THE EFFECT OF FLEXIBILITY AND RESISTANCE EXERCISE ON SELECTED BALANCE TASKS AND GAIT TRANSFER IN ELDERLY SUBJECTS

by

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(ABSTRACT)

This investigation evaluated the effects of exercise on balance and ability to transfer in an elderly population. Eighteen elderly subjects (aged 65-96) were volunteers in this study. Nine of the elderly subjects participated in a six week exercise program, while the other nine were placed into a control group. It was hypothesized that the exercise group would improve balance and gait transfer. The variables of interest were: timed one-leg stance, spontaneous sway, transfer from bed to a chair, and an ABC (Activities-specific Balance Confidence) Scale. The variable of timed one-leg stance (sec), with both eyes open and closed, increased significantly ($P<0.05$) with the exercise training. The pre and post testing measures for the timed one-leg stance found that the $\bar{X}$ increased from 2.56 to 4.64, the SD was 6.06 and the SE was 1.43. However, the pre and post testing measures for the variables of spontaneous sway (sec), transfer (high, med, low) and the ABC scale showed little or no change ($P>0.05$) for both the control and exercise groups. These

results suggest that specific exercises enhance selected balance tasks and gait transfer in the elderly population. With the improvement of balance in the elderly, the risk of falling may be decreased, which will improve the quality of life for the elderly. The conclusion is that exercise improved a selected balance index in an elderly population. The performance measures that were utilized for the study did show an enhancement in balance for the elderly subjects; therefore, demonstrating that a structured exercise intervention can improve balance in elderly subjects.

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Chapter 1

INTRODUCTION

Aging is a process that is inevitable to all. "The elderly represent the fastest growing subset of the population in the United States" (National Institute on Aging, 1991). They are presented with many obstacles as they age which causes a decrease in their quality of life. There are several factors that can decrease quality of life in the elderly: heart disease, hypertension, stroke, diabetes and falls. Balance is an important factor when considering the impact of falls on the mortality and morbidity of the elderly.

"Falls can be an aspect that can greatly decrease the quality of life in the elderly population" (Clark, 1993). Injuries can be quite detrimental to the elderly person and it can put their activities to a halt. "About three fourths of deaths caused by falls in the United States occur in the 13% of the population aged 65 years and older" (Hogue, 1982). "Approximately one third of older adults living at home will fall each year, and about 5% of them will sustain a fracture or require hospitalization" (Rubenstein, 1994). After a debilitating fall, it takes the elderly individual longer to recover and as a result his physiological function and daily activities are decreased.

STATEMENT OF THE PROBLEM

The elderly are presented with many barriers as they age with falls being the most common and serious problem. "Each year, approximately thirty percent of persons over the age sixty-five sustain a fall with about half of them having multiple events. Unintentional injury is the sixth leading cause of death in persons over sixty-five years of age, with the majority of these deaths attributed to falls, especially in persons aged eights-five or older" (Province, 1995). As people age, they are more at risk for debilitating falls and as a consequence injury or death.

Numerous studies have demonstrated that falls are hazardous to the elderly. "Fall survivors experience greater decline in activities of daily living (ADLS) and in physical and social activities than nonfallers" (Tinetti, 1993). Several risk factors have been identified as a part of the reason that falls occur. Abnormal balance and gait are common factors linked with increased falling. Balance seems to be a common link with older individuals becoming more unstable as they age.

The economic costs associated with falls and fall injuries are high. "Although the total costs associated with falls are unknown, the yearly costs for acute care associated with fall related fractures are estimated at ten billion dollars" (Tinetti, 1994). The cost of caring for the elderly only increases with falls and as a means of prevention, risk

factors should be contended with in order to lessen the costs of falls.

The purpose of this study was to examine the effects of a structured exercise intervention on improving selected balance tasks and gait transfer skills in elderly subjects.

Significance of the Study

"The elderly are a population that is continuously growing at a significant rate" (Tinetti, 1994). Their most common problem is the advent of falls. Falls become problematic because they decrease the elderly individuals physiological function and mental state. "Ten to fifteen percent of the falls that the elderly have result in serious injury and can be a precursor for death" (Tinetti, 1988).

Falls pose quite a significant threat to people over the age of sixty-five. "A fall is an event which results in a person coming to rest unintentionally on the ground or other lower level, not as the result of a major intrinsic event (such as a stroke or syncope), or overwhelming hazard" (Kennedy, 1987). Often times people have a fear of falling as they get older, including, the falls that do not result in injury. "Falls often result in the post-fall syndrome which may be manifested as a loss of confidence, hesitancy, tentativeness, and a reluctant loss of mobility and independence" (Clark, 1993). A fear of falling can be quite detrimental and cause much distress for the elderly even to

the point that they fall as a result of stress brought on by fear.

Falls can result from one cause or be the result of several factors. "Most times, the fall appears to occur as a result of several factors. Individual risk factors include dementia, visual impairment, neurological and musculoskeletal disabilities and postural hypotension, as well as medications and environmental hazards. In addition, studies suggest that abnormalities of balance and gait are associated with the increased risk of falling" (Tinetti, 1988). Balance and gait are risk factors that may be enhanced, thus aiding the elderly in reducing their possibility of injury.

As people age, the risk of debilitating falls increases. "Deterioration in postural balance may be a major contributor to many of these falls, resulting in an impaired ability to correct for the many postural disturbances experienced in everyday life, such as slips, trips, and pushes, as well as self-induced displacements occurring during movements such as turning, reaching and transferring" (Maki, 1994). The elderly may suffer many limitations due to falls. Their activities of daily living are decreased, they are at risk for injury to occur, they are placed at a greater risk for another fall and may suffer physiological and mental distress as well.

Several community studies have examined strategies to help decrease the risk of falling. (Tinetti 1988, Maki 1994) One of the more comprehensive studies was sponsored by the

National Institute on Aging and the National Institute for Nursing Research. "They sponsored a multi-centered study called Frailty and Injuries: Cooperative Studies of Intervention Techniques (FISCIT), a collection of eight independent clinical trials that assess the efficacy and feasibility of a variety of intervention strategies, including exercise, in reducing falls and/or frailty in the elderly" (Province, 1995). These trials include multiple intervention strategies making it too difficult to identify the contribution of the single component of exercise. Strategies for reducing the frequency of this common cause of mortality and morbidity for the elderly are needed. It was the purpose of this study to determine the effects of exercise on balance and transfer skills in elderly subjects.

Specifically, the goal was to target several performance measures that might enhance balance and gait transfer in elderly subjects. Timed one-leg stance with both eyes open and closed and spontaneous sway with both eyes open and closed were utilized to assess any change of balance in the elderly. The transfer from bed to a chair was utilized to determine if there was an effect from exercise on gait transfer. With these performance measures, it was hoped that they would demonstrate a positive effect on balance and gait transfer in an elderly population.

RESEARCH HYPOTHESIS

Ho1: There was no difference in timed one-leg stance with eyes open between the control and intervention groups of elderly individuals over age 65.

Ho2: There was no difference in timed one-leg stance with eyes closed between the control and intervention groups of elderly individuals over age 65.

Ho3: There was no difference in spontaneous sway with eyes open between the control and intervention groups of elderly individuals over age 65.

Ho4: There was no difference in spontaneous sway with eyes closed between the control and intervention groups of elderly individuals over age 65.

Ho5: There was no difference in transfer from bed to a chair between the control and intervention groups of elderly individuals over age 65.

Ho6: There was no difference in the confidence of balance between the control and intervention groups of elderly individuals over age 65.

Delimitations

The following delimitations were imposed in this study:

1. The subjects were an elderly population over the age of 65.
2. There were six measures in the study: timed one-leg stance (eyes opened and closed), spontaneous sway (eyes opened and closed), transfer from bed to chair, and an ABC scale.
3. Balance training program was six weeks in duration; thirty minutes a day/three days a week.

Limitations

The following restrictions were imposed in this study:

1. Subjects were recruited in a non-random manner.
2. The study only took place for a period of six weeks.
3. The limited number of subjects and their physical characteristics limits the findings to those with similar characteristics.

Basic Assumptions

The following assumptions were made by the investigator:

1: The subjects adhered to the training program of three times per week for six weeks.

2: Those who were in the control group did not engage in any new additional physical activity, but maintained their normal daily activities.

3: The subjects put forth a maximal effort with each exercise session and testing session.

4: The subjects were truthful when responding to questions about medical history, orthopedic limitations and balance questionnaires which might affect the dependent measures of the study.

Definitions and Symbols

1. ABC scale- a scale that is used for people to assess the confidence that they have in their balance.
2. Instrumental activities of daily living (ADLS)- heavy and light housework, shopping for groceries, preparing meals, going places outside of walking distance and taking medications.
3. Assisted-living- people who have their meals prepared for them, their home cleaned, those on canes or walkers.
4. Balance- able to stand unaided, able to maintain equilibrium.
5. Falls- coming to rest unintentionally on the ground.
6. Falls Efficacy Scale (FES)- scale used to assess how well people feel they can do activities without a fear of falling.
7. FISCIT (Frailty and Injuries: Cooperative Studies of Intervention Techniques)- independent, randomized, controlled clinical trials that assessed intervention

efficacy in reducing falls and frailty in elderly patients.

8. Gait transfer-moving from one place to another, i.e., rising from a bed and moving to a chair.
9. HABAM (Hiearchial Assessment of Balance and Mobility) a instrument which displays changes in balance and mobility graphically.
10. Post-fall syndrome- after a person has fallen they often fear that they will fall again and are hesitant and lose confidence because of it.
11. Tai Chi- method of dynamic balance training.

Summary

As people age, they are more at risk for a fall to occur. It takes longer for an injury to heal as people get older and this will decrease the quality of life and daily activities for an elderly person. Exercise may be an avenue for improving balance and gait transfer in the elderly. There is a need for interventions that will help improve balance and transfer skills in the elderly population.

Exercise interventions have been established to try and influence balance in the elderly; but very few use exercise as the only component. They combine several intervention techniques such as nutrition, education, etc. to determine if balance can be enhanced in the elderly. The purpose of this study was to determine if exercise used alone would improve

balance and gait transfer in the elderly. Several performance measures were utilized to determine if there was a positive effect on balance and gait transfer in the elderly. Exercise interventions can improve the quality of life and have an influential effect on improving balance and gait transfer.

CHAPTER II

Literature Review

INTRODUCTION

Falling is increasingly becoming a healthier concern with the continued growth of the elderly. Exercise has been identified as playing an important role in delaying the aging process. Exercise may be an avenue to help the elderly improve their balance and to increase their activities of daily living. This chapter examines the relevant literature regarding exercise with the elderly and how it affects balance and the ability to transfer.

Risk Factors and Reduction of Risks

There are several risk factors when looking at balance and how it affects the elderly. In order to reduce the risk of falls, we must be able to identify the risk factors that are linked to falling.

Tinetti and others (1988) conducted a study looking at risk factors for falls among elderly persons living in the community. A sample of 336 subjects at least 75 years of age were involved in the study. All subjects received a clinical evaluation, were given balance and gait measurements, and had their homes inspected for environmental hazards. Subjects reported any falls they had and the circumstances in which the falls took place. It was found that the risk of falling

increased with the number of risk factors. There are several risk factors such as neurological disabilities, medications and environmental hazards that contribute to falls. Falls are common among the elderly and the risk factors need to be recognized.

Clark and others (1993) looked at clinical parameters associated with falls in the elderly. There were 81 subjects who were residents of a hostel for the aged. The residents went through a medical exam and filled out a questionnaire that gave details on falls that they may have experienced. They also received four monthly room visits. They were followed up for a period of one year to determine whether the assessment measures were associated with falls. The risk factors identified were impaired cognition, abnormal reaction to any push, history of palpitations and abnormal stepping. The study showed that a short assessment for falls can help to reduce the risk of falls in the elderly.

Assessments of Balance

When dealing with balance and ability to transfer, assessments must be used to evaluate individuals at increased risk of falling. There are different assessments, questionnaires and ways of determining how people feel about their balance and how balance affects activities of daily living.

MacKnight and others (1995) evaluated the Hierarchial

Assessment of Balance and Mobility (HABAM). It is a new instrument which displays changes in balance and mobility graphically. The study conducted used a sample of 28 patients aged 65 and older who were admitted to a tertiary-care teaching hospital. The HABAM is administered at the bedside of patients. It separates mobility into three sections (mobility, transfer and balance) and constructs a hierarchial range of abilities in each section. The findings of the study demonstrate that the HABAM is valid, reliable and responsive to change. The HABAM is a graphic and rapid assessment of balance and mobility in the hospitalized elderly.

Powell and others (1995) conducted a study that replicated the Falls Efficacy Scale (FES) and did a comparison with the Activities-specific Balance Confidence (ABC) Scale. The study involved three phases: 1) development of the ABC scale using 15 clinicians and 12 outpatients; 2) psychometric testing in which a 45 minute interview was given with 60 seniors; and 3) readministration of the ABC scale approximately two weeks later to 21 subjects who agreed to undergo postural balance testing. The results of the study showed that both the FES and ABC scales were internally consistent and demonstrated adequate test-retest reliability ($r=.90$). The ABC scale was a more efficient discriminator and yielded a wider range of responses. The study provided additional support for the FES; but the greater item response of the ABC scale makes it more suitable for detecting loss of

balance confidence in elderly subjects. Both scales are valuable tools for assessing balance confidence, but the ABC scale is more applicable in most cases. Therefore, the ABC scale is a tool that is valuable when assessing the elderly and their confidence in their balance.

Effects of Exercise on Balance

The goal of exercise includes improving balance and ability to transfer in an elderly population. "Physical activity is inversely associated with morbidity and mortality for several chronic diseases" (Blair, 1989). Physical activity can help keep individuals mobile and functioning on their own. "The goals of regular exercise include preservation of function for independent living, the slowing or stopping of the progression of chronic disease and reducing risk factors for coronary heart disease" (Cress, 1993). To improve balance, each individual must be committed to regular participation in activity.

A greater percent of the population are initiating activity programs. "A key ingredient to healthy living is physical activity. Increased physical activity increases bone mineral content, reduces the risk for osteoporotic fractures, helps maintain body weight and increases longevity" (Healthy People 2000).

Province and others (1995) conducted a study looking at the effects of exercise on falls in the elderly. They used

information from several sites to determine the effect that exercise has on the elderly. The conclusions were that the subject becomes more aware of his or her limitations of stability and allows compensation for the deficits. Also, balance training will increase the limits of stability and strength of the subject. As a person becomes more aware of his surroundings, he will be more aware of what he is doing and will pay closer attention to his balance and ability not to fall.

Gender Differences in Relation to Balance

When looking at balance and the ability to transfer, the question of gender often arises. "The assumption is that gender does play a role in the balance of the elderly" (Wolfson et. others, 1994). "A number of studies suggest that falls occur more often in females than in males, but do not find that it is gender related" (Prudham, 1981; Sattin, 1990; Tinetti, 1988). It is possibly related to a higher percent of females in the groups that take part in the studies. Women also live longer than men, therefore, the women in the study may have been older than the men which would account for the differences in gender.

Although studies have shown that females fall more than males, to date, there is no evidence of gender-based balance disparities. Wolfson and others (1994) conducted a study looking at balance to see if gender differences do occur. Two

hundred and thirty-four healthy, elderly subjects were recruited for the study. The subjects were tested on a computerized, dynamic posturography platform. The protocol consisted of a sensory organization test and a motor coordination test. There were several reasons for the balance disparities found: women have less strength than men, difference in body composition, range of motion and musculoskeletal factors. The study found pronounced gender differences in balance which are likely to be major factors in the occurrence of falls.

Treatment Programs for Improving Balance

"There have been several programs developed attempting to increase physical activities in the elderly" (Tinetti, 1994; Maki, 1994). There are several reasons for trying to improve balance in the elderly because it can be an important factor. "Physiological declines associated with age and disuse include aerobic work capacity, strength, flexibility, balance, reaction time and bone mass. These declines are major contributors to the loss of independence in older adults. Many of the physiological declines associated with aging can be countered by exercise training programs in elderly subjects. These factors are important in performing the activities of daily living and in resisting falls and fractures" (Smith, 1990). Physical activity is an intervention that traditionally has been used in trying to

improve balance in the elderly.

A new program at the 112-unit Heritage at Meridian Park in Tualatin, Or. has decreased the number of falls and accidents. The program is called RISE-Restoring independence, strength and energy. The program provides one-on-one help with restorative and strengthening exercises. It has demonstrated that regular exercise can improve balance. The goal of the RISE program is to support aging in place and help the residents stay healthier, safer and stronger longer. Overall, the program's mission is that people who participate, experience an increase in their quality of life. The tools used for the program are weights, exercises, social support, and specific balance and transfer exercises. Balance exercises and practicing transfers are extremely important in reinforcing the residents awareness of their environment and physical condition.

Province and others (1995) conducted a pre-planned meta-analysis of the FISCIT trials. FISCIT was an independent, randomized, controlled clinical trial that assessed intervention efficacy in reducing falls and frailty in elderly patients. The study included two nursing homes and five community dwelling sites. The number of participants ranged from 100 to 1323 per study. All of the trials included an exercise component lasting for 10 to 36 weeks. Fall and injury follow-up was obtained for up to 2 to 4 years. The exercise training was performed in one area or more of

endurance, flexibility, balance platform, Tai Chi and resistance. The findings of the analysis showed that treatments including exercise do reduce the risk of falls in elderly patients.

Exercise protocols and treatments have demonstrated to contribute to the reduction of falls for the elderly. Exercise can become an important component of the elderly individual's daily life.

Summary

The elderly are a subset of the population that is continuing to grow. Quality of life is very important and can be improved by improving balance in the elderly. There are considerable risks when looking at how balance deficiencies affect the elderly. As exercise professionals, we need to take the time to assess balance and to find effective exercises that will help improve balance and gait transfer.

There are several risk factors that effect balance. Environmental hazards, medications, physiological disabilities, etc, have been identified as contributing to an increased risk in falling. The risk factors must be minimized to obtain a positive influence on balance and gait transfer.

Assessments of balance are important to identify individuals at high risk levels. The assessments give an effective measure of balance and provide quantitative measures in which to track progress.

Exercise interventions have been shown to improve balance. Exercise helps to keep the elderly individual mobile and functioning on his own. Exercise interventions can improve balance and gait transfer; therefore, researchers need to continue to develop exercise interventions that will target balance and gait transfer in the elderly population.

Chapter III

Journal Manuscript

ABSTRACT

This investigation evaluated the effects of exercise on balance and ability to transfer in an elderly population. Eighteen elderly subjects (aged 65-96) were volunteers in this study. Nine of the elderly subjects participated in a six week exercise program, while the other nine were placed into a control group. It was hypothesized that the exercise group would improve balance and gait transfer. The variables of interest were: timed one-leg stance, spontaneous sway, transfer from bed to a chair, and an ABC (Activities-specific Balance Confidence) Scale. The variable of timed one-leg stance (sec), with both eyes open and closed, increased significantly ($P<0.05$)with the exercise training. The pre and post testing measures for the timed one-leg stance found that the $\bar{X}$ increased from 2.56 to 4.64, the SD was 6.06 and the SE was 1.43. However, the pre and post testing measures for the variables of spontaneous sway (sec), transfer (high, medium, low) and the ABC scale showed little or no change ($P>0.05$) for both control and exercise group. These results suggest that specific exercises enhance selected balance tasks and gait transfer in the elderly population. With the improvement of balance in the elderly, the risk of falling may be decreased, which will improve the quality of life for the elderly. The conclusion is that exercise improved selected balance index in

an elderly population. The performance measures that were utilized for the study did enhance balance in the elderly subjects; therefore, demonstrating that a structured exercise intervention can improve balance in elderly subjects.

Key words: balance, transfer, elderly population, timed one-leg stance, spontaneous sway, ABC Scale, falling, quality of life

INTRODUCTION

Every day people are faced with obstacles that they must overcome. The elderly population is the group that is hindered the most with obstacles in their path. There are several factors that can decrease the quality of life in the elderly: heart disease, hypertension, stroke, diabetes and falls. "Reduced balance has been identified as an important contributor to increased risk of falls" (Clark, 1993). When examining balance in the elderly, one of the questions to be asked is whether or not exercise has a positive impact on balance.

"The elderly are presented with many obstacles as they age, with falls being a common problem" (Province, 1995). "Each year, approximately thirty percent of persons over the age of sixty-five sustain a fall with about half of them having multiple events. Unintentional injury is the sixth leading cause of death in persons over sixty-five years of age, with the majority of these deaths attributed to falls, especially in persons aged eight-five years or older" (Province, 1995). As people age they are more at risk for debilitating falls and as a consequence injury or death. "Ten to fifteen percent of the falls that the elderly have result in serious injury and can be a precursor for death" (Tinetti, 1988).

Problems with balance and gait transfer lead to decreased quality of life and the incidence for injuries to occur.

Exercise is a means of improving balance and gait transfer in the elderly population. In Tualatin, Or. a new program has been initiated to help improve balance and transfer in the elderly. The program is called RISE-restoring independence, strength and energy. The program has demonstrated that exercise can improve balance. The tools that are used are weights, exercise, social support, and specific balance and transfer exercises. The RISE program has been successful in improving balance and gait transfer in the elderly.

There are also other programs that have been successful in improving balance and gait transfer with exercise. Province and others (1995) conducted a meta-analysis of the FISCIT trials. FISCIT was a independent, randomized, controlled clinical trial that assessed intervention efficacy. The study included two nursing homes and five community dwellings. All of the trials included and exercise component lasting for 10 to 36 weeks. The exercise training was performed in one area or more of endurance, flexibility balance platform, Tai Chi and resistance. The findings of the analysis demonstrated that treatments including exercise do reduce the risk of falls in the elderly. Exercise can improve and have a positive effect on balance in the elderly.

The purpose of the present study was to determine the effect of flexibility and resistance exercise on selected balance tasks and gait transfer in elderly subjects.

METHODS

Subjects

Eighteen elderly males and females from an assisted-living retirement community in southwest Virginia were volunteers for this study. The subjects ranged in age from 65-96 years old. All participants were informed of the exercise intervention and gave signed informed consent, as approved by the Human Subjects Review Board of VPI and SU. Criteria for recruitment included:

1. Able to stand unaided for ninety seconds
2. Able to walk ten meters
3. Able to understand verbal instruction
4. Experienced no falls within one month prior to testing
5. Not engaged in physical therapy

Recruitment of subjects was obtained by placing flyers explaining the study in mailboxes at the retirement community. The most effective recruitment was accomplished by going to individuals one-on-one and explaining the study and the requirements of it.

Procedures

An orientation was held for pre-testing measurements in which the requirements of the study were explained. Subjects' height and weight were also recorded at this time. (Table 1)

The subjects were given a medical screening to determine their eligibility for the program. A brief part of the

Table 1. Descriptive statistics, characteristics of subjects

Test	Pre		
	$\bar{X}$	SD	SE
Age			
Female	79.7	9.86	2.63
Male	73.8	7.54	3.77
Height (cm)			
Female	160.8	5.83	1.56
Male	175.9	5.63	2.81
Weight (kg)			
Female	64.3	15.09	4.03
Male	84.6	12.92	6.46

questionnaire included a section on falling history. They recalled any falls they had in the last twelve months. Also, they were asked about the circumstance of the fall, extent of injury and the time it took to recover from the fall.

The medical screening form was used to determine what types of subjects were being used for the study. Three of the subjects used canes, two of the subjects used walkers and one of the subjects used a tripod walker. The orthopedic limitations that were dealt with were mainly arthritis, while one subject had a back problem. The types of medications used were for blood pressure and arthritis. Some took a daily vitamin and a few took no medications at all.

The subjects filled out a questionnaire to help assess their confidence in their balance skills. The Activities-specific Balance Confidence Scale (Powell, 1995) was used to give a comprehensive look at balance and how each person perceived their ability to perform balance skills.

The subjects were given four balance tests to assess their balance. They were given explicit instructions on how to perform each assessment. The balance tests consisted of a spontaneous sway, a timed one-leg stance and transfer from bed to a chair.

The spontaneous sway (Maki, 1994) was completed with eyes opened and closed. The person stood with his arms by his side and looked straight ahead. The person tried to maintain his balance without using his arms or legs. The person was timed

to see how long he could stand without swaying from side to side and back and forth. The subjects were scored according to how many seconds they were able to stand without swaying.

The timed one-leg stance (Maki, 1994) was completed with eyes opened and closed. Each person stood on one leg for as long as possible up to a maximum of ninety seconds with eyes open and closed. Each person was given three attempts to perform the skill. This was the only test that used multiple observations for both eyes open and closed. The criterion measure was obtained by taking the best score out of the three attempts. They were scored according to how long they could stand on one leg.

The transfer from a bed to a chair (Maki, 1994) was a subjective test. The person was assessed for steadiness in rising from the bed and moving to a chair. A score of high, medium and low was given according to how steady the individual could move from place to another.

Upon completion of the balance testing, the subjects were randomly assigned to one of two groups: a control and an intervention. The control group did not engage in any additional new physical activity; while the intervention group was given an exercise program for three times a week for six weeks.

The exercise sessions for the intervention group lasted for six weeks. The exercises were performed three times a week with each session lasting twenty-five to thirty minutes.

Each session was supervised and led by an exercise leader to ensure that the exercises were being performed correctly and to enhance compliance.

For the exercise sessions, the participants sat in a half-circle with the leader at the front to demonstrate the exercises. For the exercises that required standing, the participants held on to the back of their chairs while doing the exercises for safety. A leader along with an observer ensured that no falls took place.

The exercises that were used for the study were chosen by a physical therapist and an orthopedic surgeon. The exercises chosen were the most likely to improve balance and gait transfer.

The specific exercises used in the study were as follows: bicep curls with yellow or red dynabands (12 reps), tricep curls with yellow or red dynabands (12 reps), leg extensions with or without ankle weights (10-12 reps), leg lifts with or without ankle weights (10-12 reps), metatarsal flexibility, and dorsi and plantar flexion with dynaband resistance (10-12 reps). The yellow dynaband had the least resistance and the red dynaband had the most resistance.

Each exercise session began with stretching exercises to warm up the individual, then the specific exercises were performed for balance. Dynabands were used to help improve coordination and to assist with flexibility. Rubber eggs were used for hand exercises to focus on grip strength as when a

person rises from a chair. A system of flash cards were used to help with balance, i.e. standing on one leg, raising up on tip toes and holding for five to seven seconds, and marching in place. This allowed the participant to visually see how the exercises were to be performed. The exercise program is presented in Table 2.

At the end of six weeks of exercise training, a post-test was performed to assess if any change in balance had occurred. The ABC scale, four balance tests and the falling history was administered to each subject.

DATA ANALYSIS

SigmaStat (1995) was utilized for the statisitcal procedures in the present study. A one-way repeated measures (ANOVA) was used to estimate the intraclass reliability coefficients for the dependent measures of timed one-leg with eyes open and the timed one-leg stance with eyes closed. A two-way repeated measures ANOVA was used to determine interactions and main effects for the dependent measures of timed one-leg stance with eyes open, timed one-leg stance with eyes closed, spontaneous sway with eyes open, spontaneous sway with eyes closed, and the ABC Scale. Bonferroni's multiple comparison procedures was used for timed one-leg stance with eyes open and timed one-leg stance with eyes closed. Mann-Whitney U test was used for analysis of data for transfer from bed to a chair to determine differences among

Table 2. Specific six week exercise intervention program

Exercise	Reps	Sets	Weight
Stretching			
Look to right/left	1	1	
Arm across chest	2	1	
Shoulder shrugs	10	1	
Reach up high w/arm	1	1	
Straight leg, point/flex	5	1	
Dynabands			
Behind back, pull front	10-12	1	yellow or red
In front, to the side	10-12	1	yellow or red
Bow and arrow	10-12	1	yellow or red
Extend out to side, front	10-12	1	yellow or red
Specific exercises			
Bicep curls	10-12	2	yellow or red
Tricep curls	10-12	2	yellow or red
Leg extensions	10-12	2	1,2 or 3 lbs.
Leg lifts	10-12	2	1,2, or 3lbs.
Metatarsal flexibility	10-12	2	
Dorsi & plantar flexion	10-12	2	yellow or red
Rubber eggs			
Grip strength supinated	10	1	red/blue/purple
Grip strength pronated	10	1	red/blue/purple
Finger adduction	10	1	red/blue/purple
Thumb opposition	10	1	red/blue/purple
Finger flexion	10	1	red/blue/purple
Pinch grip	10	1	red/blue/purple
Balance exercises			
Stand on one leg	5-7 sec.	1	
Stand on one leg/eyes shut	5-7 sec.	1	
Rise on toes & hold	5-7 sec.	1	
Rock back on heels & hold	5-7 sec.	1	
Sit and stand	5-7	1	
Leg out to the side	7-10	1	
Knees up and down	7-10	1	
March in place	10-15 sec	1	

the control and intervention groups. Statistical significance was determined at an alpha level of $p<0.05$.

For internal validity, extraneous variance in this study was reduced by utilizing the same trained technicians to conduct each test and exercise session, orientating the subjects to the training and measurement procedures prior to testing and the completion of a pilot study. For external validity, the characteristics of the subjects and exercise training three times a week for thirty minutes a session restricts the generalization of the findings of the investigation to populations with similar characteristics.

RESULTS OF THE STUDY

Descriptive statistics were used to estimate the mean ($\bar{X}$), standard deviation (SD), and standard error (SE) for the dependent measures of: timed one-leg stance with eyes open, timed one-leg stance with eyes closed, spontaneous sway with eyes open, spontaneous sway with eyes closed, transfer from bed to a chair, and the ABC Scale. The descriptive statistics are presented in Table 3.

One way repeated measures ANOVA was used to estimate the intraclass reliability coefficients for the dependent measures of timed one-leg stance with eyes open and timed one-leg stance with eyes closed. The intraclass reliability estimates for both the timed one-leg stance with eyes open and the timed one-leg stance with eyes closed was $R=0.98$ (Tables 4 and 5).

Table 3. Descriptive statistics for dependent measures

Test	Pre			Post		
	X	SD	SE	X	SD	SE
One-leg op (sec.)	2.56	1.89	0.447	4.64	6.06	1.43
Spon swayop (sec.)	6.80	7.32	1.724	4.41	3.90	0.92
Spon swayc (sec.)	4.06	4.37	1.030	2.97	2.78	0.65
ABC Scale (numerical)	62.5	32.7	7.72	67.8	28.0	6.60

One-leg op stands for timed one-leg stance with eyes open. Spon swayop stands for spontaneous sway with eyes open. Spon swayc stands for spontaneous sway with eyes closed.

Table 4. One way repeated measures analysis of variance for timed one-leg stance with eyes open (sec.)

Source of variance	DF	SS	MS	F	P
Between subjects	17.00	162.64	9.567		
Between trials	2.00	1.70	0.850	5.14	0.011
Residual	34.00	5.62	0.165		
Total	53.00	169.97			

Calculations of Intraclass Correlation for reliability estimates

$$R = \frac{\text{Mean Square Subjects - Mean Square Error}}{\text{Mean Square Subjects}}$$

$$R = \frac{9.6 - .165}{0.96}$$

$$R = 0.98$$

Table 5. One way repeated measures analysis of variance for timed one-leg stance with eyes closed (sec.)

Source of variance	DF	SS	MF	F	P
Between subjects	17.00	81.5949	4.7997		
Between trials	2.00	0.0544	0.0272	0.290	0.750
Residual	34.00	3.1934	0.0939		
Total	53.00	84.8427			

Calculations of Intraclass Correlation for reliability estimates

$$R = \frac{\text{Mean Square Subjects - Mean Square Error}}{\text{Mean Square Subjects}}$$

$$R = \frac{4.79 - .09}{4.79}$$

$$R = 0.98$$

The timed one-leg stance with eyes open had a significant relation to balance in the elderly. The two-way ANOVA revealed significant main effects (condition, $F_{1,16} = 4.87$, $P < 0.04$: time, $F_{1,16} = 5.06$, $P < 0.04$). There was also a significant interaction between these main effects (condition*time, $F_{1,16} = 5.03$, $P < 0.04$). (Table 6)

The timed one-leg stance with eyes closed had a significant relation to balance in the elderly. The two-way ANOVA revealed significant main effects (condition, $F_{1,16} = 5.63$, $P < 0.03$: time, $F_{1,16} = 11.85$, $P < 0.003$). There was also a significant interaction between these main effects (condition, $F_{1,16} = 12.50$, $P < 0.002$). (Table 7)

The spontaneous sway with eyes open did not have a significant relation to balance in the elderly. The two-way ANOVA did not reveal significant main effects (condition, $F_{1,16} = 0.56$, $P > 0.46$: time: $F_{1,16} = 3.94$, $P > 0.06$). There also was not a significant interaction between these main effects (condition*time, $F_{1,16} = 0.05$, $P > 0.82$). (Table 8)

The spontaneous sway with eyes closed did not have a significant relation to balance in the elderly. The two-way ANOVA did not reveal significant main effects (condition, $F_{1,16} = 0.85$, $P > 0.36$: time, $F_{1,16} = 4.28$, $P > 0.06$). There also was not a significant interaction between these main effects (condition*time, $F_{1,16} = 0.04$, $P > 0.83$). (Table 9)

The transfer from bed to a chair did not have a significant relation to balance in the elderly. The Mann-

Table 6. Two way repeated measures analysis of variance on timed one-leg stance with eyes open (sec.)

Source of variance	DF	SS	MS	F	P
Condition	1	144.9	144.9	4.87	0.0423
Condition (Sub)	16	476.1	29.8		
Time	1	77.6	77.6	5.06	0.0388
Condition x Time	1	77.1	77.1	5.03	0.0394
Residual	16	245.0	15.3		
Total	35	1020.7	29.2		

Multiple comparison procedures (Bonferroni's method)

Comparison	Diff of means	t	P<0.05
con-1 vs ex-2	-6.94778	-3.10459	Yes
con-1 vs ex-1	-1.08556	-0.48508	No
con-1 vs con-2	-0.00889	-0.00482	No
con-2 vs ex-2	-6.93889	-3.10061	Yes
con-2 vs ex-1	-1.07667	-0.48110	No
ex-1 vs ex-2	-5.86222	-3.17766	Yes

Table 7. Two way repeated measures analysis of variance on timed one-leg stance with eyes closed (sec.)

Source of variance	DF	SS	MS	F	P
Condition	1	41.9	41.88	5.63	0.0305
Condition(Sub)	16	119.1	7.44		
Time	1	21.2	21.21	11.85	0.0033
Group x Time	1	22.4	22.36	12.50	0.0028
Residual	16	28.6	1.79		
Total	35	233.1	6.66		

Multiple comparison procedures (Bonferroni's method)

Comparison	Diff of means	t	P<0.05
con-pre vs ex-post	-3.6922	-3.6459	Yes
con-pre vs ex-pre	-0.5811	-0.5738	No
con-pre vs con-post	0.0411	0.0652	No
con-post vs ex-post	-3.7333	-3.6865	Yes
con-post vs ex-pre	-0.6222	-0.6144	No
ex-pre vs ex-post	-3.1111	-4.9344	Yes

Table 8. Two way repeated measures analysis of variance on spontaneous sway with eyes open (sec.)

Source of variance	DF	SS	S	F	P
Condition	1	32.852	32.852	0.5678	0.4621
Condition (Sub)	16	925.686	57.855		
Time	1	51.624	51.624	3.9443	0.0644
Condition x Time	1	0.675	0.675	0.0516	0.8232
Residual	16	209.411	13.088		
Total	35	1220.248	34.864		

Table 9. Two way repeated measures analysis of variance on spontaneous sway with eyes closed (sec.)

Source of variance	DF	SS	MS	F	P
Condition	1	20.976	0.976	0.8513	0.3699
Condition (Sub)	16	394.264	24.641		
Time	1	10.758	10.758	4.2823	0.0551
Condition x time	1	0.111	0.111	0.0442	0.8361
Residual	16	40.197	2.512		
Total	35	466.306	13.323		

Whitney U did not reveal a significant difference between the conditions of control and intervention (P>.182). (Table 10)

The ABC Scale did not have a significant relation to balance in the elderly. The two-way ANOVA did not reveal significant main effects (condition, $F_{1,16} = 0.98$, $P > 0.33$; time, $F_{1,16} = 1.63$, $P > 0.21$). There also was not a significant interaction between these main effects (condition*time, $F_{1,16} = 4.42$, $P > 0.052$). (Table 11)

Overall, compliance for exercise attendance for the study was sixty-two percent. Two of the participants in the intervention group had a compliance rate of one hundred percent. Out of nine participants, five had a compliance rate better than sixty percent.

During the course of the study none of the participants experienced a fall. Toward the end of the study, one participant was able to let go of her walker while doing the standing portion of the exercises. At the beginning of the study, the subject would not let go of the walker; but by the end the subject was standing on her own.

DISCUSSION

The findings of the study demonstrate that some balance indexes are influenced by exercise training. The spontaneous sway showed no significant difference in the control or experimental groups. It could be related to the visual and vestibular systems of the subjects.

Table 10. Mann-Whitney U measures of test, posttest transfer skills (subjective= high, medium, low)

Group	N	Missing	Median	P
Control	9	0	2.00	.182*
Intervention	9	0	3.00	

* The differences in the median values among the two groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P= 0.182).

Table 11. Two way repeated measures analysis of variance on the ABC Scale (numerical score)

Source of variance	DF	SS	MS	F	P
Condition	1	1634.3	1634.3	0.980	0.3369
Condition (Sub)	16	26681.8	1667.6		
Time	1	258.5	258.5	1.633	0.2195
Condition x Time	1	700.8	700.8	4.429	0.0515
Residual	16	2531.9	158.2		
Total	35	31807.3	908.8		

It may be that with the eyes closed, a person does not have the advantage of focusing on an item; so when his eyes are closed he is unfamiliar with the situation. Rubenstein and others (1994) found that with age a person loses some of his lower body strength due to disuse which may cause him difficulty with standing without experiencing a sway. Along with decreased lower body strength, there is an increase in postural sway. As people age, they have poor posture control which makes it difficult to control their movements.

The transfer from bed to a chair showed no significant difference in the control or experimental group. The evaluation was subjective so slight differences in pre and post testing may have not been observed leading to no differences in the groups. Also, with the loss of muscle strength a person may have more difficultly in rising up and down. More emphasis on muscle strength and hand grip may be necessary. Rubenstein and others (1994) conducted a study that looked at balance and gait transfer in the elderly. One of the problems with gait transfer is muscle weakness. Muscle weakness can stem from prolonged bedrest or limited physical activity. Gait can also be impaired by increased postural sway, decreased gait velocity and prolonged reaction time. Gait problems can also be the result of simple deconditioning after a period of inactivity. Most of the participants in the study were not active in exercise; therefore, no significant difference in transfer from bed to a chair could be a result

of limited physical activity.

The ABC scale did not depict changes in confidence with exercise training which suggests that it was not a factor in predicting the confidence of elderly individuals. There could be several reasons for this conclusion. One is that discrepancies in ages. The ages ranged from 65 to 96 years. Some of the participants on the low end of the scale did have a change in the confidence scores over time; but those who were on the upper end the whole tome made it seem overall that the ABC Scale was not an accurate predictor of confidence in balance for the elderly subjects. Also, physical impairment of the participants may have caused them to downplay their confidence in their balance. Some felt that they were not capable of improving their balance, when in reality they did make improvements in balance and gait transfer. "The downside of the greater item response specificity and the inclusion of activities that are perceived as more hazardous in nature is that some subjects may respond that they do not do the activity in question, or have not done so for some time" (Powell, 1995). Powell conducted a study that demonstrated that the ABC Scale is an accurate predictor of detecting loss of balance in highly functioning seniors. The ABC Scale was found to be highly stable over a two-week period ($r=0.92$, $P<.001$); therefore, demonstrating that it is an accurate predictor of balance in the elderly.

The timed one-leg stance did demonstrate significant

differences for both eyes open and closed in the experimental group. There may have been a learning response taking place with this activity and with each trial the individual became better and improved their time. Learning may have been occurring which helped improve their score. Maki (1994) used the timed one-leg stance as one of his measures of balance in a study of risk of falling in an elderly population and found that people did improve when doing the test with eyes closed. The timed one-leg stance with eyes open and closed demonstrated significant differences that show that these performance measures were helpful in establishing that exercise can improve balance in the elderly.

The results of the present investigation and others, (Tinetti, 1994; Maki, 1994; Province, 1995), show that exercise can improve balance and gait transfer. Very few studies have been conducted showing that exercise alone can improve balance in the elderly. Additional research is merited to determine types of exercise which are most effective and should be applied. The conclusion of this study is that exercise can improve selected balance tasks in this sample population.

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Chapter IV

Summary and Research Recommendations

I. Summary

"Each year, approximately thirty percent of persons over age sixty-five sustain a fall with about half of them having multiple events. Unintentional injury is the sixth leading cause of death in persons over sixty-five years of age, with the majority of these deaths attributed to falls, especially in persons aged eighty-five years or older" (Province, 1995). As people age, they are more at risk for debilitating falls and as a consequence injury or death.

Numerous studies have demonstrated that falls are hazardous to the elderly. "Fall survivors experience greater decline in activities of daily living (ADLS) and in physical and social activities than nonfallers" (Tinetti, 1993). Several risk factors have been identified as a part of the reason that falls occur. Abnormal balance and gait are common factors linked with increased falling. Balance seems to be an important issue because people as they age tend to become more unstable and lose their balance more easily.

This investigation was designed to: 1) examine the effects of exercise on balance, 2) evaluate the effects of exercise on gait transfer, and 3) examine the confidence of balance in the elderly. Measures of interest were timed one-leg stance, spontaneous sway, transfer from bed to a chair and the ABC Scale.

As was expected, balance did improve with some of the exercise measures. A two-way analysis of repeated measures (ANOVA) showed a significant difference ($P<0.05$) in timed one-leg stance both with eyes open and closed. However, the other variables showed little or no change for both the control and exercise group. Some exercises are more suited for balance and gait transfer, and the results of this study demonstrate that exercise does improve balance.

These results agree with Maki and cohorts (1994) who found that the timed one-leg stance as a measure of balance does have an effect on balance and gait transfer. Some measures of balance demonstrated that exercise has a positive effect on balance and the ability to transfer in an elderly population.

The results of the present investigation and others, (Tinetti, 1994; Maki, 1994; Province, 1995), show that exercise can improve balance and gait transfer. Very few studies have been conducted to show that exercise alone can improve balance in the elderly. Additional research is needed to determine what types of exercise are the most effective and should be applied in intervention programs. The conclusion of this study is that exercise can improve some indexes of balance and gait transfer.

Deficiencies in balance can increase risk of falling and during exercise falling risk will increase. During the exercise sessions, while one individual leads, one or two more

should act as exercise guides to prevent falls from taking place.

Intervention programs should combine standing exercises with sitting exercises. Often times, elderly individuals tire easily so alternating standing and sitting exercises will work to their advantage and benefit them more than if they would have to stop because they were too tired to continue.

In this study, the intervention took place for six weeks. A long-term study would be valuable to determine if the effects of exercise are lasting. There could be a follow-up study to determine if balance and gait transfer continue to improve or stay the same over time, or if they decrease with continued aging and disuse.

This investigation found that exercise alone can improve balance and gait transfer in the elderly. Very few studies have looked at exercise as the sole factor of improving balance and gait transfer. More research needs to be conducted showing that exercise alone can improve balance in the elderly. Balance is important for the elderly to function independently and to carry out activities of daily living, therefore; a balance training program must be of concern in order to help the elderly to age in place and with grace.

Appendix A

Methodology

METHODOLOGY

Introduction

When looking at the elderly population, we must be able to determine how we can help them improve their lives. In order to do this, we must have tools to measure and assess their performance and their skills. There are different ways to assess performance and motor skills of the elderly. Balance is an important factor for the elderly and should be looked at in order to determine how to improve it as people age. The goal is to improve balance in the elderly and to be able to measure it to see if it has improved with an exercise intervention program.

Selection of Subjects

Prior to subject selection, permission to perform the exercise program and testing was given by the University's Human Subjects Committee. Eighteen volunteers were recruited from a retirement community in southwest Virginia. Descriptive characteristics are presented in Table I (Appendix F). Subjects were at least sixty-five years or older selected from an assisted-living population. Criteria for recruitment included:

1. Able to stand unaided for ninety seconds
2. Able to walk ten meters
3. Able to understand verbal instructions

4. Experienced no falls within one month prior to testing
5. Not engaged in physical therapy

Recruitment of subjects was established by placing flyers explaining the study in mailboxes at the retirement community. The most effective recruitment was accomplished by going to individual's one-on-one and explaining the study and the requirements of it.

Preliminary Testing Procedures

A pilot study was conducted using a group of graduate students at Virginia Tech. The purpose was to establish that the measures used were stable and that safety precautions would be applied.

Experimental Procedures

An orientation session was held for pre-testing measurements in which the investigator explained the requirements of the study. Subjects' height and weight were also recorded at this time.

Prior to participation in the study, each person completed an informed consent (Appendix B) in accordance with the Human Subjects Review Board of VPI and SU. A medical screening form (Appendix C) was given to each individual to assess their health history. A brief part of the questionnaires included a section on falling history. They

recalled any falls that they had in the last twelve months. Also, they were asked about the circumstance of the fall, extent of injury and the time it took to recover from the fall.

The medical screening form was used to determine what types of subjects were being used for the study. Three of the subjects used canes, two of the subjects used walkers and one of the subjects used a tripod walker. The orthopedic limitations that had to be dealt with were mainly arthritis, while one subject had a back problem. The types of medications used were for blood pressure and arthritis. Some took a daily vitamin and a few took no medications at all. From the medical screening form, two subjects were excluded from the study. One individual was taking physical therapy and one had Alzheimer's which prevented her from understanding the requirements of the study.

Subjects were also asked to fill out a questionnaire to help assess their confidence in their balance skills. The Activities-specific Balance Confidence (ABC) Scale (Appendix D) was used to give a comprehensive look at balance and how each person perceived their ability to perform balance skills.

Subjects were given four balance tests (Appendix E) to assess their overall balance. They were given explicit instructions on how to perform each assessment. The balance tests consisted of a spontaneous sway, timed one-leg stance and transfer from a bed to a chair.

The spontaneous sway (Maki, 1994) was completed with eyes open and eyes closed. The person stood with his arms by his side and looked straight ahead. The person tried to maintain his balance without using his arms or legs. The person was timed to see how long he could stand without swaying from side to side and back and forth. The subjects were scored according to how many seconds they were able to stand without swaying.

The second test was a timed one-leg stance (Maki, 1994). Each person stood on one leg for as long as possible up to a maximum of ninety seconds with eyes opened and closed. Each person was given three attempts to perform the skill. This was the only test that used multiple observations for the both eyes open and closed. The criterion measure was obtained by taking the best score out of the three attempts. They were scored according to how long they could stand on one leg.

The third and final test was a transfer from a bed to a chair (Maki, 1994) The person was assessed for steadiness in rising from the bed and moving to the chair. (Maki, 1994) A score of high, medium and low was given according to how steady the individual could move from one place to another.

Upon completion of the balance testing, the subjects were randomly assigned to one of two groups: a control or a intervention. The control group did not engage in any new additional physical activity; while the intervention group was given an exercise program three times a week for six weeks.

The exercise sessions for the intervention group lasted for six weeks. The exercises were performed three times a week with each session lasting twenty-five to thirty minutes. Each session was supervised and led by an exercise leader to ensure that the exercises were being performed correctly and to enhance compliance.

The exercises that were used for the study were recommended by a physical therapist and an orthopedic surgeon. The exercises were the most appropriate for trying to improve balance and gait transfer.

For the exercise sessions, the participants sat in a half-circle with the leader in the middle to demonstrate how to do the exercises. For the exercises that required standing, the participants held on to the back of their chairs while doing the exercises for safety. The leader along with an observer ensured that no falls took place.

The purpose of the exercises was to improve balance and the ability to transfer in the elderly. The specific exercises were as follows: bicep curls with yellow or red dynabands (12 reps), tricep curls with yellow or red dynabands (12 reps), leg extensions with or without ankle weights (10-12 reps), leg lifts with or without ankle weights (10-12 reps), metatarsal flexibility, and dorsi and plantar flexion with dynaband resistance (10-12 reps). The yellow dynaband had the least resistance while the red dynaband had the most resistance.

Each exercise session began with stretching exercises to warm up the individual, then their specific exercises were performed. Dynabands were used to help improve coordination and to assist with flexibility. Rubber eggs were used for hand exercises to focus on grip strength as when a person rises from a chair. A system of flash cards were used to help with balance exercises, i.e. standing on one leg, raising up on tip toes and holding for five to seven seconds, and marching in place. This was used so that the participants could visually see how the exercises were to be performed. The exercise program is presented in Table 2 (Appendix F). Exercises were alternated on different days to help prevent boredom and overuse. Incentives were used to motivate subjects to exercise regularly. Each Friday a surprise gift was given to one of the subjects. Names were placed in a bag and the one drawn out was the winner.

At the end of six weeks of exercise training, a post-test was performed to assess if any changes in balance had occurred. The ABC scale, four balance tests, and the falling history was administered to each subject.

Research Design and Statistical Analysis

SigmaStat (1995) was utilized for the statistical procedures for the present study. A one-way repeated measures (ANOVA) was used to estimate the intraclass reliability coefficients for the dependent measures of timed one-leg

stance with eyes open and timed one-leg stance with eyes closed. A two way repeated measures ANOVA was used to determine interactions and main effects for the dependent measures of timed one-leg stance with eyes open, timed one-leg stance with eyes closed, spontaneous sway with eyes open, spontaneous sway with eyes closed, and the ABC Scale. Bonferroni's multiple comparison procedures was used for timed one-leg stance with eyes open and timed one-leg stance with eyes closed. Mann-Whitney U was used for transfer from bed to a chair to determine differences among the control and intervention groups. Statistical significance was determined at an alpha level of $P<0.05$.

Internal Validity

Extraneous variance in this study was reduced by utilizing the same trained technicians to conduct each test and exercise session, orientating the subjects to the training and measurement procedures prior to testing, and the completion of a pilot study by the investigator.

External Validity

The characteristics of the subjects, i.e., males and females (65-96 years), and exercise training three times a week for thirty minutes a session restricts the generalization of the findings of the investigation to populations with similar characteristics.

Results/Conclusions

Descriptive statistics were used to estimate the mean ($\bar{X}$), standard deviation (SD), and standard error(SE) for the age, height and weight of males and females. The descriptive statistics are presented in Table 1 (Appendix F). Also, mean, standard deviation and standard error were used for the pre and post test measures of: timed one-leg stance with eyes open, timed one-leg stance with eyes closed, spontaneous sway with eyes open, spontaneous sway with eyes closed, transfer from bed to a chair, and the ABC Scale. The descriptive statistics for dependent measures are presented in Table 3 (Appendix F).

One way repeated measures ANOVA was used to estimate the intraclass reliability coefficients for the dependent measures of timed one-leg stance with eyes open and the timed one-leg stance with eyes closed. The intraclass reliability estimates for both the timed one-leg stance with eyes open and the timed one-leg stance with eyes closed was R=0.98. The ANOVA Table and intraclass reliability calculations are found in Table 4 and 5 (Appendix F).

Two way repeated measures ANOVA were used to test the main hypothesis in the investigation:

Ho1: There is no difference in balance scores between the pre and post test scores of the intervention and control group when measured with the timed one-leg stance with eyes open.

There was a statistically significant difference (P=0.04) between the main effect of condition. There was also a significant difference (P=0.038) between the main effect of time. There was a significant interaction between condition and time (P=0.039). The ANOVA TAble and multiple comparison procedures (Bonferroni's method) are presented in Table 6 (Appendix F).

Ho2: There is no difference in balance scores between the pre and post test scores of the intervention and control group when measured with the timed one-leg stance with eyes closed.

There was a statistically significant difference (P=0.03) between the main effect of condition. There was also a significant difference (P=0.003) between the main effect of time. There was a significant interaction between condition and time (P=0.002). The ANOVA Table and multiple comparison procedure (Bonferroni's method) are presented in Table 7 (Appendix F).

Ho3: There is no difference in balance scores between the pre and post test scores of the intervention and control group when measured with the spontaneous sway with eyes open.

There was not a statistically significant difference (P=0.46) between the main effect of condition. There also was not a significant difference (P=0.064) between the main effect of time. There was not a significant interaction between condition and time (P=0.082). The ANOVA Table is presented

in Table 8 (Appendix F).

Ho4: There is no difference in balance scores between the pre and post test measures of intervention and control group when measured with the spontaneous sway with eyes closed.

There was not a statistically significant difference (P=0.37) between the main effect of condition. There also was not a significant difference (P=0.055) between the main effect of time. There was not a significant interaction between condition and time (P=0.836). The ANOVA Table is presented in Table 9 (Appendix F).

Ho5: There is no difference in transfer skills between the pre and post test scores of the intervention and control group when measured with transfer from bed to a chair.

There was not a statistically significant difference between the control and intervention groups (P=0.182). The Anova Table is presented in Table 10 (Appendix F).

Ho6: There is no difference in confidence of balance between the pre and post test scores of the intervention and control group when measured with the ABC Scale.

There was not a statistically significant difference (P=0.33) between the main effect of condition. There also was not a significant difference (P=0.129) between the main effect of time. There was not a significant interaction between the condition and time (P=0.051). The ANOVA Table is presented in Table 11 (Appendix F).

The findings of the study demonstrate that some balance indexes are influenced by exercise training.

The results of the present investigation and others, (Tinetti, 1994, Maki, 1994, Province, 1995), show that exercise can improve balance and gait transfer. Very few studies have been done on showing that exercise alone can improve balance in the elderly. Additional research is merited to determine types of exercise which are most effective and should be applied. The conclusion of this study is that exercise can improve balance and gait transfer.

Appendix B

Informed Consent

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants of Balance and Exercise Project

Title of Project: Effects of Exercise on Balance and Ability to Transfer in an Elderly Population.

Principal Investigator: DeJuana S. Bowers

I. PURPOSE OF RESEARCH/PROJECT

You are invited to participate in a study about exercise and its effect on balance and ability to transfer. The purpose is to examine the effects of a structured intervention on improving balance and transfer skills in an elderly population.

II. PROCEDURES

Prior to inclusion in the study, you will be given a medical screening form to determine if any health problems will exclude you from the study. The study will last for six weeks with two additional weeks for performance assessments. An orientation will be held for pre-testing measurements in which a series of balance tests will be administered. You will also be asked to complete a questionnaire: the ABC Scale. At the end of six weeks of training, a post test will be administered to assess changes in balance and transfer skills.

The balance tests will consist of a one-leg timed stance, a spontaneous sway and transfer from a bed to a chair. If possible, each persons assessment will be videotaped and their performance assessed by different investigators.

Upon completion of the balance testing, the exercise training will take place for six weeks. The exercises will be held three times a week with each session lasting twenty-five to thirty minutes in duration. All exercise sessions will be recorded to monitor attendance. Supervision will be given to ensure that the exercises are being done correctly.

The exercise training will be explained and demonstrated so that you will understand what is expected of you.

III. RISKS OF THIS PROJECT

As with all exercise there is some degree of risks in this study. Individuals may experience muscle soreness, muscle fatigue, and possible loss of balance. The researchers are CPR certified and are competent in the care for the participating individuals. There will also be a support person who will provide help with the exercises sessions.

IV. BENEFITS OF THIS PROJECT

Your participation in this study will provide information that will help determine the effects of exercise on balance and transfer skills. Each person will receive the results of their exercise training and how they progressed. Also, each person will receive the knowledge of how to do exercises that will help strengthen them and help with their balance which will improve their physical condition and exercise tolerance.

V. EXTENT OF ANONYMITY AND CONFIDENTIALITY

All information received will be kept strictly confidential. The results of the study will not be released to anyone other than those working on the project without your consent. The information you give will have your name removed and you will be identified by a subject number assigned to you.

VI. COMPENSATION

For this project there is no monetary compensation given for participation in the study. However, each individual will be given the results of their training to see if there is an effect on balance and transfer skills. At the end of each week, a surprise gift will be given to one of the participants for their participation in the study. Also, Warmhearth will receive dynabands, ankle weights and rubber eggs for future use.

VII. FREEDOM TO WITHDRAW

At any time during the study, you may withdraw without penalty. If you feel that you do not want to continue for any reason you may withdraw and not be held accountable for it.

VIII. APPROVAL OF RESEARCH

This research project has been approved, as required, by the Institutional Review Board for projects involving human subjects at Virginia Polytechnic Institute and State University and the Department of Education.

IX. SUBJECT'S RESPONSIBILITIES

I know of no reason that I cannot participate in this study. I understand that I have the following responsibilities:

1. If assigned to the exercise group will comply with the exercise sessions.
2. If assigned to the exercise group will comply by attending the exercise sessions.
3. If assigned to the control group will continue with normal daily activities.

X. SUBJECT'S PERMISSION

I have read the informed consent and fully understand the procedures and requirements of the study. All of my concerns and questions have been addressed and I consent to freely participate in the study.

If I participate in the study, I may withdraw at any time without penalty. I agree to comply with all the rules and requirements of this study.

Should I have any questions about the research project, I will contact:

DeJuana S. Bowers	Investigator	(304) 753-4792
Shala E. Davis. Ph.D.	Dept. Exercise Science	(540) 231-8320
Ernest Stout	Chair, IRB(Research Division)	(540) 231-6077

_____ _____

Subject's Signature Date

Appendix C

Medical Screening Form

MEDICAL SCREENING FORM

Name: _____

Address: _____
_____

Phone #: _____

Age: _____ **Gender:**_____

Do you have any of the following vision problems:
Glasses: yes_____ no_____
Cataracts: yes_____ no_____
Double vision: yes_____ no_____

Do you have any of the following hearing problems:
Hearing aid: yes_____ no_____
Deafness: yes_____ no_____

Do you have any orthopedic difficulties? yes_____ no_____

If yes, what orthopedic problems do you suffer from?
_____
_____

How long have you experienced the orthopedic problem?_____

Are you currently involved in physical therapy?
yes_____ no_____

Please list the medications you are currently taking?
_____
_____

Name of your current physician:_____

Falling History

Have you experienced a fall in the last month: yes_____no_____
Have you experienced a fall in the last six months:
yes___ no____
Have you experienced a fall in the last year:
yes_____ no_____
If yes, what were the circumstances of the fall?

_____

_____

How long did it take to recover from the fall?
_____Did you receive any permanent injuries as a result of the fall and what were they?_____

_____

Appendix D

The Activities-specific Balance Confidence (ABC) Scale

The Activities-specific Balance Confidence (ABC) Scale

For <u>each</u> of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

0%	10	20	30	40	50	60	70	80	90	100%
No Confidence										Completely Confident

"How confident are you that you can maintain your balance and remain steady when you...

1. ...walk around the house?_____%
2. ...walk up or down stairs?_____%
3. ...bend over and pick up a slipper from the front of a closet floor?_____%
4. ...reach for a small can off a shelf at eye level?_____%
5. ...stand on your tip toes and reach for something above your head?_____%
6. ...stand on a chair and reach for something?_____%
7. ...sweep the floor?_____%
8. ...walk outside the house to a car parked in the driveway?__%
9. ...get into or out of a car?_____%
10. ...walk across a parking lot to the mall?_____%
11. ...walk up or down a ramp?_____%
12. ...walk in a crowded mall where people rapidly walk past you?_____%
13. ...are bumped into by people as you walk through the mall?__%
14. ...step onto or off an escalator while holding onto a rail?_%
15. ...step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing?_____%
16. ...walk outside on an icy sidewalk?_____%

*Powell LE & Myers AM. The Activities-specific Balance Confidence (ABC) Scale. Journal of Gerontology Med Sci 1995; 50 (1):M28-34.

Appendix E

Data Sheet

BALANCE AND EXERCISE STUDY

Subject:_____

Age: _____ Gender:_____

Height: _____cm

Weight: _____kg

Test 1
One leg timed stance

Eyes open
Trial one:_____sec.
Trial two:_____sec.
Trial three:_____sec.

Eyes closed
Trial one:_____sec.
Trial two:_____sec.
Trial three:_____sec.

Test 2
Spontaneous sway

Eyes open
Trial one:_____sec.

Eyes closed
Trial one:_____sec.

Test 3
Transfer from bed to chair

High_____

Medium_____

Low_____

ABC Scale score:_____

Appendix F

Statistical Tables

Table 1. Descriptive statistics, characteristics of subjects

Test	Pre		
	$\bar{X}$	SD	SE
Age			
Female	79.7	9.86	2.63
Male	73.8	7.54	3.77
Height (cm)			
Female	160.8	5.83	1.56
Male	175.9	5.63	2.81
Weight (kg)			
Female	64.3	15.09	4.03
Male	84.6	12.92	6.46

Table 2. Specific six week exercise intervention program

Exercise	Reps	Sets	Weight
Stretching			
Look to right/left	1	1	
Arm across chest	2	1	
Shoulder shrugs	10	1	
Reach up high w/arm	1	1	
Straight leg, point/flex	5	1	
Dynabands			
Behind back, pull front	10-12	1	yellow or red
In front, to the side	10-12	1	yellow or red
Bow and arrow	10-12	1	yellow or red
Extend out to side, front	10-12	1	yellow or red
Specific exercises			
Bicep curls	10-12	2	yellow or red
Tricep curls	10-12	2	yellow or red
Leg extensions	10-12	2	1,2 or 3 lbs.
Leg lifts	10-12	2	1,2, or 3lbs.
Metatarsal flexibility	10-12	2	
Dorsi & plantar flexion	10-12	2	yellow or red
Rubber eggs			
Grip strength supinated	10	1	red/blue/purple
Grip strength pronated	10	1	red/blue/purple
Finger adduction	10	1	red/blue/purple
Thumb opposition	10	1	red/blue/purple
Finger flexion	10	1	red/blue/purple
Pinch grip	10	1	red/blue/purple
Balance exercises			
Stand on one leg	5-7 sec.	1	
Stand on one leg/eyes shut	5-7 sec.	1	
Rise on toes & hold	5-7 sec.	1	
Rock back on heels & hold	5-7 sec.	1	
Sit and stand	5-7	1	
Leg out to the side	7-10	1	
Knees up and down	7-10	1	
March in place	10-15 sec	1	

Table 3. Descriptive statistics for dependent measures

Test	Pre			Post		
	$\bar{X}$	SD	SE	$\bar{X}$	SD	SE
One-leg op (sec.)	2.56	1.89	0.447	4.64	6.06	1.43
Spon swayop (sec.)	6.80	7.32	1.724	4.41	3.90	0.92
Spon swayc (sec.)	4.06	4.37	1.030	2.97	2.78	0.65
ABC Scale (numerical)	62.5	32.7	7.72	67.8	28.0	6.60

One-leg op stands for timed one-leg stance with eyes open. Spon swayop stands for spontaneous sway with eyes open. Spon swayc stands for spontaneous sway with eyes closed.

Table 4. One way repeated measures analysis of variance for timed one-leg stance with eyes open (sec.)

Source of variance	DF	SS	MS	F	P
Between subjects	17.00	162.64	9.567		
Between trials	2.00	1.70	0.850	5.14	0.011
Residual	34.00	5.62	0.165		
Total	53.00	169.97			

Calculations of Intraclass Correlation for reliability estimates

$$R = \frac{\text{Mean Square Subjects - Mean Square Error}}{\text{Mean Square Subjects}}$$

$$R = \frac{9.6 - .165}{0.96}$$

$$R = 0.98$$

Table 5. One way repeated measures analysis of variance for timed one-leg stance with eyes closed (sec.)

Source of variance	DF	SS	MF	F	P
Between subjects	17.00	81.5949	4.7997		
Between trials	2.00	0.0544	0.0272	0.290	0.750
Residual	34.00	3.1934	0.0939		
Total	53.00	84.8427			

Calculations of Intraclass Correlation for reliability estimates

$$R = \frac{\text{Mean Square Subjects - Mean Square Error}}{\text{Mean Square Subjects}}$$

$$R = \frac{4.79 - .09}{4.79}$$

$$R = 0.98$$

Table 6. Two way repeated measures analysis of variance on timed one-leg stance with eyes open (sec.)

Source of variance	DF	SS	MS	F	P
Condition	1	144.9	144.9	4.87	0.0423
Condition (Sub)	16	476.1	29.8		
Time	1	77.6	77.6	5.06	0.0388
Condition x Time	1	77.1	77.1	5.03	0.0394
Residual	16	245.0	15.3		
Total	35	1020.7	29.2		

Multiple comparison procedures (Bonferroni's method)

Comparison	Diff of means	t	P<0.05
con-1 vs ex-2	-6.94778	-3.10459	Yes
con-1 vs ex-1	-1.08556	-0.48508	No
con-1 vs con-2	-0.00889	-0.00482	No
con-2 vs ex-2	-6.93889	-3.10061	Yes
con-2 vs ex-1	-1.07667	-0.48110	No
ex-1 vs ex-2	-5.86222	-3.17766	Yes

Table 7. Two way repeated measures analysis of variance on timed one-leg stance with eyes closed (sec.)

Source of variance	DF	SS	MS	F	P
Condition	1	41.9	41.88	5.63	0.0305
Condition(Sub)	16	119.1	7.44		
Time	1	21.2	21.21	11.85	0.0033
Group x Time	1	22.4	22.36	12.50	0.0028
Residual	16	28.6	1.79		
Total	35	233.1	6.66		

Multiple comparison procedures (Bonferroni's method)

Comparison	Diff of means	t	P<0.05
con-pre vs ex-post	-3.6922	-3.6459	Yes
con-pre vs ex-pre	-0.5811	-0.5738	No
con-pre vs con-post	0.0411	0.0652	No
con-post vs ex-post	-3.7333	-3.6865	Yes
con-post vs ex-pre	-0.6222	-0.6144	No
ex-pre vs ex-post	-3.1111	-4.9344	Yes

Table 8. Two way repeated measures analysis of variance on spontaneous sway with eyes open (sec.)

Source of variance	DF	SS	S	F	P
Condition	1	32.852	32.852	0.5678	0.4621
Condition (Sub)	16	925.686	57.855		
Time	1	51.624	51.624	3.9443	0.0644
Condition x Time	1	0.675	0.675	0.0516	0.8232
Residual	16	209.411	13.088		
Total	35	1220.248	34.864		

Table 9. Two way repeated measures analysis of variance on spontaneous sway with eyes closed (sec.)

Source of variance	DF	SS	MS	F	P
Condition	1	20.976	0.976	0.8513	0.3699
Condition (Sub)	16	394.264	24.641		
Time	1	10.758	10.758	4.2823	0.0551
Condition x time	1	0.111	0.111	0.0442	0.8361
Residual	16	40.197	2.512		
Total	35	466.306	13.323		

Table 10. Mann-Whitney U measures of test, posttest transfer skills (subjective= high, medium, low)

Group	N	Missing	Median	P
Control	9	0	2.00	.182*
Intervention	9	0	3.00	

* The differences in the median values among the two groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P= 0.182).

Table 11. Two way repeated measures analysis of variance on the ABC Scale (numerical score)

Source of variance	DF	SS	MS	F	P
Condition	1	1634.3	1634.3	0.980	0.3369
Condition (Sub)	16	26681.8	1667.6		
Time	1	258.5	258.5	1.633	0.2195
Condition x Time	1	700.8	700.8	4.429	0.0515
Residual	16	2531.9	158.2		
Total	35	31807.3	908.8		

Appendix G

Statistical Figures

Figure 1A: Timed One-Leg Stance with Eyes Closed

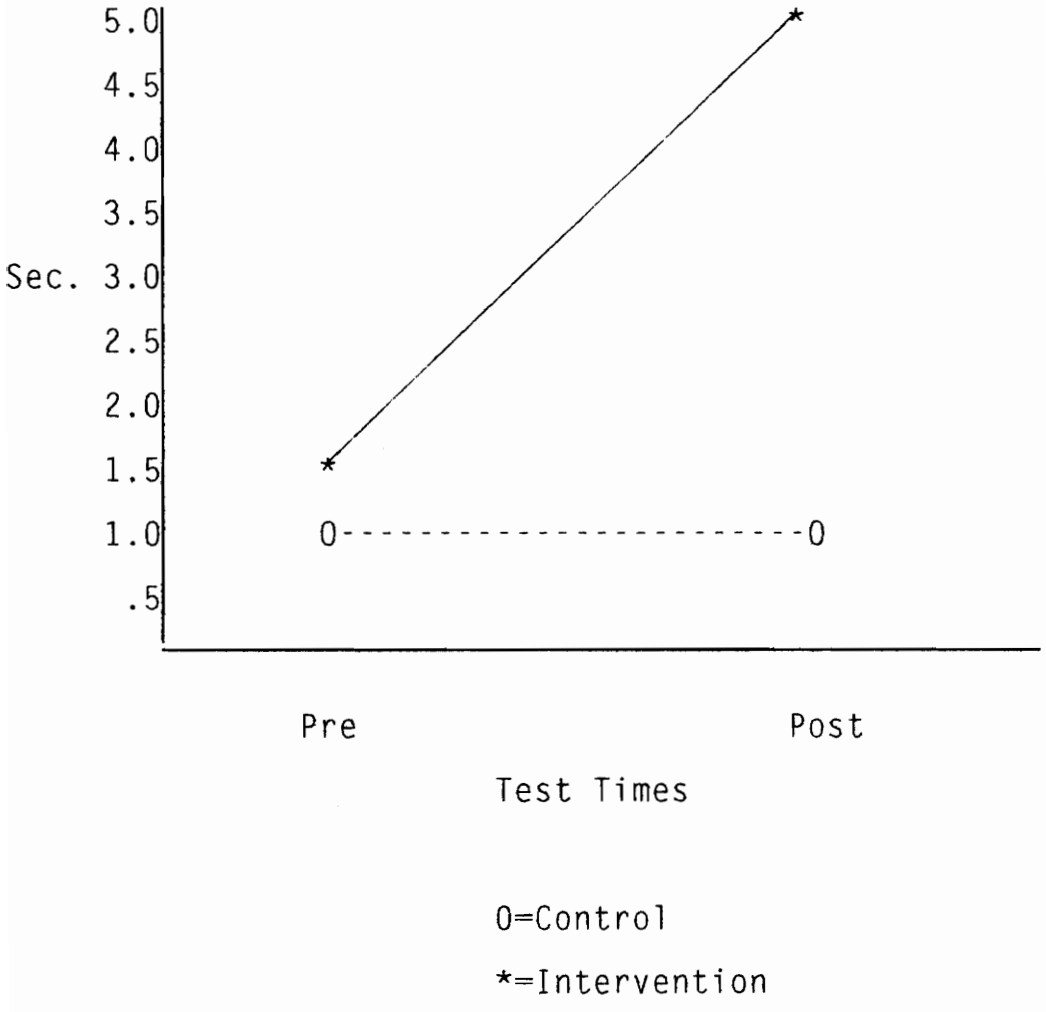
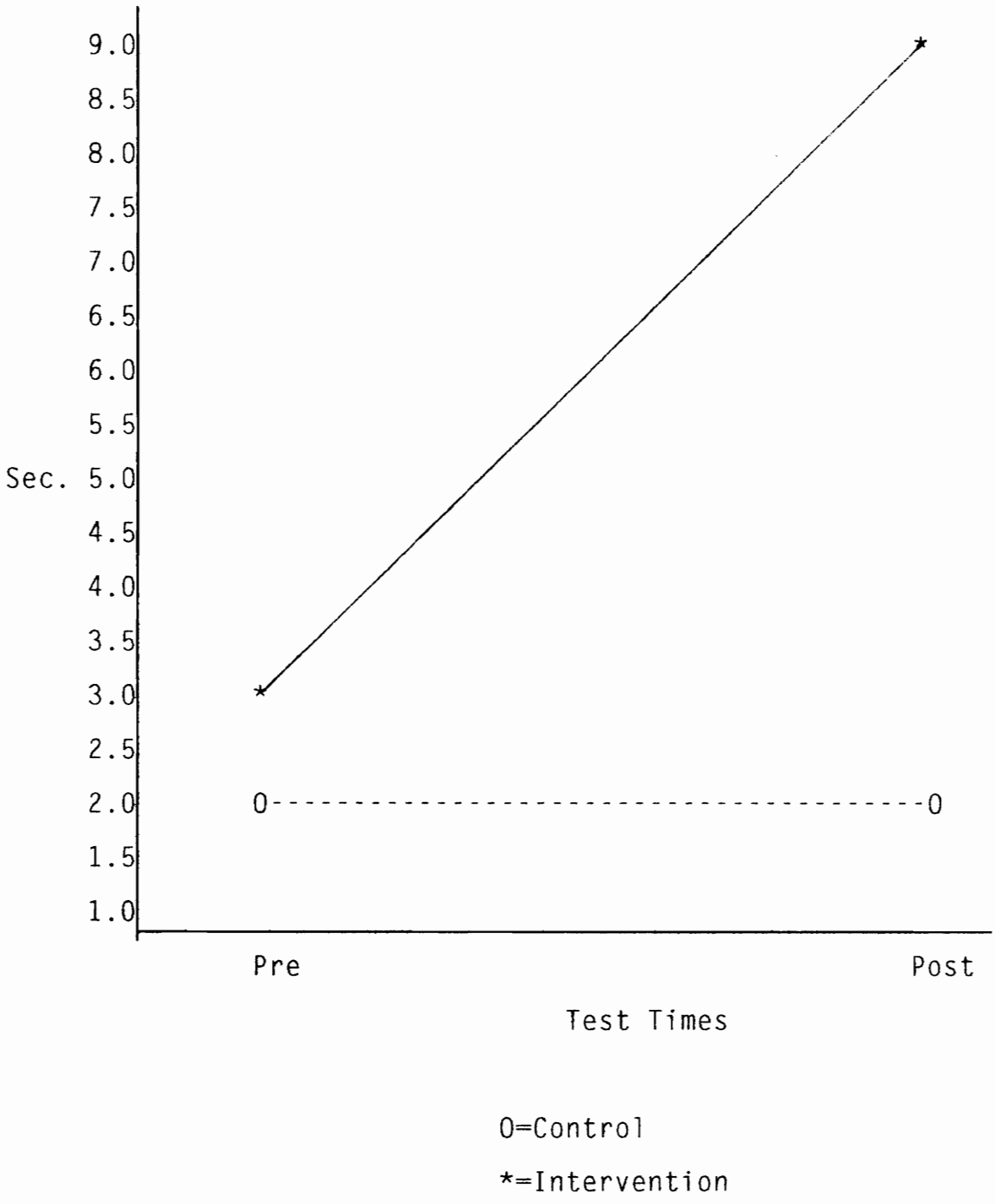


Figure 2A: Timed One-leg Stance with Eyes Open



Appendix H

Raw Data

Raw Data for descriptive statistics

Subject	Condition	Age	Ht.(cm)	Wt(kg)	Gender
1	Control	80	165.1	83.91	F
2	Control	96	152.4	50.80	F
3	Control	81	165.1	53.07	F
4	Control	70	182.8	88.90	M
5	Control	66	162.0	77.11	F
6	Control	71	170.1	77.11	M
7	Control	72	152.4	77.11	F
8	Control	70	172.7	82.55	F
9	Control	82	160.0	60.78	F
	$\bar{X}$	76	164.75	72.37	
10	Intervention	75	162.0	47.63	F
11	Intervention	64	160.0	78.02	F
12	Intervention	85	177.8	71.67	M
13	Intervention	84	152.4	38.44	F
14	Intervention	93	165.0	54.88	F
15	Intervention	69	172.7	100.69	M
16	Intervention	78	165.1	54.88	F
17	Intervention	82	157.4	60.78	F
18	Intervention	93	160.0	80.74	F
	$\bar{X}$	80	163.6	65.30	

Raw data for timed one-leg stance

		Eyes open		Eyes closed	
Subject		Pre	Post	Pre	Post
1	Con	1.3	2.2	.5	.5
2	Con	1.0	1.1	1.0	.5
3	Con	1.6	1.0	.5	.5
4	Con	5.3	5.4	4.3	4.5
5	Con	2.6	2.4	.75	.5
6	Con	.5	.5	.5	.5
7	Con	2.5	2.5	2.1	2.0
8	Con	.5	.5	.5	.5
9	Con	3.0	2.7	1.1	1.4
	$\bar{X}$	2.0	2.0	1.2	1.2
10	Int	4.1	10.	3.7	8.2
11	Int	1.9	7.5	1.0	5.2
12	Int	7.0	30.	5.0	10.
13	Int	2.0	.5	.5	.3
14	Int	0.0	1.0	0.0	.5
15	Int	3.8	6.8	2.1	3.3
16	Int	3.9	3.8	2.2	2.0
17	Int	1.0	14.	.5	8.2
18	Int	4.9	5.7	1.5	5.3
	$\bar{X}$	3.1	8.8	1.8	4.7

Con stands for control group and Int stands for intervention group.

Raw data for spontaneous sway

		Eyes open		Eyes closed	
Subject		Pre	Post	Pre	Post
1	Con	13.57	10.43	7.39	7.01
2	Con	6.0	4.13	3.0	2.4
3	Con	3.5	1.36	1.2	.81
4	Con	12.94	11.35	9.77	8.54
5	Con	16.76	13.62	13.10	9.03
6	Con	2.87	2.36	1.12	1.27
7	Con	2.41	1.52	1.11	1.36
8	Con	4.54	3.77	3.21	2.76
9	Con	6.0	.96	3.2	.88
	$\bar{X}$	7.61	5.5	4.78	3.78
10	Int	4.1	3.64	3.2	2.72
11	Int	2.24	1.79	1.0	1.66
12	Int	30.0	8.80	15.0	6.64
13	Int	5.0	1.81	3.1	1.2
14	Int	0.0	1.0	0.0	.72
15	Int	2.32	3.84	1.46	1.84
16	Int	5.0	4.49	3.9	2.29
17	Int	3.2	1.79	1.4	.86
18	Int	2.0	2.68	1.0	1.34
	$\bar{X}$	5.98	3.31	3.34	2.14

Con stands for control group and Int stands for intervention group.

Raw data for transfer skills

		Transfer	
Subject	Condition	Pre	Post
1	Control	3	3
2	Control	3	2
3	Control	2	2
4	Control	3	3
5	Control	3	3
6	Control	2	3
7	Control	2	2
8	Control	2	2
9	Control	2	2
	$\bar{X}$	2.4	2.4
10	Intervention	3	3
11	Intervention	2	3
12	Intervention	3	3
13	Intervention	2	3
14	Intervention	1	1
15	Intervention	2	3
16	Intervention	2	3
17	Intervention	3	3
18	Intervention	3	3
	$\bar{X}$	2.3	2.7

Raw data for ABC Scale

		ABC Scale	
Subject	Condition	Pre	Post
1	Control	87.5	87.5
2	Control	42.5	36.25
3	Control	37.5	31.87
4	Control	100	100
5	Control	96.87	93.12
6	Control	100	100
7	Control	73.75	70.62
8	Control	92.5	84.37
9	Control	31.8	27.5
	$\bar{X}$	73.6	70.1
10	Intervention	41.75	56.25
11	Intervention	93.75	86.25
12	Intervention	98.75	90.0
13	Intervention	21.25	43.75
14	Intervention	8.12	8.75
15	Intervention	59.37	76.25
16	Intervention	6.85	79.37
17	Intervention	58.75	55.63
18	Intervention	73.13	93.12
	$\bar{X}$	51.30	65.48

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VITA

DeJuana Sue Bowers was born on June 9, 1972 in Red Sulphur Springs, West Virginia. DeJuana grew up in a small town where she now resides. She grew up with three older boys so she learned how to hold her own and to be a tomboy. By her teenage years, she started to form her own identity and to become a independent female.

DeJuana graduated from Peterstown High School in June of 1990. She attended Radford University where she majored in Sportsmedicine and graduated in May of 1994. Upon completion of undergraduate school, she was accepted into graduate school at Virginia Tech and is now currently completing her degree requirements. She would like a job working in a cardiac rehabilitation program because she enjoys working with the elderly and receives a sense of satisfaction and contentment from it.

In her free time, she likes to care for animals, especially cows and she hopes to one day have her own farm. Hopefully, by the end of her education and the adventures of a job she will fulfill her dreams and exceed all of her goals.

DeJuana S. Bowers