, some argue the use of an assistive device actually increases the risk of falling by tripping and disrupting normal gait patterns.[19] In a prospective cohort intervention study, Kressig et. al reported a three to fourfold increase in fear of falling when assessing older adults fear when walking with a walking device.[20] Further effects of fear of falling and gait will be addressed later in this review.

Further negative effects were consistent across evaluated articles. Bateni and Maki generalized that assistive devices require a high level of attentional and neuromotor demands that not all older adults can match.[19] The ability to lift and advance a walker, control additional forces and moments, and increased reaction times were just a few demands noted in the literature.[19] Further, a higher level of cognitive functioning was also required to safely and accurately manipulate canes and walkers. The addition of a mobility aid also adds weight and inertial forces that not all older adults can compensate for, thus the potential for reduced balance and stability. Additional factors that affect balance and stability include: decreased ability for compensatory sidestepping and increased demands on upper extremity strength and proprioception.[19]

Unfortunately, Bateni and Maki also concluded that up to 30-50% of prescribed assistive devices are abandoned by patients after receiving them.[19] Reported reasons included: difficulty with use, feelings of safety, discomfort, pain, and injury. These reports enforce the need of the research for new possibilities of assistive devices, such as walking poles, in order to address these common complaints.

It is noteworthy that the studies reviewed by Bateni and Maki involved healthy subjects that reported no disability or pathology.[19] It is important to be aware that, when it comes to use and effectiveness of assistive devices, users respond in individual ways depending on pathology, experience, and confidence. Further research is required to generalize benefits and negative effects for specific populations. More research is also needed to characterize specific demands and adverse consequences; characterize neuromotor and cognitive demands; and analyze behavioral and environmental factors.[19]

With new research being conducted on assistive device technology, it is first important to understand past trends in mobility aid use. In a prospective study by Agree et al., data from the 1992-2001 Medicare Current Beneficiary Survey was used to assess the trends in assistive device use in community dwelling older adults over the age of 65.[21] This survey assessed difficulty, assistance, and use of assistive devices for six personal care activities (walking, transferring, bathing, dressing, toileting, and eating). This data revealed that difficulty with self-care activities declined an average of 2.1% per year over the ten year span.[21] Among those experiencing difficulty with activities, the percentage of those using adaptive equipment for assistance increased significantly from 26% to 32%.[21] These increases inversely correlated declines in dependence on personal care and in unassisted difficulty, 3.6% and 1.4-1.9% respectively per year.[21] Ambulation, specifically, saw an annual 3.5% increase in mobility device technology and a decline of 1.3% and 2.4% for personal care and unassisted difficulty respectively.[21] These results lead us to conclude that older populations are becoming less dependent on assistance from others, and rather are becoming more independent with the use of assistive technology.[21] Though reports for 2002-2011 are not yet available, these trends can be assumed to follow into the next decade. With the swing of seniors seeking assistive devices for further independence, it is necessary to do appropriate research on all available devices, including walking poles.

Fear of Falling

It is also important to assess the effect of an older adults' fear of falling on components of his or her gait and functional mobility. Kressig et. al completed a prospective cohort intervention study consisting of 297 subjects, 70 years of age and older (mean age 80.9 +/-6.2).[20] Results showed a significant negative correlation of gait speed with fear of falling using the Falls Efficacy Scale (FES) and a positive correlation with the Activities-Specific Balance Confidence Scale (ABC). When subjects had slower gait speeds, they were reported to be 3.1 and 3.8 times more fearful on the FES and ABC, respectively. This conclusion was further supported in a regression analysis by Rodgers et al. who also reported a significant negative correlation with gait speed and the ABC.[22] Further, Kressig et. al reports significantly higher performance of functional reach, single limb stance, 360 degree turns, picking up an object off the floor and repeating three chair stands when comparing high fear of falling (ABC<50) and a low fear of falling (ABC>50).[20] This study also concluded that older adults reporting a fear of falling were more likely to use an assistive device.[20]

Snellen Eye Chart

There are several normal age-related changes in the visual system including presbyopia, a decrease in visual receptors, and a decrease in tear production. These changes in combination lead to a decrease in visual acuity in older adults.[13] Therefore, screening visual acuity in older adults is necessary because it is an important component of performing functional tasks. The prevalence of visual impairment in individuals aged 60 years or older living in the United States is 59.5 percent.[23] The majority of the visual impairments are due to uncorrected refractive error, such as nearsightedness and farsightedness.[23] This study determined that the majority of the older adult population in the United States experiences some loss of visual acuity.[23]

One way to screen visual acuity is the Snellen Eye Chart. This chart defines normal vision as a score of 20/40 or better and impaired vision as a score of 20/50 or worse.[24] Although the Snellen Eye Chart is considered the gold standard of assessment tools for visual acuity, a systematic review by Kalinowski concluded that this tool lacks sensitivity by greatly underestimating the level of visual impairment in the adult population.[24] The Snellen Eye Chart still remains useful for assessing vision in older adults because it is quick and easy and visual acuity is a significant component of performing functional tasks.[24] Other authors have made similar recommendations regarding the use of the Snellen Eye Chart. For example, Squirrell et al determined that distance visual acuity should be measured bedside using the Snellen Eye Chart following femoral neck fracture surgical repair because it is able to easily identify the majority of individuals with visual impairments.[25]

Mini Mental State Examination Questionnaire

The Mini Mental State Examination (MMSE) is a widely used and well-accepted cognitive screening tool.[26,27,28] This screening tool consists of 12 questions or tasks that examine different aspects of cognition for a maximum total score of 30. The most commonly used cutoff point for cognitive abnormality in the literature is 24.[26,27] This score is often required for inclusion criteria needed for subject participation in research as well.[28]

Multiple studies have found the MMSE to be both valid and reliable.[26,27] The initial investigators confirmed the validity of this screening tool by examining both the concurrent validity and the construct validity.[27] High interrater and intrarater reliability were also determined.[27] The results of this study parallel the findings of more recent research. One such study determined the optimal cutoff point of the MMSE for screening dementia to be 24 or 25 with a sensitivity of 87.6 percent and a specificity of 81.6 percent.[26] Thus, both ruling in and ruling out cognitive impairment or dementia has high validity in the geriatric outpatient population.[26]

The MMSE is not only commonly used in the clinic but also in research to screen for cognitive dysfunction. For example, a control study by Lark et al. used the MMSE score as inclusion criteria in their investigation of the validity of a functional walking test for the elderly.[28] The authors determined the cutoff score to be 23 or greater because it was well above the normal accepted score that indicates cognitive impairment.[28]

GAITRite®

The GAITRite® is a 12-meter walkway system that encloses 16,128 switches between two sheets of vinyl. It measures spatial and temporal parameters of gait as well as dynamic pressure mapping of the feet. The concurrent validity of the GAITRite® walkway system for temporal and spatial parameters of gait has been established through multiple studies.[29,30] Specifically, gait speed, stride length, step time, and cadence are GAITRite® measurements that have been validated in the literature. Also, good reliability of the GAITRite® walking system has been determined with ICC values greater than 0.9 for gait speed and stride length. It is noteworthy, that all evidence supporting the validity and reliability of the GAITRite® walkway system was collected on healthy middle aged to older adult subjects with no utilization of assistive devices.[29,30] Also, other measurements of gait performance including single limb support time and double limb support percentage have not been shown to be valid.

Fear of Falling – Visual Analog Scale

Fear of falling is an intrinsic factor that relates to actual falls in older adults.[31] One way to objectively measure fear of falling is with a visual analog scale (VAS-FOF). This is a ten-centimeter line that ranges from "no fear of falling" to "very afraid of falling." Participants then mark a vertical line where their current overall feelings of fear of falling are located on the scale.[31] The score is determined by the number centimeters between "no fear of falling" and the participant's vertical mark.[31]

The research on the psychometric properties of the VAS-FOF is limited. One study determined the concurrent validity of the scale to be moderate and the reliability of the scale to be low with an ICC value of 0.57.[32] Though the validity and the reliability of VAS-FOF are not well supported in the literature, the authors concluded that this instrument is quick, easy, and convenient.[32] It is important to note that there are some other limitations of the VAS-FOF like the lack of sensitivity to change.[32] One study discusses how the VAS-FOF may be limited in assessing change in the fear of falling and is only preferred to be used in times when longer fear of falling measures cannot be used.[33]

The fear of falling visual analog scale is commonly used in the literature to measure fear of falling.[31,34] For example, Wolf et al utilized the VAS-FOF as an outcome measure to assess balance dysfunction in an elderly population following individualized exercise program.[31] Similarly, Ozcan et al used the scale to indicate fear of falling in daily life in their research investigating the relationship between falling risk factors and quality of life.[34]

Global Rating of Change Scale

Global change measures are commonly used in research as the criterion measure because of the widely accepted face validity of the measure, even though the measure itself has not been thoroughly investigated.[35] One randomized block study supported the high face validity of the global rating of change measure by comparing the patient's perceived global change with the patient's perceived meaningful change in patients with low back pain. The correlation was 0.72, which shows the gradation of change of Global Rating of Change (GROC) scale parallels the change that the patients find important.[36] Also, studies have shown statistically significant correlations between GROC scales and the change in score of the Oswestry low back pain disability questionnaire and the Roland Morris disability questionnaire for example.[37, 38] These findings support the construct validity of GROC measures.

The test-retest reliability of the GROC scale is high with an ICC value of 0.90. This psychometric property was determined within a study population with low back pain.[39] In a review article of global rating of change measures, the authors concluded that the minimally clinically important change to be two points or more on an 11-point scale by comparing the standard deviations of the GROC scale across several studies. These authors also determined that the minimum detectable change on an 11-point GROC scale to be 0.45 points by using data from the Costa et al. study that investigated psychometric properties of outcome measures in patients with low back pain.[35,39]

Older Adult Education

Older adults experience several normal age related changes, including physical, cognitive, and psychosocial changes, which influence the way in which they learn and communicate.[40,41,42,43] A few of these changes include; hearing, speech processing, vision, and short-term memory retention. There is a significant amount of literature available regarding the ways in which older adults learn and techniques to use when teaching older adults.[40,41,42,43] Research has consistently shown that older adults learn best when educators use visual aids, allow for more processing and practice time, establish an environment conducive to learning, and use patient friendly language.[40,41,42,43]

In order to maximize learning for older adults, it is important to establish an effective learning environment. The room should be well lit with natural lighting and care should be taken to avoid glare or high intensity light in order to account for normal age related changes in vision.[40,41,42] The environment should be free of background noise and distractions in order to help older adults focus on the task at hand.[41] In order to account for the normal age related changes, which occur in the auditory system, the older adult learner should always have a direct view of the presenter in order to allow for lip reading if needed. Teachers should speak slowly and clearly in a low frequency range in order to account for individuals with hearing impairments. Increasing the volume of the voice does little to compensate for hearing loss.[43] Teachers should be positioned 3 to 5 feet in front of the learners and be at their same level.[40,41] Chairs should also be at a comfortable height for the sitting comfort of the average older adult.[41]

Older adult learners may learn best with one-on-one instruction but teaching in a small group has also been found to be effective.[41,42,44,45] Teaching methods should be structured utilizing a variety of methods. Older adult learning performance can be enhanced with both verbal instructions and demonstrations from the teacher. Teachers should encourage students to be active in the learning process and ask questions as they arise.[42]

Older adult learners are primarily visual learners and special considerations need to be taken into account when designing or selecting visual aides. Written materials should be at least 18 point font, have at least 1.25 spaces between lines, and black colored print on plain white paper is best.[42] There should be a limited amount of information on the visual aid which relates directly to the key points and supplements the verbal descriptions.[41] If pictures are used as a supplement they should be age-appropriate, simple, and accurately represent the older adult population by not being ageist.[41]

A major barrier, which has been identified in the research, is the stereotype that older adults lack understanding and the ability to learn. Evidence has shown that older adults do learn, however; there is a decline in information processing resulting in a need to learn more slowly in order to retain information.[42,46] It is recommended that older adults be exposed to information multiple times with key points outlined and repeated at the beginning and end of the session in order to maximize learning.[41] Information given in one session should be presented in an organized, clear manner to enhance performance.[40,41,46] Teachers should ensure that the older adult learners understand the simple tasks before continuing onto more complex tasks.[42]

Teachers should seek feedback from the older adult learners to check for understanding.[40] Asking for feedback is also a good way to ensure that the teacher is being heard and understood.[42] Another method used to check for understanding includes return demonstration. The teacher is able to assess the students learning by observing them perform the activity.[46]

Learning a new motor skill correctly and safely requires practice and good instruction. This can be even more difficult in the older adult population due to normal age related changes across multiple systems in the body. Older adults require more time to respond to motor and sensory stimulation especially when performing complex motor patterns. With sufficient practice time, older adults are able to improve motor performance of a complex task.[45,46] A 2007 study by Voelcker-Rehage examined the effect of practice on motor-cognitive dual-tasks in both younger and older adults.[47] The average age of the healthy participants was 21.93 and 71.08 respectively. The results showed improvement of motor performance with practice during single and dual-task conditions for the younger and older adults. It is important to note that when older adults had more practice with a task, the task became more automatic, thus requiring less cognitive resources and an increased ability to dual-task.[47] It is unclear whether long-term training would have a greater impact on motor performance.

Several studies have shown older adults demonstrating immediate motor effects following a short training session in both the healthy and pathological older adult populations. Two studies utilized one training session lasting 10 or 20 minutes and showed increase in gait speed, increase in step length, and a decrease in gait variability.[48,49] The training sessions lasted up to 20 minutes and demonstrated improvements in gait speed, step length for both the paretic and non-paretic lower extremity, and cadence. Older adults also demonstrate the ability to develop fall-resisting motor skills and an increase in preslip stability after only one 60-minute perturbation training session. This training led to a decrease in the incidence of falls from 44 to 0 percent at the six month follow up during the same perturbation activity.[50] It can be inferred that older adults demonstrate improvements in motor performance after short training sessions.

A 2001 study by Peel C et al describes a community based education program for older adults with osteoporosis.[45] Special consideration of normal age related changes as well as the concepts from the Social Cognitive Theory were taken into account when designing the program. Researchers accounted for normal age related changes by conducting multiple sessions close together, limiting the amount of information given in each session, and using a variety of teaching methods. The multidisciplinary program involved eight 90-minute sessions of physical therapy, medicine, and nutrition spaced out over four weeks. A variety of media was used to illustrate the key points including lecture, visual aids, handouts, demonstration and problem-solving activities. Participants were also asked to perform tasks upon completion of the program to test for competency. Measurements of strength, balance, flexibility and health status were taken at the beginning of the program and upon completion. Improvements were found in all of the measurements. The authors deemed the program a short term success due to not only the improvements in the measurements, but also the attendance, participation by the subjects and their follow-through of the home exercise program. Therefore, a successful education program for older adults requires multiple sessions with varied teaching styles, avoidance of providing excessive information at one time and a variety of media.

CHAPTER III: METHODS

Subjects

Sixteen healthy subjects (six male, ten female) were recruited on a volunteer basis from a local assisted living facility in the St. Paul-Minneapolis metropolitan area. Each subject received a detailed description of the study methods and signed an informed consent form prior to testing. Inclusion criteria: Age 65 years or older, community dwelling, novice in the use of walking poles, independent in ambulation without an assistive device or with a wheeled-walker, pain-free upper extremity range of motion, minimum score of 24/30 on the Mini Mental State Examination, minimum score of 20/50 on the Snellen vision screen, able to repeat spoken sentence at conversation level volume and symmetrical gait pattern. Exclusion criteria: Dependent in ambulation, or having a medical condition that would interfere with the ability to complete the study.

Screening Protocol

One day prior to testing, each subject was individually screened for participation eligibility. Researchers described the study to the potential subject, reviewed the consent form and obtained consent before proceeding (see Appendix A). Following consent, the subject participated in the following screenings to determine eligibility (see Appendix B).

Vision screen

The subject's distance vision was screened using the Snellen Eye Chart. Per the recommendation of Dr. Aaron Shukla, PhD, COMT, Program Director of St. Catherine University Ophthalmic Technician Program, a score of less than 20/50, which signifies visual impairment in older adults, was used as the cutoff criteria for this study. The subject used corrective eyewear, if applicable. The subject stood 20 feet away from the Snellen Eye Chart, was instructed to keep both eyes open, and read the letters in consecutive order. This screen was used as a safety precaution.

Hearing screen

The subject was asked to repeat a spoken sentence, which was stated using conversational level volume to ensure the ability to hear the researcher's voice during the walking pole training session. This was used as a safety precaution.

Upper extremity range of motion screen

The subject was asked to swing his/her arms forward and backward to ensure pain free, unrestricted range of motion for walking pole manipulation.

Memory screen

The Mini Mental State Examination was administered per the testing protocol.[27] A score of at least 24/30 was required for participation. This was used primarily as a safety precaution to ensure that the subject had the cognitive capacity to remember the directions provided during walking pole training.[26,27,28]

Gait screen

The subject was asked to verify whether or not he/she typically used a gait assistive device when ambulating outside of his/her home, as well as whether or not he/she had previous experience/training with walking poles. The subject was also asked how long he/she had been using an assistive device, if applicable. Gait was observed to rule out obvious gait asymmetries.

Testing protocol

The study was designed as a double-blinded randomized control trial. The testing procedure was conducted in five steps.

Step 1: The subject was welcomed. The researcher verbally inquired as to whether or not the subject had experienced any changes since the prior screening session with regards to vision, hearing, upper extremity range of motion, memory, or walking ability. If the subject reported a change, he/she was re-screened. If not, researchers proceeded with data gathering. The height of each subject was measured while standing against a wall with a tape measure taped to it. The height was recorded in centimeters and was used for calculations with the GAITRite® system.

Step 2: The subject walked on a 12-meter x 1-meter electronic GAITRite® mat, which was secured to the floor with duct tape on both ends. The subject walked on the mat with his/her four-wheeled walker (4ww), or no device if he/she did not typically use one when out of his/her home. The electronic mat recorded each footstep. The subject had a transfer belt around his/her waist and a researcher guarded just to the side and behind the subject to ensure his/her safety with care to avoid setting the pace for the subject. The subject walked three 12-meter trials, with rest breaks as needed. A chair was placed 2.75 m from the start and end of the walkway for acceleration/deceleration space. This distance was determined by the space allowed in the testing room. Following the three trials, the subject was asked to rate his/her fear of falling (FOF) using a visual analog scale with size 18 black print on a piece of white paper (see Appendix C). The subject was asked to draw a line somewhere between one end of the scale that states “no fear of falling” and the other end, which states “very afraid of falling”.

In order to ensure confidentiality and accurate tracking of data, a pre-established coding mechanism was used. Each subject's data was identified by a data-collector separate from the primary researchers.

Step 3: The subjects were randomly assigned to either group A or group B for walking pole training. Group A consisted of structured training and group B, unstructured training. Each subject selected a sealed envelope containing an assigned group letter from a table of randomly placed envelopes. The table contained an equal number of group letter assignments. The envelope remained sealed until the subject was with a researcher assigned to conduct walking pole training. All other researchers remained blinded to specific training groups. The subjects were trained in one of two training areas which were secluded from other researchers and participants in order to maintain subject privacy and researcher blinding, as well as to provide a quiet, private training area free from distractions.[41] Once in the designated training area, a set of walking poles was adjusted for the subject's specific height per the technique recommended by Exerstrider.[3] The subject stood with arms relaxed at sides, elbows flexed to 90-degrees, palms facing in. The tip of a walking pole was placed at the outside of the foot, aligned with the most posterior-lateral aspect of the heel. The telescoping pole was then extended to the hand where the top of the handgrip gently rested on the top of the hand when a fist was formed. The pole was secured at this position and the process was repeated on the opposite side.

Group A: Structured Training

A researcher assigned to conduct walking pole training worked with the subject, one on one, to train him/her on the proper use of walking poles for a maximum of twenty minutes. A script was used to promote consistency in training between all four researchers (see Appendix D). The methods for instruction were based on the DVD manual that accompanied the Exerstrider poles but were modified to enhance learning for the older adult population.[3] Verbal instructions and the instructors utilized demonstrations and the subject was encouraged to be active in the learning process. Complex medical terms, jargon and acronyms were avoided in order to ensure understanding.[40,41] The key points were outlined multiple times to account for a decline in information processing which occurs with aging.[42,46] The researchers ensured the subject understood simple tasks before moving onto more complex ones and limited the overall amount of information provided during the session.[42] The subject was provided ongoing feedback by researchers and questions were answered as they arose.

The subject practiced with the poles until he/she stated a readiness to walk with them on the GAITRite® mat. The subject continued to wear a transfer belt at all times for safety. A researcher provided standby assist, with manual assist as needed, at all times while the subject practiced with the poles. Two chairs were placed at opposite ends of the training areas and rest breaks were provided as needed. The subject was led to a chair outside of the data collecting station at the end of the training session where another researcher retrieved him/her for data collection in step four.

Group B: Unstructured Training

A researcher worked with the subject, one on one, to train him/her on the basic principles of walking pole use for a maximum of twenty minutes. The researcher provided a brief training, with a focus on maintaining a reciprocal arm swing while using the walking poles. Questions by the subject were answered as they arose but the researcher did not correct technique as the subject practiced. The subject practiced with the poles until he/she stated a readiness to walk with them on the GAITRite® mat. The subject continued to wear a transfer belt at all times for safety. A researcher provided standby assist, with manual assist as needed, at all times while the subject practiced with the poles. Two chairs were placed at opposite ends of the training areas and rest breaks were provided as needed. The subject was led to a chair outside of the data collection station where another researcher retrieved him/her for data collection in step four.

Step 4: The same data gathering procedure was used as outlined in Step 2 above, except that the subject walked with the walking poles rather than with his/her four-wheeled walker or no device if he/she did not typically use one. The subject continued to wear a transfer belt around his/her waist and a researcher guarded at all times by standing just to the side and behind the subject to assure his/her safety. Rest breaks were provided as needed. Upon completing the laps, the subject was asked to rate his/her FOF using two different visual scales both with size 18 black print on a piece of white paper (see Appendix C). The visual analog fear of falling scale was administered as mentioned in Step 2. A second scale, the global rating of change scale (GROC), required the subject to compare his/her fear level with use of the walking poles compared to the use of his/her gait assistive device if applicable, indicating whether his/her fear was worse or better, or no change, and the degree (see Appendix E). Upon completion of Step 4, the walking poles were collected from the subject by the researchers and his/her usual device was returned.

Step 5: To conclude the data gathering session, researchers answered any questions that the subject had, and thanked him/her for participating in the study.

Data Analysis

The GAITRite® system collects information from each reciprocal footfall and transmits data to a computer software system which analyzes and averages various gait characteristics such as gait speed and stride length. Gait speed was collected using the mean normalized velocity in order to account for each subjects leg length and was reported in units of leg lengths per second (LL/sec). Stride length was calculated in centimeters. Fear of falling was determined using a visual analog scale measured in centimeters. Measurements were taken from the line indicating 'no fear of falling' to the subjects perceived fear of falling. The global rating of change scale was used to compare the perceived change in quality of gait with the use of the walking poles as compared to usual walking.

The data analysis was run using the SPSS Statistics, version 20, IBM Corporation, 2011. Final analysis was performed on 12 healthy subjects (mean age 84.5 +/- 9.5 years; 8 female/4 males). Four subjects were excluded from final data analysis for the following reasons: two subjects were excluded due to an insufficient number of successful GAITRite® trials and two subjects were removed because they were 4ww dependent and it was decided that 4ww users be eliminated from data analysis due to a low number of subjects.

Differences in gait parameters of gait speed and stride length, as well as fear of falling and global rating of change scales were analyzed between the test conditions of walking with no device and walking with walking poles.   Analysis was also conducted between training groups to determine whether differences existed in gait speed, stride length, fear of falling and/or global rating of change between groups with different levels of training in the use of walking poles.

An independent 2-sample t-test was used to find differences in gait parameters between the pre and post-training. The statistical test was also used to find differences between the two training groups examining the same gait parameters. A paired t-test was used to determine if differences existed among the same variables and within the same groups. Spearman and Pearson correlations were used to look for relationships between gait parameters, FOF and GROC.

CHAPTER IV: RESULTS

Gait Speed

The structured training group averaged a mean normalized gait speed of 1.38 LL/sec prior to training and 1.33 LL/sec post-training. The average change in gait speed from pre-training to post-training was -0.05 LL/sec. While the unstructured training group averaged 1.15 LL/sec prior to training and 1.00 LL/sec. The average change in gait speed from pre-training to post-training was -0.15 LL/sec.

The structured training group showed no significant change in gait speed from independent walking to walking pole use. The unstructured training group showed a significant decrease (p=0.009) in gait speed when comparing normal, independent walking to walking pole walking. No significance was found between training groups when comparing change in gait speed from pre-and post-walking pole ambulation. See Figure 1.

Mean stride length

The structured training group averaged 128.23 cm prior to training and 131.18 cm post-training. The average change in mean stride length from pre-training to post-training was 2.95 cm. The unstructured training group averaged 108.08 cm prior to training and 112.98 cm post-training. The average change in mean stride length from pre-training to post-training was 4.90 cm.

The structured training group had no significant changes in mean stride length between normal independent ambulation versus walking pole ambulation, though the unstructured training group did show a significant increase (p=0.001) in mean stride length. See Figure 2. The difference in change in stride length between training groups is trending toward significance (p=0.087).

Fear of Falling

The structured training group averaged 0.56 out of 10, as measured in centimeters, prior to training and 0.37 post-training. The average change in FOF from pre-training to post-training improved by 0.19. The unstructured training group averaged 0.00 prior to training and 0.65 post-training. The average change in FOF from pre-training to post-training worsened by 0.65. See Figure 3.

Due to non-parametric data in reports of FOF, an independent two-sample t-test could not be utilized to determine significance between training groups.

Global Rating of Change

When subjects were asked to rate how the quality of their walking changed on a scale of zero to seven, after training and walking with poles, the structured training group averaged a change of 1.0 points, while the unstructured training group averaged a change of 0.5 points. See Figure 4. Furthermore, when subjects were asked to grade the importance of that change on a scale of zero to seven, the structured training group averaged 1.33 points, while the unstructured training group averaged 0.5 points. To test for a relationship, correlations were utilized to analyze the GROC data points.

Correlations

A moderate negative correlation was found comparing change scores of gait speed and fear of falling (-0.580). See Figure 5. A fair correlation (0.396) was found between change scores of the GROC and FOF, though not significant ($p=0.202$). See Figure 6.

CHAPTER V: DISCUSSION

The structured training group showed no significant change in gait speed or stride length, while the unstructured training group had a significant decrease in gait speed and a significant increase in stride length post-training. This change in unstructured training is consistent with research by Wilson et al. that found a significant decrease in gait speed and increase in stride length with the use of walking poles although the subjects were all younger adults.[5]

The difference found in the current study between training groups could be explained in the way in which each group was trained. The structured training focused on maintaining a normal walking pattern with the addition of the walking poles rather than focusing on the walking poles alone. The instructors also demonstrated this focus on normal gait pattern, and the subjects were given visual instruction on how to drag the poles and add them to a normal gait pattern. The structured training group also received feedback and correction of technique during the practice time. The unstructured training group may have experienced a decrease in gait speed while increasing stride length due to the focus on reciprocal arm swing and lack of visual demonstration that resulted in subjects keeping the walking poles in front of them versus dragging the poles, as with structured training. Further, instructors for the unstructured training group did not correct this incorrect use of walking poles.

The theory that the way groups were trained may have contributed to the differences in gait characteristics between groups may further be explained when considering the dual-tasking component of walking pole use. Unstructured training focused more on the poles versus normal gait pattern, which increased the number of details subjects in this group had to focus on. Springer et al. who concluded gait speed decreased when adding a dual-tasking component.15 support this thought

The results also found that as change scores of gait speed increased, fear of falling change scores decreased. This result was expected and has been previously concluded in multiple studies. Both Kressig et al and Rodgers et al. found similar correlations with gait speed and fear of falling with both the Falls Efficacy Scale (FES) and Activity-Specific Balance Confidence Scale (ABC). [20,22]

Though there was not sufficient power to run analysis on the FOF scale due to low 'n' value caused by the number of '0' scores representing no fear, interesting results with remaining data is worth noting. No subjects in the structured training group experienced an increased FOF with the use of walking poles after training. Furthermore, two subjects who did report fear with usual walking actually reported a decrease in FOF when walking with the walking poles. Average improvement for these subjects was 0.19cm on the FOF visual analog scale. It could be inferred that this decrease in fear was a result of the effects of the type of training in which this group received prior to walking with the walking poles. In contrast, six subjects in the unstructured training group reported an increased FOF with poles while none in this group reported a fear with usual walking. Average increase in FOF was 1.77 cm for this group. See Figure 3. This finding emphasizes the need for further research with greater numbers in order to further test the significance that type of training may have on one's fear of falling.

As with FOF, no significant results were found for the GROC Scale, though findings should be discussed. In the structured training group, four subjects reported an improved quality of gait with the use of poles while only one reported a decline in perceived quality of walking when using poles. It should be noted that this one subject who reported a decline in perceived quality of walking did not, however, report an increase in fear of falling. Two subjects in the unstructured training group reported an improvement in gait quality while three subjects reported a decline in gait quality. These results were inconsistent and also highlight the need for further research to determine if the method of training has a significant impact on the GROC when learning to use walking poles.

There were limitations to this study. Though a script for the structured training was established to ensure consistency between instructors, training may have varied between instructors for both training groups. Having one assigned instructor for each type of training to ensure consistency between subjects could eliminate this limitation.

The time allowed for training of the older adults was limited due to concerns regarding fatigue. Research has shown an increase in motor performance with extended practice time[47,48] although a specific time frame was not recommended. Older adults also show a decline in information processing resulting in a need to learn more slowly in order to retain information,[42,46] which supports a need for greater practice and training time to better enhance motor learning and information retention. Thus, it is important to consider length of training time when planning future research in the area of walking poles and the effects of training.

Another limitation is the small number of total subjects in the study. Similarly, data analysis was not completed on the subjects who required a 4ww due to the small sample size. Due to these factors there were not enough subjects to reach sufficient power during the data analysis. Increasing the number of subjects would give more depth to the analysis of not only change in gait characteristics, but also the change in both fear of falling and perceived quality of gait. In addition, the subjects were all older adults residing in communal senior housing, which does not allow for generalizability to the broader older adult population.

Increasing sample size would benefit the study of the effects of training on a wider range of patients with a wider array of assistive device need. As previously discussed by Agree et. al, there was an annual increase in the use of assistive devices and a decrease in personal care assistance by older adults.[21] These findings may lead to the conclusion that older adults are more dependent on assistance devices, which makes it important to conduct research on all available assistive devices, including walking poles. The current study did not analyze walking poles as an assistive device due to limited number of 4ww dependent subjects.

With these considerations in mind, future research should focus on recruitment of larger sample sizes in order to generate a broader analysis of gait characteristics, fear of falling and perceived gait quality across a diverse subject population with varying assistive device needs. Future research should address various modes of training with specific instruction, practice time, and structured training in mind.

CHAPTER VI: CONCLUSION

Results did not support the hypothesis that the use of walking poles would impact gait speed, stride length and fear of falling differently in subjects who participated in structured training as compared to those who did not participate in structured training. Regardless of the type of training, our research did not support advertisers' claims that walking poles improve gait speed, stride length, or confidence with walking.

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FIGURES

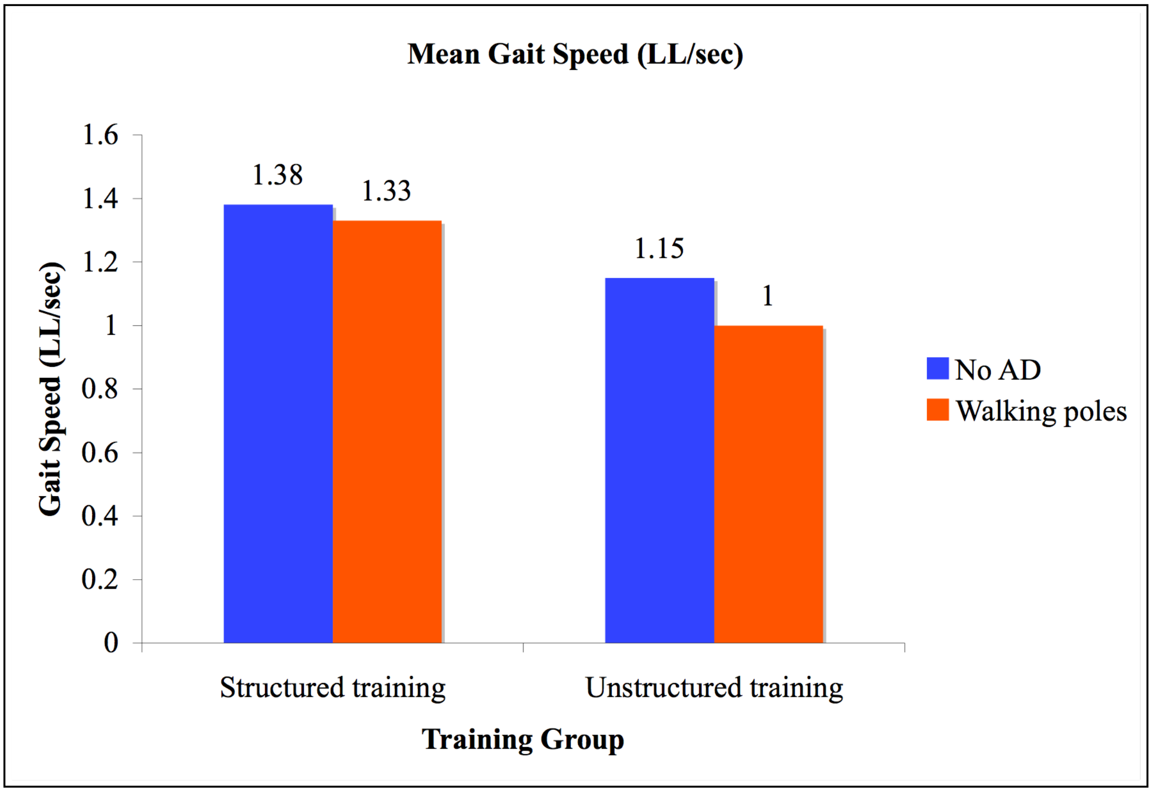

Figure 1. Mean change in gait speed. The structured training group showed no significant change in gait speed from independent walking to walking pole use. The unstructured training group showed a significant decrease (p=0.009) in gait speed when comparing independent walking to walking pole use. No significance was found between groups when comparing change in gait speed from pre and post walking pole ambulation.

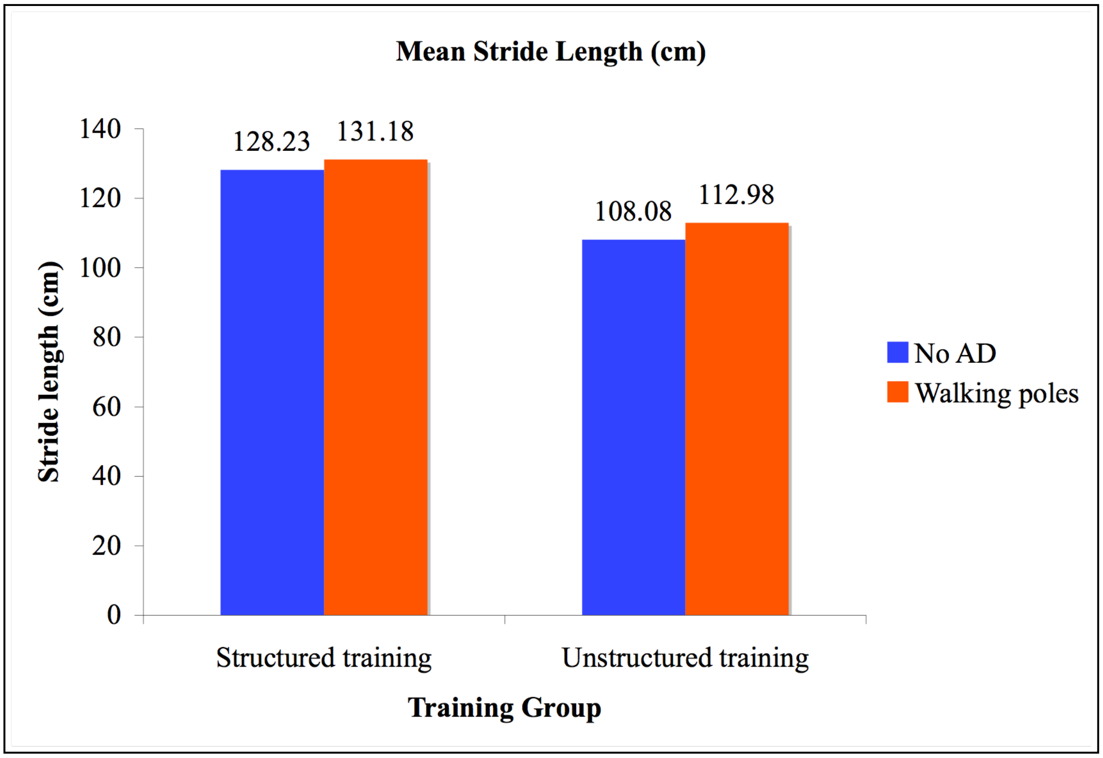

Figure 2. Mean change in stride length. The structured training group showed no significant changes in mean stride length between independent and walking pole ambulation, though the unstructured training group did show a significant increase (p=0.001) in mean stride length. The difference between training groups is trending toward significance (p=0.087).

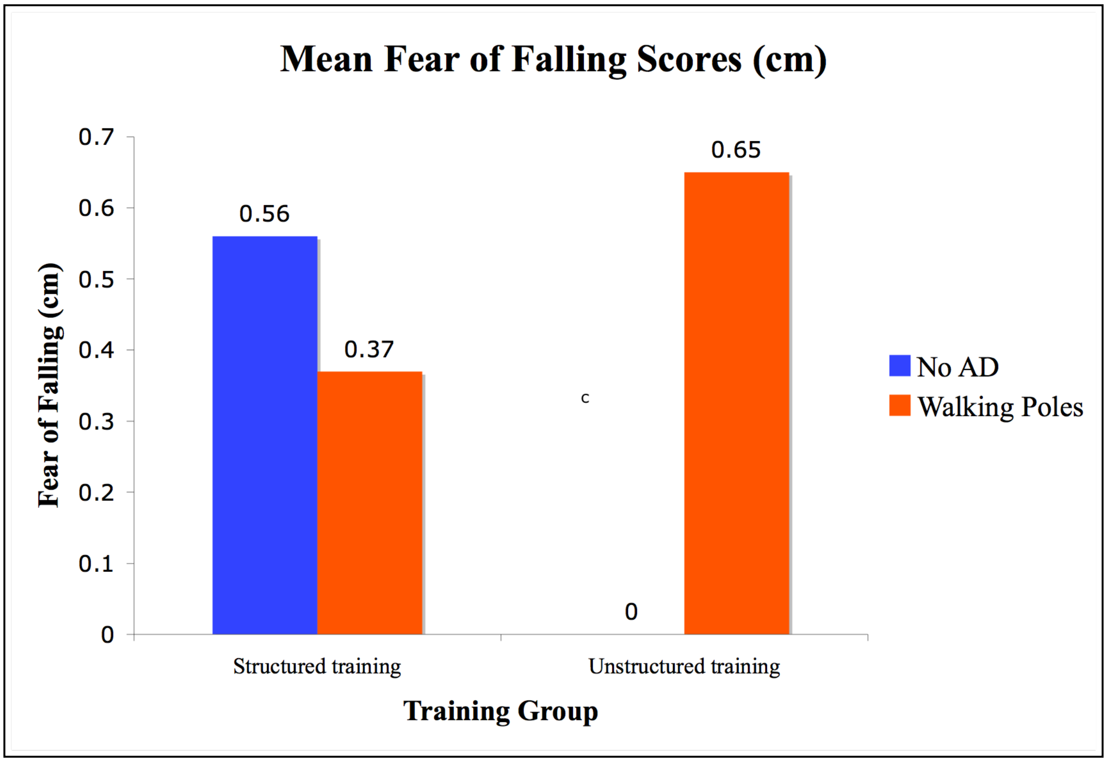

Figure 3. Mean change in fear of falling. Due to non-parametric data in subjective report of Fear of Falling, statistical significance could not be determined between or within training groups.

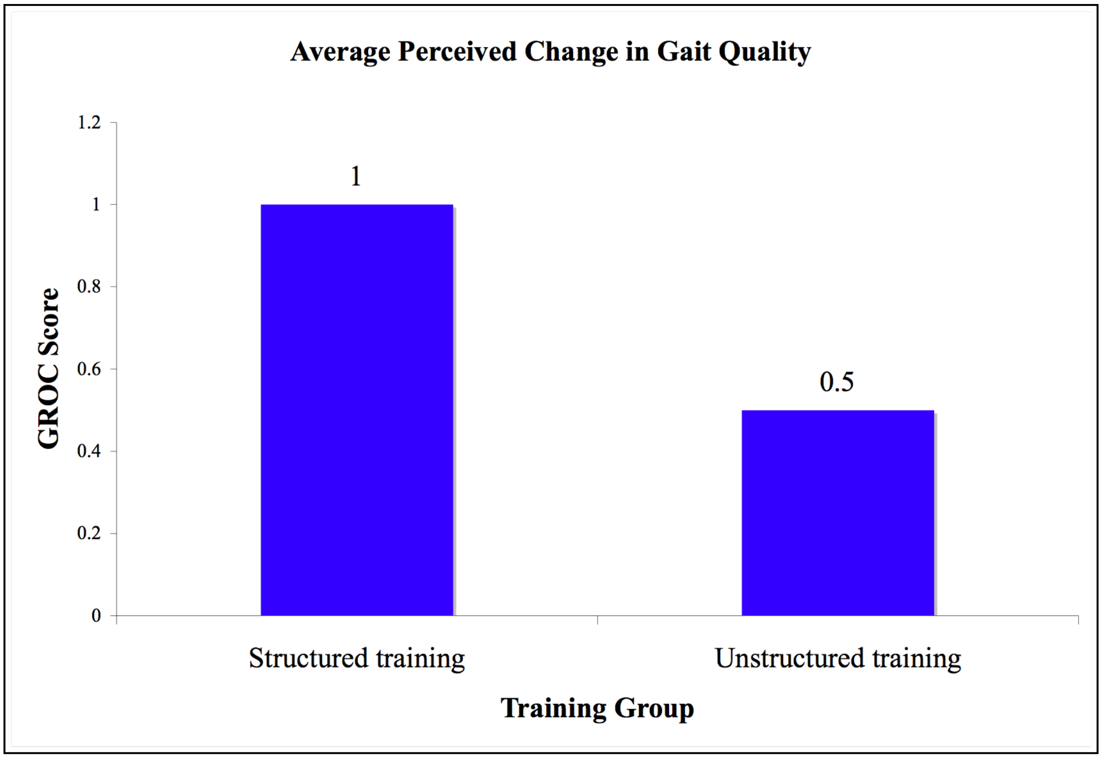

Figure 4. Mean perceived change in gait quality as described on the GROC. The structured training group averaged a change of 1.0 points, while the unstructured training group averaged a change of 0.5 points. Statistical significance was not determined.

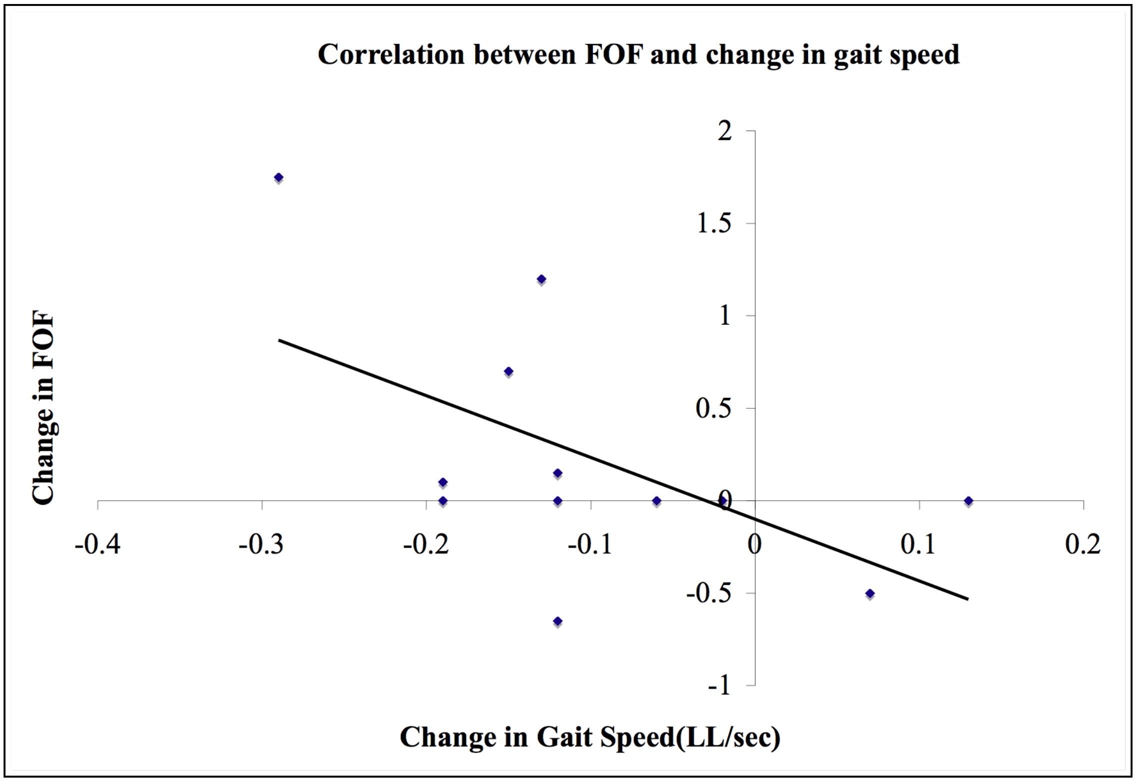

Figure 5. A moderately strong negative correlation was found between change scores of gait speed and fear of falling (-0.580).

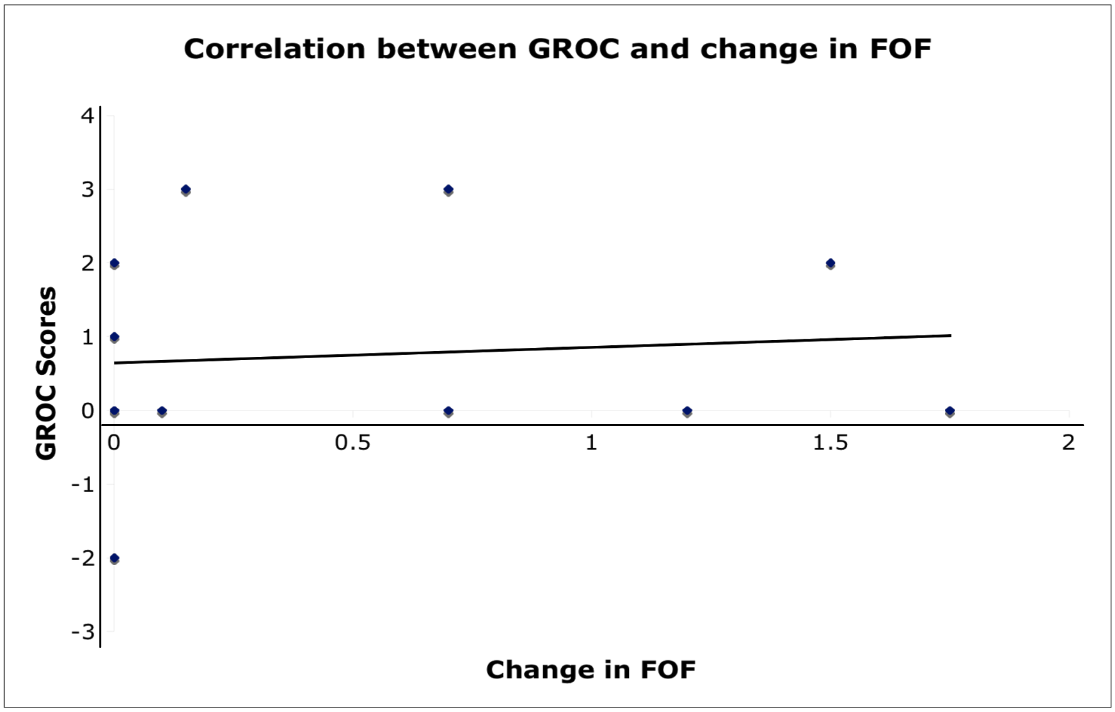

Figure 6. A fair correlation (0.396) was found between change scores of FOF and perceived change in gait quality on the GROC.

APPENDIX A: INFORMATION AND CONSENT FORM

The Effects of Walking Poles and Training on Gait Characteristics and Fear of Falling in Community Dwelling Older Adults

INFORMATION AND CONSENT FORM

Introduction:
You are invited to participate in a research study investigating how walking poles affect walking in individuals who normally use a walker, or no assistive device. This study is being conducted by Sarah Becker, Lisa Glad, Kelsie Nebelsick, Katherine Yernberg, Doctor of Physical Therapy students at St. Catherine University, under the supervision of Assistant Professor Deborah A. Madanayake. You were selected as a potential participant in this research because you walk by yourself with walker, or no device, in the community and you have expressed an interest in this study. Please read this form and ask questions before you agree to participate in the study.

Background Information:
The purpose of this study is to look at the effects that walking poles have on your walking speed, step length, and fear of falling, following a brief training session, compared to when you use your walker or no assistive device if you normally do not use one. Approximately 44 people are expected to participate in this research.

Procedures:
If you decide to participate, you will be asked to go through five steps over a period of two days:

First Day:
Step 1: Welcome (Time: 20 minutes)
We will describe this research study, review this consent form, and ask for your informed consent before proceeding. If you choose to participate, you will have your vision, hearing, arm range of motion, memory, and walking screened.

Second Day:
Step 2: Data gathering – with use of your usual walker or no assistive device (Time: 10 minutes)
You will be asked to walk three times down a 10-meter x 1-meter electronic mat that has been secured to the floor. You will use your usual walker or no assistive device (whatever you normally walk with outside your apartment). You will have a transfer belt around your waist and a researcher will stand just to the side and behind you to ensure your safety. Upon completing the three laps, you will be asked to rate your fear of falling using a visual scale on a piece of paper. Rests will be provided as needed.

Step 3: Pole fitting and training (Time: 30 minutes)

You will be fit with a pair of walking poles for your use during this study. You will choose an envelope that randomly assigns you to one of two different walking pole training groups. In a group of 2 to 4 participants, researchers will instruct you in the use of the walking poles. You will practice with the poles until you state that you are ready to walk with them on the electronic mat (maximum training time of 20 minutes). You will continue to wear the transfer belt around your waist for safety. A researcher will provide standby assistance, with manual assistance as needed, as you practice with the walking poles. At no time will you be left alone to walk with the poles

Step 4: Data gathering – repeat - with use of walking poles after training session (Time: 10 minutes)
This is a repeat of Step 2 above, with use of walking poles. Rests will be provided as needed. . After this step of the study, you will return the poles to the researchers.

Step 5: Thank-you (Time: 5 minutes)
The purpose of this step is to answer any questions you may have, as well as thank you for your participation in this study.

Overall, this study will take approximately 1 hour and 15 minutes of your time over two days.

Risks and Benefits of Being in the Study:
The study has several risks. First, there is a potential fall risk during the study. In order to reduce this risk, you will wear a transfer belt around your waist and have standby assistance at all times when on your feet. The assister will be a Doctor of Physical Therapy student, or a Physical Therapist, all of whom are skilled in assisting persons with walking/balance difficulties, as well as in training people how to use assistive devices for walking. Second, there is a slight risk that your arm muscles may be sore for a few days following the study since pole walking involves a new motion for your arms. If at any time you become fearful of falling, or if your arms become tired or sore, or should you in any other way feel uncomfortable, you may terminate your participation in the study.

The benefits of participation do not extend beyond the fact that you will have an opportunity to experience walking with walking poles and have a brief training session with the poles. It is not the intent of this study to determine whether or not walking poles will be safe for your use, nor to prescribe walking poles.

In the event that this research activity results in an injury, such as that resulting from a fall or muscle strain from walking pole use, we will assist you in obtaining medical attention. Research related injuries are not always covered by insurance and you should check with your insurance company if you are concerned about this. If you think you have suffered a research-related injury, please contact Assistant Professor Deborah A. Madanayake at 651-690-7787.

Confidentiality:
Any information obtained in connection with this research study that can be identified with you will be disclosed only with your permission; your results will be kept confidential. In any written reports or publications, no one will be identifiable and only group data will be presented.

We will keep the research results in a locked office at St. Catherine University and on a password protected computer. Only the student researchers: Sarah Becker, Lisa Glad, Kelsie Nebelsick, Katherine Yernberg, their research advisor, Assistant Professor Deborah A. Madanayake, and two supporting professors: Professor Laura Gilchrist and Associate Professor John Schmidt, both faculty members in the Doctor of Physical Therapy Program, will have access to the paper and electronic data while we work on this project. We will finish analyzing the data by December 2015. We will then destroy all original reports and identifying information.

Voluntary Nature of the Study:
Participation in this research study is voluntary. Your decision about whether or not to participate will not affect your future relations with Presbyterian Homes or St. Catherine University in any way. If you decide to participate, you are free to withdraw at any time without affecting these relationships.

Contacts and Questions:
If you have any questions, please feel free to contact Assistant Professor Deborah A. Madanayake at 651-690-7787. You may ask questions now, or if you have any additional questions later I will be happy to answer them. If you have other questions or concerns regarding the study and would like to talk to someone other than the researchers, you may also contact Lynne Linder, IRB Office, at 651-690-6203.

You may keep a copy of this form for your records.

Statement of Consent:
You are making a decision whether or not to participate. Your signature indicates that you have read this information and your questions have been answered. Even after signing this form, please know that you may withdraw from the study at any time.

I consent to participate in the study.

____
Signature of Participant Date

____
Signature of Researcher Date

APPENDIX B: SCREENING FORM

Welcome/Screening Form ID: Name______Birth Year___ Gender: M / F

-Wear nametag; introduce self; give overview of the research study Height (cm)______

-Verbally and visually go through consent form; to assess understanding ask to summarize for you what it is he/she will be asked to do and ask to explain back what would happen if he/she withdraws from the study (stress that he/she may withdraw at any time without consequence)

- If consents, obtain signature on form; leave a copy (must obtain consent before proceeding); otherwise thank for time and leave Deb M's card – may call if any questions or to further discuss study

-Following consent, perform the following screens to determine eligibility

Screening Tool	Instructions for Screener / Patient	Results
Vision	-Better than 20/60 using Snellen eye chart -must get 3 letters correct on 20/50 line -Hold Snellen chart 10 ft away, in front of wall -May use corrective lenses -Test both eyes at same time (binocular)	_____/_____
Hearing	-Repeat a spoken sentence (which will be stated at conversational-level volume) -Done in context of MMSE -May use hearing aids	___ Normal ___ Abnormal
UE ROM	-Standing -Swing arms forward and backward to assure pain free, unrestricted ROM	___ Normal ___ Abnormal
Memory	-"To learn how to use the walking poles we will need to teach you some new things, I need to ask you a few questions to screen your memory; is that alright…" -Take MMSE; administered according to test's protocol -Need 24/30 score	_____/30

Gait	-PT: observe gait while in apartment, look for abnormalities -What do you use to walk to the mailbox? -How long have you used this assistive device? -Have you ever used walking poles?	Gait abnormalities? Y / N Normal AD: ___ none ___ (SEC – single end cane) ___(2ww) ___ (4ww) ___(other) How long have they used: Used walking poles before? Y / N If so, when?
Leg Length	-Measure leg length from greater trochanter to floor without shoes (right leg)	_____ cm

-If meets inclusion criteria, remind of time slot on Saturday or Sunday for testing; give reminder note.
-Ask subject to bring normal assistive device and wear shoes they would normally wear for walking

APPENDIX C: FEAR OF FALLING SCALE

FEAR OF FALLING (VAS)

NO FEAR OF FALLING	VERY AFRAID OF FALLING

|____|

APPENDIX D: STRUCTURED TRAINING SCRIPT

Fitting Walking Poles

- A set of walking poles will be adjusted to the subject's specific height per the technique recommended by Exerstrider. Participants will stand with arms relaxed at sides, elbows flexed to 90-degrees, palms facing in. The top of a walking pole will be placed at the outside of the subject's foot, aligned exactly with the most posterior-lateral aspect of the heel. The telescoping pole will be extended to where it rests gently on the hand when a fist is formed. The pole will be secured at this position and the process will be repeated on the other side.

Structured Walking Pole Training Group

- Subject is seated
  - Researcher demonstrates the technique to facilitate a proper reciprocal arm swing
- If the subject is able to walk without the assistance of a device, the researcher will demonstrate by walking with the poles dragging behind his/her body in order to allow a normal gait and arm swing pattern.
- If the subject is unable to walk without the assistance of a device, the researcher will demonstrate the reciprocal arm swing pattern in a stationary, supported position.
- Subject is given time to practice the above skill.
  - Cues will be given as needed to promote a normal, reciprocal arm swing
- Subject is seated

○Researcher demonstrates walking with a full arm swing, keeping the arm extended, not locked, while keeping the eyes up.

●Subject is given time to practice the above skill

○The following verbal cues can/will be provided:

●"The motion should resemble reaching out as though you are giving a handshake"

●"The motion should resemble moving a pump handle similar to that of an old fashioned well-pump"

●"The grip should loosen on forward swing and tighten when swinging through, just like milking a cow"

●Other optional cues that can be given while the subject is practicing

○In order to maintain an upright posture: "Shoulders back, eyes looking up ahead"

○If subject is having difficulty maintaining reciprocal arm swing, cue them to stop walking, place poles at their sides and start the whole process over.

APPENDIX E: GLOBAL RATING OF CHANGE SCALE

__ No change
__ Worse
__ Better

1	A tiny bit, almost the same	1	
2	A little bit		2
3	Somewhat		3
4	Moderately	4	
5	Quite a bit		5
6	A great deal	6	
7	A very great deal		7