



1997

The Effects of a Dorsiflexor Strengthening and Plantarflexor Stretching Program on Balance in the Elderly: A Pilot Study

Danielle R. Mongeon
University of North Dakota

Follow this and additional works at: <https://commons.und.edu/pt-grad>



Part of the [Physical Therapy Commons](#)

Recommended Citation

Mongeon, Danielle R., "The Effects of a Dorsiflexor Strengthening and Plantarflexor Stretching Program on Balance in the Elderly: A Pilot Study" (1997). *Physical Therapy Scholarly Projects*. 320.
<https://commons.und.edu/pt-grad/320>

This Scholarly Project is brought to you for free and open access by the Department of Physical Therapy at UND Scholarly Commons. It has been accepted for inclusion in Physical Therapy Scholarly Projects by an authorized administrator of UND Scholarly Commons. For more information, please contact zeinebyousif@library.und.edu.

**THE EFFECTS OF A DORSIFLEXOR STRENGTHENING AND
PLANTARFLEXOR STRETCHING PROGRAM
ON BALANCE IN THE ELDERLY:
A PILOT STUDY**

by


Danielle Renee Mongeon
Bachelor of Science in Physical Therapy
University of North Dakota, 1996




An Independent Study
Submitted to the Graduate Faculty of the
Department of Physical Therapy
University of North Dakota
in partial fulfillment of the requirements
for the degree of
Master of Physical Therapy

Grand Forks, North Dakota
May
1997

This independent study submitted by Danielle Mongeon, in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.


(Faculty Preceptor)


(Graduate School Advisor)


(Chairperson, Physical Therapy)

PERMISSION

Title The Effects of a Dorsiflexor Strengthening and
 Plantarflexor Stretching Program on Balance in the
 Elderly: A Pilot Study

Department Physical Therapy

Degree Master of Physical Therapy

In presenting this Independent Study Report in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the Department of Physical Therapy shall make it freely available for inspection. I further agree that permission for the extensive copying for scholarly purposes may be granted by the professor who supervised my work, or in her absence, by the chairperson of the department. It is understood that any copying or publication or other use of this independent study or part hereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and the University of North Dakota in any scholarly use which may be made of any material in my Independent Study Report.

Signature Danielle R. Monger

Date 12/19/96

TABLE OF CONTENTS

	Page
List of Figures	v
List of Tables	vi
Acknowledgments	vii
Abstract	viii
Chapter	
I. Introduction	1
II. Methodology	9
III. Results.	17
IV. Discussion	25
V. Conclusion	30
Appendices	32
Reference List	42

LIST OF FIGURES

Figure	Page
1. Microfet™ hand-held dynamometer.	11

LIST OF TABLES

Table	Page
1. Berg Balance Test Subtests.	14
2. Pre-exercise Results: Student Group	18
3. Pre-exercise Results: Group Over Age Sixty	18
4. Post-exercise Results: Student Group.	20
5. Mean Differences and <i>t</i> Values: Student Group	20
6. Post-exercise Results: Group Over Age Sixty.	21
7. Mean differences and <i>t</i> values: group over age sixty	21
8. Pre-exercise test results concerning left versus right side strength	24
9. Post-exercise test results concerning left versus right side strength	24

ACKNOWLEDGEMENTS

I would like to thank all of the subjects who so generously contributed their time for participation in this study. I would like to especially thank my faculty preceptor, Meridee Green, for her help and support throughout the work on and completion of this study.

ABSTRACT

Today, falls have become the most common life-threatening hazard in seniors. Falls have been associated with a number of disabilities including the muscular weakness and decreased flexibility that accompany aging. These factors may be involved in the poor balance that has also been identified as a risk factor for falling. It was the purpose of this research project to: (1) determine if the exercises prescribed to increase strength and flexibility of the ankle were effective in a control group of ten college students, and (2) to test the effects of a plantarflexor stretching and dorsiflexor strengthening program on balance in a group of five elderly subjects. It was hypothesized that all groups would show improved scores on all measurements at the end of a four week exercise regimen.

A group of ten healthy students had their dorsiflexor strength tested with the Microfet™ hand-held dynamometer, and their plantarflexor flexibility measured with a goniometer. They were asked to perform a simple home exercise program for strengthening the ankle dorsiflexors and stretching the ankle plantarflexors. Strengthening was achieved by raising the forefoot against gravity by bending at the ankle. These were performed in a set of

fifteen repetitions three times per day. Stretching was achieved through a stretch done in long-sitting and using a belt or towel to pull the forefoot towards the knee through bending at the ankle. This stretch was held for thirty seconds per session, three times per day.

The elderly subjects, those over the age of sixty, were tested according to the Berg balance assessment tool, and using the strength and flexibility measurements as above. All groups performed the exercises for four weeks and were retested at that time.

Although the small subject groups made it impossible to draw concrete conclusions from the results, it was found that the only significant improvements in scores was seen on right-side ankle flexibility in the student group. This research should help to lay the groundwork for future studies on balance and muscle strength and flexibility.

CHAPTER I

INTRODUCTION

Today, falls have become the most common life-threatening hazard in seniors.¹ In previous studies, rates of falling in the population over the age of sixty-five ranged from one third who were living at home to two thirds living in institutions who would experience at least one fall in a given year.²⁻⁶ Tinetti et al⁷ found that in a group of persons aged 75 and older, over 30 percent fell at least once, and almost a quarter of those who fell suffered serious injury. Serious injury may have included, but was not limited to, fractures, soft tissue injuries, and even death. Waller⁸ concluded that the death rate from unintentional injury—including those injuries caused by falls—increased rapidly with age, approaching 625 per 100 000 persons aged 85 and older.

Not all falls will result in these types of serious injury; however, other consequences have the potential to be debilitating in their own right. Many elderly persons who have fallen have had to endure a “long lie”, defined as needing to lie on the floor or ground for five minutes or more before being able to get up or before help arrived.⁹ The most serious result of this may be an increased fear of falling. Nevitt et al⁹ found that about one fall in ten was followed by a long lie, one in four resulted in limitation of activity and nearly

two-thirds of the subjects who had fallen reported a fear of falling again. The same study found that the most common reason for limiting activity after a fall was injury, followed by fear and physician's orders. The fear of falling may be especially harmful inasmuch as it may contribute to a vicious cycle of fear, reduced activity, increased weakness and immobility, and a greater risk of falling again.³

In order to reduce the risk of falling, several studies have focused on determining the risk factors associated with falls in the elderly population.^{2-3,7,9} The basic consensus of these studies was that falls could be caused by any combination of physical, pharmaceutical, and/or environmental factors. In the physical realm, falling has been attributed to poor balance.^{2-3,7,10,11} Tinetti et al⁷ studied 336 subjects in order to determine the risk factors associated with falls in the elderly. Standardized assessments of balance that were used included: arising from and sitting in a chair, side-by-side standing with eyes opened and closed, withstanding a nudge on the sternum, turning the neck, turning in place, standing on one leg, reaching up and bending over. It was found that impairment in the ability to perform the above tasks was associated with an increased risk of falling.

Lord et al¹⁰ looked at body sway as a measure of balance, studying ninety-five participants in a one year prospective project. Body sway was measured under a variety of circumstances including eyes open and closed

while standing on the floor, and eyes open and closed while standing on foam. It was concluded that those who fell on two or more occasions in the year after testing had increased sway on the floor with eyes closed, and increased sway on the foam with eyes open and closed when compared with those who did not fall or who fell on only one occasion during the year following the testing.

Woollacott¹² compared the muscle response characteristics of twelve older (sixty-five to seventy-eight years) and younger (nineteen to thirty-eight years) subjects. In this study, platform translations and rotations in different directions were used to disturb balance, and it was observed that "...automatic postural responses of older adults were altered in specific timing and amplitude characteristics compared with young adults."^{12(p58)} Specifically, when platform translations caused posterior sway the tibialis anterior responses were significantly slower in older adults.

Whipple et al¹¹ used the Postural Stress Test (PST) to determine subjects' balance strategy scores (BSS). During the PST, subjects stood with their back to a wall mounted pulley system. The free end of the pulley cable was attached to the back of a belt worn around the subject's pelvis. By attaching specific percentages of the subject's body weight to the pulley, reproducible destabilizing forces could be administered. The subjects received a numerical rating for their reactions to each of these forces and the

total of these ratings constituted their BSS. Whipple et al¹¹ concluded that elderly groups scored significantly lower than young control subjects and that elderly fallers scored significantly lower than non-fallers.

Poor balance may be due to a variety of factors including vestibular deficiencies, poor vision, decreased proprioception, muscular weakness, and decreased joint flexibility.¹³⁻¹⁶ Larsson et al¹⁷ studied muscle strength and speed of movement in relation to age and muscle morphology. An attempt was made to look at the influence age had on isometric strength, dynamic strength, and maximum knee extension velocity (MEV) and to "...correlate the changes in mechanical performance at different ages with the histochemical muscle characteristics."^{17(p451)} One hundred and fourteen healthy male subjects between the ages of 11 and 70 were studied, and it was found that isometric and dynamic muscle strength increased from ages 20-29, remained almost constant from 40-49 years, then decreased with age in the oldest groups (approximately 60-70 years). It was also found that "...altered fiber type distribution and the preferential atrophy of type II [fast twitch] fibers represent specific features of the skeletal muscle in old age."^{17(pg455)} This specific atrophy may lead to slower reaction time and decreased stability in the elderly. Indeed, it has been shown that there is a decrease in maximum strength that parallels increasing movement velocity for elderly men and women.¹⁸

Several researchers have looked for a specific muscle group that is most closely associated with decreased balance and increased risk of falling. Whipple et al¹⁹ studied 17 subjects with a history of one or more unexplained falls in the year previous to the study as well as a group of 17 control subjects. Each subject's dominant knee and ankle were tested at 60°/s and 120°/s constant angular velocities. Ankle strength was found to be considerably less than knee strength in both groups. Also, the relative difference in peak torque and power between these two joints was much greater in fallers versus nonfallers. The ankle dorsiflexion power was the most compromised of all motions and a decreased power was quite prevalent in the faller group. This, however, is one of few studies that has focused on and has successfully identified the ankle as a source of dysfunction in association with balance deficiencies and increased falls. On the whole, research on the ankle's role in balance is quite limited despite the observation by Wolfson et al that "Ankle movement regulates the interaction of the foot and ground and is, therefore, critical for both walking and balance."^{20(p341)}

Joint flexibility is another important factor in stability and balance. Flexibility often decreases as a person ages because of the loss of a natural substance called elastin from the body.¹ In a study by Gehlsen et al¹⁶, hip flexion, knee flexion, and ankle plantar- and dorsiflexion flexibility were

measured using a goniometer. There was a significant difference in hip flexion and ankle dorsiflexion flexibility between groups of elderly fallers and nonfallers. As mentioned previously, Woollacott¹² found anterior tibialis response to posterior sway to be reduced in elderly subjects and Whipple et al¹⁹ found dorsiflexor strength to be reduced in fallers versus nonfallers.

Of interest in the current study is this combination of decreased ankle flexibility and decreased ankle dorsiflexor strength. It is the belief of this researcher that a combination of dorsiflexor weakness and plantarflexor tightness are major contributors to the decrease in balance and reaction time that is seen in elderly individuals.

Exercise may be an important way to improve the muscle weakness and loss of flexibility that leads to decreased balance. Several researchers have advocated the use of programs to increase physical activity and muscle strength in order to decrease falls in those individuals at risk for falling and in the entire elderly population.^{3,7,13-14,16,20-24} Tinetti et al⁷ concluded that, because the risk of falling increased as the number of disabilities increased, modification of even a few risk factors might decrease the individuals' chances of falling. While there have been studies that have pinpointed a few of these risk factors such as the quadriceps or hamstrings as a focus muscle group for balance improvement, studies with an emphasis on the ankle

dorsiflexors are decidedly sparse.^{12,21-24} While some studies have included the ankle joint in an overall exercise regime to test that regime's effectiveness in treating balance deficits, few, if any have isolated the ankle to test the effects of strength and flexibility improvements on balance.^{13-14,20}

This study focused on muscular weakness and decreased joint flexibility as possible contributing factors to poor balance and, thus, an increased risk of falling. The purpose of this pilot study was: (1) to determine if the exercises prescribed to increase strength and flexibility of the ankle were effective in a control group of ten college students, and (2) to test the effects of a plantarflexor stretching and dorsiflexor strengthening program on balance in a group of five elderly subjects. It was hypothesized that: (1) the exercises would be proven effective as evidenced by an increased strength of the dorsiflexors and increased measurement of dorsiflexion in the group of students, and (2) the group of subjects over the age of 60 would have higher average balance scores, greater dorsiflexion motion, and improved dorsiflexion strength at the end of the program.

As a pilot study, no concrete conclusions could be drawn due to the small subject populations; however, this study should provide initial information that may lead to future research concerning the role the ankle plays in balance and what types of exercises are most effective for ankle strengthening, flexibility, and improved balance. By singling out the ankle in

this way, medical professionals will have been provided with more information concerning the role the ankle plays in balance and the importance of focusing, or at the very least including, exercise for this joint in patients presenting with balance deficiencies. Although this would be only a small step towards discovering effective treatment programs to reduce the rate of falls and serious injury associated with falling, it would be an important step towards creating an exercise regime that would best fit the needs of a patient with balance problems.

CHAPTER II

METHODOLOGY

Subjects

A control group of ten healthy students were chosen from among the 100 physical therapy students currently attending classes at the University of North Dakota, Grand Forks. Participation was voluntary, and subjects were found through a sign-up in the physical therapy department. The ages ranged from 20 to 33, with an average of 23. This group of students was fairly active, varying from running daily, in-line skating, working out on cross-country ski machines, and attending aerobics classes, to participating in regular workouts with free weights or weight machines.

A group of five subjects over the age of sixty were found in an aquatic exercise class, and through staff at the University of North Dakota School of Medicine and Health Sciences. The ages ranged from 64 to 73, and the average age was 67. The subjects' activity levels varied, including walking daily, low impact range of motion exercises, free-weight and multi-weight machines, tennis, bicycling, and participating in an aquatic exercise classes two to three times per week. One subject reported a prior medical history that included bilateral total hip replacements. All subjects, both students and

those over sixty, signed written consent forms in agreement to participate in the program that was outlined (see Appendix A).

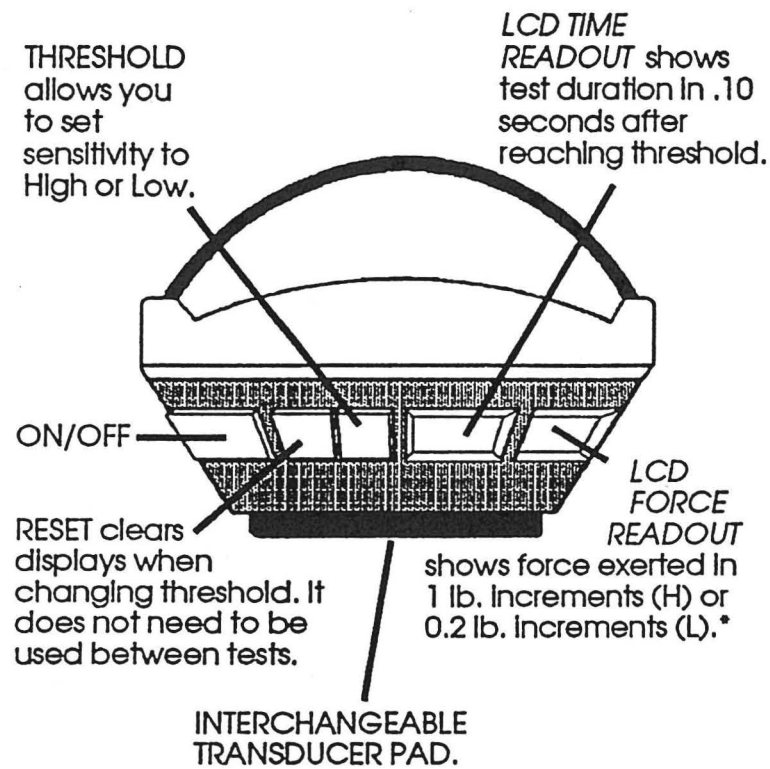
Assessment

Both the student group and the group over age sixty had strength tested using the Microfet™ hand-held dynamometer and had flexibility tested using the Army technique for goniometry measurement.²⁶ Strength and flexibility were measured three times on each side for every subject, and the results were averaged for the subjects' final measurements. The group of subjects over the age of sixty were assessed for balance with the Berg balance assessment tool²⁵ described below.

Strength

Strength was evaluated in all subjects through the use of a Microfet™ hand-held dynamometer. A diagram of this equipment is shown in Figure 1. The testing procedure was based on a study by Williams-Andrews et al²⁹ that was designed to determine normative values using a hand-held dynamometer to assess isometric contractions: Ankle dorsiflexion was tested with the hip, knee, and ankle at 0° and with the dynamometer placed just proximal to the metatarsophalangeal joints. The knee was maintained in full extension, and the leg was supported with foot resting off of the table. The muscle action was assessed in the gravity-neutralized position, and the dynamometer was held perpendicular to the surface being tested. Subjects were allowed to build to peak force over a two-second period, then held the

Fig 1. Microfet™ hand-held dynamometer



contraction for five seconds. This is known as an isometric “make” test.

Hand-held dynamometry was chosen because of its portable nature and its ability to give sensitive, objective scores for muscle strength.

Before using the dynamometer in the current study, six students were tested on two separate occasions to determine intratester reliability.

Experimental error was calculated to determine how much of the difference between measurements was due to the experimenter. Error for left side strength measurements was 14% and was 18% for right side strength measurements.

Flexibility

Ankle flexibility was measured using a goniometer with the Army technique for measurement.²⁶ Subjects had plantarflexor flexibility measured in a sitting position with the knees flexed to 90°. The axis of the goniometer was placed below the lateral malleolus on the heel of the foot, the fixed shaft was placed along the fibula, and the moveable shaft was placed along the fifth metatarsal. Normal dorsiflexor movement with the foot in this position is 0-20°.²⁸

Balance

The Berg balance assessment was used to give each elderly subject an objective balance score before and after participating in the exercise program. This test utilizes fourteen different tasks which are scored on a five point scale (0-4) according to the quality of performance or time required to

complete the task, as ranked by the test developers.^{25,29} These tasks are outlined in Table 1, and the entire Berg assessment is provided in Appendix B. The equipment used included: a stool, an exercise mat or a chair without armrests, a chair with armrests, a meter stick, a watch, and a small plastic cone. The cone was used for activity nine, when the subject was asked to retrieve an object from the floor. The highest possible score is a 56. Berg et al³⁰ contend that a cutoff score of 45 will indicate those persons who are at an increased risk of falling.

In order to practice giving the commands and using the test, the researcher administered the test on fifteen healthy college students. While the test is not considered appropriate for this age group (mean age \approx 25), it did provide an opportunity to repeatedly administer the test and become accustomed to the different rank scores for each activity. Interrater reliability between the researcher and two other physical therapy students directing the same test at the same time was 100%, with only one student scoring less than the total 56 points.

Berg et al²⁵ found interrater reliability on the intended target group—the elderly population—to be 98%, and a study by Bogle-Thorbahn et al²⁹ found interrater reliability to be 88%. The latter study attempted to determine an elderly person's risk of falling through use of the Berg test. Validity was assessed by examining sensitivity and specificity of the test. A sensitive test was defined as one that accurately identified the person who should have

Table 1.—Berg Balance Test Subtests

Item	Description
1	Sitting to standing
2	Standing unsupported
3	Sitting unsupported
4	Standing to sitting
5	Transfers
6	Standing with eyes closed
7	Standing with feet together
8	Reaching forward with outstretched arm
9	Retrieving object from floor
10	Turning to look behind
11	Turning 360°
12	Placing alternate foot on stool
13	Standing with one foot in front of the other foot
14	Standing on one foot

had a negative result. Six months after an initial assessment with the Berg test, subjects were asked to recall the number of falls suffered. The sensitivity of the test was determined to be 53% and the specificity of the test was 92%. The Berg balance test has been shown to correlate with the Tinetti mobility index ($r = .91$) and the "Get Up and Go" test ($r=.76$).²⁹ Overall, measurements obtained with the Berg test have shown excellent interrater reliability and at least moderately strong concurrent validity.^{25,29-30}

All subjects were retested following the above guidelines after four weeks on an exercise program, which is described below. Again, only the over-sixty subjects were tested for balance.

Exercise Program

Each of the subjects was given a written copy of the exercise program and was asked to perform each exercise three times per day for four weeks. The program consisted of exercises that are designed to improve the strength and flexibility of the muscles surrounding the ankle. These particular exercises were chosen because of their simplicity and accepted effectiveness clinically. They were obtained from the Exercise X-press™ computer software program. The exercises are outlined in Appendix C.

Strengthening

Dorsiflexor strengthening was accomplished with the subject in a seated position performing "ankle pumps", consisting of bringing the forefoot up towards the knee by bending at the ankle. The subjects then held an

isometric contraction for three seconds at the end range. Subjects performed these in a set of fifteen repetitions three times per day. The three-second hold was based on Kraemer's³¹ theory that the frequency of repetitions times the hold of the contraction should be greater than thirty for the exercises effectively strengthen the muscle.

Flexibility

Plantarflexor stretching was achieved through a sustained pull on the heel cord. Subjects sat in the long-sitting position, either on the floor or sitting in a chair with their foot up on another chair. Using a towel or belt, they pulled their foot up towards their knee through bending at the ankle. They held the stretch for thirty seconds in accordance with a study performed by Bandy and Irion³² which found that stretches held for 30 or 60 seconds were equally effective in improving flexibility.

Data Analysis

Data was analyzed using the SPSSxTM computer software package. A repeated measures *t* test was used ($\alpha = .05$) to determine if there was a significant difference between pre-and post-exercise balance scores, strength, and flexibility measurements. If the post-exercise results showed a significant increase in these values, it should lead to future research with larger subject populations to confirm the results. As a pilot study, one of the major purposes was to lead to further research. The results of this study were designed to provide some direction for those investigations.

CHAPTER III

RESULTS

Pre-exercise results

The student group (see Table 2) showed little variance between subjects' pre-exercise dorsiflexor strength measures on both the left ($X = 19.10 \pm 1.74$) and right ($X = 16.40 \pm 1.70$). Individual flexibility averages varied from 9.17 degrees to 29 degrees on the left ($X = 16.78 \pm 7.46$) and from 6 degrees to 26.7 degrees on the right ($X = 15.30 \pm 7.78$). There were no apparent trends according to age or activity level, but dorsiflexion strength on the right was significantly lower than strength measurements on the left.

The pre-exercise results of the group over the age of sixty are summarized in Table 3. Again strength measurements were less variable between subjects than flexibility measurements, and strength on the right was less than strength on the left. There were no apparent trends in scores or measurements according to age. Subject number four reported more activity, including tennis and regular workouts with weight machines at least two times per week, and this subject also had the highest measurements in bilateral strength and flexibility. In assessing subject number three's left side flexibility

Table 2.— Pre-exercise Results: Student Group

Subject	Age	(L)Strength	(R)Strength	(L)Flex	(R)Flex
1	33	24.33	20.67	23.67	25.67
2	22	19.00	15.33	9.17	10.33
3	21	19.00	16.33	23.00	23.00
4	20	19.00	14.67	23.33	17.00
5	24	19.67	16.33	9.33	6.00
6	24	18.33	15.00	9.67	6.33
7	23	20.33	16.67	16.33	17.33
8	23	19.67	16.67	9.33	10.33
9	20	18.33	17.00	29.00	26.70
10	23	19.33	15.33	15.00	10.33
MEANS	23.30	19.10	16.40	16.78	15.30
SD	3.71	1.74	1.70	7.46	7.78

Flex = Flexibility as measured with the ankle in dorsiflexion

Table 3.— Pre-exercise Results: Group Over Age Sixty

Subject	Age	Berg	(L)Strength	(R)Strength	(L)Flex	(R)Flex
1	65	53	14.00	14.67	-3.67	-3.00
2	73	53	10.33	9.33	6.00	1.00
3	64	52	12.67	9.33	-9.00	.33
4	68	56	16.33	14.33	28.00	33.00
5	67	56	10.67	10.67	1.17	6.67
MEANS	67	54	12.80	11.67	7.60	4.50
SD	3.51	1.87	2.48	2.65	14.62	14.27

Flex = Flexibility as measured with the ankle in dorsiflexion

limitations (-9°), inclusion in this study may have been questionable. If that subject was unable to even attain a neutral position, the ability to perform the exercises correctly and effectively were in doubt. All pre-exercise results are presented in Tables 2 and 3. Measurements for each subject, both the students and the group over age sixty, were the average of three measurements taken at the data collection sessions.

Post-exercise results

All ten student subjects returned after four weeks to repeat the measurements, while four of the five subjects over the age of sixty returned. Subject number three was invited to participate and return for post-exercise testing, but failed to return after four weeks. The ankle exercises described in chapter two were identified as the independent variables. Three related samples t tests were performed for the dependent variables of plantarflexor flexibility, ankle dorsiflexor strength, and Berg balance test scores. A 95% confidence interval was used ($\alpha = .05$) for the group of ten students ($df = 9$) and the group of four subjects over the age of sixty ($df = 3$). Using these values and a non-directional statistical analysis, the t value for the student group must have been greater than ± 2.62 in order to be significant, and a t value of greater than ± 3.18 was required for significance in the group over the age of sixty.

Table 4.— Post-exercise Results: Student Group

Subject	(L)Strength	(R)Strength	(L)Flex	(R)Flex
1	21.00	17.00	32.33	28.67
2	16.33	13.67	15.00	11.00
3	19.67	15.00	19.67	24.67
4	16.67	12.67	20.67	19.33
5	19.67	15.00	11.33	10.33
6	20.67	15.67	10.33	10.00
7	20.33	18.67	21.67	20.33
8	19.67	15.33	15.00	13.00
9	17.00	15.33	28.33	25.33
10	20.00	19.00	12.33	12.00
MEANS	19.10	15.73	18.67	17.47
SD	1.74	2.00	7.34	7.01

Flex = Flexibility as measured with the ankle in dorsiflexion

Table 5.— Mean Differences and *t* Values: Student Group(df = 9)

Variable	Mean difference	SD	SE of Mean	<i>t</i> value	p value
(L) Strength	-5.98	1.77	.560	-1.07	.313
(R) Strength	-6.67	2.16	.682	-.98	.354
(L) Flexibility	1.88	4.27	1.35	1.39	.197
(R) Flexibility*	2.16	1.63	.515	4.20	.002

* significant results

Table 6.— Post-exercise Results: Group Over Age Sixty

Subject	Berg Score	(L)Strength	(R)Strength	(L)Flex	(R)Flex
1	54.00	12.33	10.33	0.00	6.33
2	54.00	11.67	10.67	0.00	-2.00
4	56.00	21.33	16.00	33.00	34.33
5	56.00	20.00	14.33	11.00	8.33
MEANS	55.00	16.33	12.83	11.00	11.75
SD	1.16	5.04	2.78	15.56	15.71

Flex = Flexibility as measured with the ankle in dorsiflexion

Table 7.—Mean Differences and *t* Values: Group Over Age Sixty (df = 3)

Variable	Mean difference	SD	SE of Mean	<i>t</i> value	p value
Berg Score	.50	.58	.29	1.73	.182
(L) Strength	3.50	4.75	2.38	1.47	.237
(R) Strength	.58	3.44	1.72	.34	.757
(L) Flexibility	3.13	6.63	3.32	.94	.416
(R) Flexibility	2.33	5.13	2.56	.91	.430

The post-exercise results, mean differences, *t* values, and *p* values for the student group are presented in Tables 4 and 5. Those for the group over the age of sixty are summarized in Tables 6 and 7. The repeated measures *t* test showed that the only post-exercise value that was significant in either group for any test was right side ankle flexibility in the student group (Table 4). The mean difference between pre-exercise and post-exercise measurements was +2.16 and the *t* value was 4.20, with *p* = .002. (Table 6). With the exception of decreased strength between trials in the student group, most measures showed improvement, but these were not statistically significant.

Trends in left versus right side strength

In tabulating the results for this study, it became apparent that right side strength measurements were consistently lower than those for the left side in both the student group and the group over the age of sixty. In order to determine if these findings were significant, another paired-samples *t* test was run, comparing the mean differences in right versus left side strength for both subject groups. A 95% confidence interval was used for the ten student subjects (*df* = 9) and the four subjects over the age of sixty (*df* = 3). Using these values and a non-directional statistical analysis, the *t* value for the student group must have been greater than ± 2.62 in order to be significant,

and a t value of greater than ± 3.18 was required for significance in the group over the age of sixty.

In both pre-exercise and post-exercise testing, the mean differences between left and right side strength in the student group were significantly different ($t = 12.45$ [$p = .001$] and $t = 7.20$ [$p < .001$] for pre- and post-exercise tests, respectively). In the group over age sixty the mean differences showed a trend towards greater left-side strength, but the t values were not high enough to show statistically significant results ($t = 1.00$ [$p = .392$] and $t = 2.98$ [$p = .059$] for pre- and post-exercise testing, respectively)

Tables 8 and 9 summarize these results.

Overall, both groups showed gains in flexibility and balance measures, although only the gains shown in right side flexibility in the students were found to be statistically significant. The group over the age of sixty showed insignificant gains in strength bilaterally, while the students showed insignificant decreases in strength between trials. There was a significant difference between left and right side strength noted in the student group, and a trend of greater left side strength that was statistically insignificant in the group over the age of sixty. Many circumstances may have factored in to the results found here. These will be discussed, along with the implications of these results, in detail in chapter four.

Table 8.— Pre-exercise Test Results Concerning Left Versus Right Side Strength

Subjects	df	Mean Difference	SD	SE of Mean	<i>t</i> value	p value
Students*	9	3.30	.838	.265	12.45	<.001
Over age sixty	3	.5825	1.168	.584	1.00	.392

* significant results

Table 9. Post-exercise Test Results Concerning Left Versus Right Side Strength

Subjects	df	Mean Difference	SD	SE of Mean	<i>t</i> value	p value
Students*	9	3.37	1.48	.468	7.20	<.001
Over age sixty	3	3.50	2.35	1.18	2.98	.059

* significant results

CHAPTER IV

DISCUSSION

As a pilot study, one of the main purposes of this research was to determine trends in the results and lead the way to a larger study concerning the role the ankle plays in balance. Two trends were found in this study. First, right side flexibility was shown to increase in the student population after four weeks of ankle strengthening and flexibility exercises. The stretching exercises that were chosen could have been directly responsible for this improvement. Also, the strengthening exercises that were chosen could have had an effect on the length of the plantarflexors through active, anti-gravity dorsiflexion in the seated position. The strengthening exercises may have had an especially powerful influence on the soleus muscle group due to the fact that the stretch was performed while the subjects were seated. This is of particular interest in this study because the flexibility measurements were taken in this same seated position, thus targeting the flexibility of the soleus muscle. The stretching exercises that were chosen, which had the patient in a long-seated position, could have also aided in the overall flexibility at the ankle, but were more focused on the gastrocnemius muscle.

The second trend that was noticed was the fact that left side strength was consistently greater than right side strength in both the student group and the group over the age of sixty. It may have been expected that the right side, which is generally the dominant side, would have had greater strength, and so to find a trend such as this is of some interest. However, tests done with larger subject groups will have to be performed in order to confirm if this trend is true for the larger population.

In 1996, Williams-Andrews et al²⁷ published a study that was designed to establish normative values for isometric muscle force measurements obtained with hand-held dynamometers, and their method was repeated in the current study. Rather than labeling left and right side strength, however, they looked at dominant and nondominant sides. There was a tendency for nondominant side ankle dorsiflexors to be stronger for both males and females in the age bracket of 60 to 69 years old. From 50 to 59 years and from 70 to 79 years, the dominant sides were stronger. In the present study, all but one of the subjects in the group over the age of sixty fell in the 60 to 69 age range, and so the greater left sided strength may indeed have been expected. In the subjects involved in the present study, though, dominance was not established, and so it cannot be assumed that they were all right-side dominant. There was not a younger age group included in the study by

Williams-Andrews et al,²⁷ and so it remains to be seen whether the strength differences in the student group were as expected.

Suggestions for Replication of this Study

The small subject group sizes were a major limitation in this study, and any future research would require a larger subject base in order to make its results transferable to the population at large. A subject group size of at least 30 in both a control and experimental group would be recommended. It would also be advisable to focus on either the balance aspect or the effectiveness of the exercises in future research in order to help to maintain the focus of the research and simplify data collection and processing.

The methods used in this study were researched and well-documented; however, changes could be made to assure accurate results. First, flexibility measurements should be taken in the same position in which the prescribed stretching exercises are performed. This will assure that the muscle groups that are being stretched are the same as those that are being measured. Second, because strength can only be gained when a muscle is required to perform against a load that is above and beyond the previous requirements, external resistance should be applied, rather than simply making the exercises anti-gravity.³¹ Even doing the exercises standing rather than sitting may be beneficial by working against the weight and sway of the

body. Theraband or sand weights applied to the forefoot for resistance would also be recommended.

Another factor concerning the strength measurements in this study was the use of the Microfet™ hand-held dynamometer. While the device had been used by the researcher prior to beginning this study, the subject group was again small and the experimental error was at 18% for right side strength measurements and 14% for left side strength measurements. In future studies, more extensive pre-experimental use of the dynamometer would be advised with a larger subject base to establish proficiency. For example in the study performed by Williams-Andrews et al,²⁷ each of the researchers had had at least eight years of experience with the hand-held dynamometer, and had tested thousands of patients with the device in that time.

It may also be advisable to use a balance measure that is somewhat more sensitive to subtle balance deficiencies than the Berg balance assessment. The Berg assessment was chosen because of its acceptance clinically and in research, but like all balance measures, it does have its limitations. The Berg assessment is in general a static balance test with items such as standing unsupported and one-footed standing being among its subtests.²⁵ Duncan et al³³ advocate dynamic balance measures, focusing on the ability to maintain equilibrium in response to either self-motivated or external disturbance, as opposed to static tasks. They also contend that

ordinal scoring such as that used in the Berg assessment may be less sensitive than a continuous measurement system and may be unable to finely discriminate levels of postural impairment. Using a more sensitive test would allow the use of healthy, community dwelling subjects with little or no balance problems to still show some improvement with exercise.

If the Berg balance assessment is to be used in future studies, it may be advisable to establish a cut off score of 45 out of 56 as a pre-requisite for inclusion in the study.²⁹⁻³⁰ This score identifies those with a balance impairment who are at risk for falling, and it would allow room for improvement and thus proof of the effectiveness of the ankle exercises in improving balance. The subjects in this study showed little to no balance deficits, with the lowest pre-exercise score being 52 out of 56 and two subjects actually scoring a perfect 56 in both pre-exercise and post-exercise trials.

CHAPTER V

CONCLUSION

This study attempted to establish the effectiveness of a specific ankle exercise program as well as to clarify the overall role that the ankle plays in balance in the elderly population. As the subject sizes were quite small, this study was further designed to establish pilot research for future investigations on these topics. In order to achieve these goals, a control group of ten student subjects were used to determine the effectiveness of a simple home exercise program designed to improve dorsiflexor strength and plantarflexor flexibility. An experimental group of five subjects over the age of sixty were included to test the effects of this exercise program on balance as scored by the Berg balance assessment. Future studies should include larger subject groups, more consistency in flexibility measurements, a measurement tool that the researcher has adequate experience with, and an appropriate balance assessment tool.

Two trends presented themselves in this research: (1) Right side flexibility was shown to increase in the student population after four weeks of dorsiflexor strengthening and plantarflexor stretching exercises, and (2) Left side strength was significantly greater than right side strength in both pre-

exercise and post-exercise trials in the student subjects. The implications of these results as well as their ability to be expanded to the population at large will not be fully understood until research with larger subject sizes can be performed.

Mary Tinetti, a well-known author on falls and balance assessments, wrote "...if every abnormality increases the chance of falling or immobility, perhaps every successful intervention, no matter how small or seemingly insignificant, may result in an improvement in mobility and a lesser chance of falling."^{34(p125)} It was this concept that provided the basis for the present study. By isolating the ankle, it can be shown that even a simple home exercise program that will improve strength and flexibility at the ankle can improve balance in the elderly population and reduce the risk of falls. Falls remain the most common life-threatening hazard in seniors, and research concerning exercise programs that can help to reduce this hazard and decrease the number of persons hurt, disabled, and even killed by fall accidents each year continue to be warranted.¹

APPENDICES

**Appendix A
Subject Consent Form (student)**

**THE EFFECTS OF AN ANKLE FLEXIBILITY AND
STRENGTHENING PROGRAM ON BALANCE IN THE
ELDERLY**

Name of Investigator: Danielle R. Mongeon

_____ has been asked to take part in a research study on the effects of ankle flexibility and strengthening program on balance in the elderly. The purpose of this study is to determine if flexibility and strength at the ankle are important determinants in improving balance and thus preventing falls in the elderly.

This subject will have strength tested with a Microfet™ hand-held dynamometer and will have flexibility measured with a goniometer (a protractor-type device that measures the amount of movement at the joint). He/she will then be instructed on how to safely and correctly perform toe raises for strengthening and a heel cord stretch for ankle flexibility. She/he will be asked to perform these exercises three times per day for four weeks. He/she will, after four weeks, be reassessed for strength using the Microfet™, and flexibility through goniometry measurements. The results of these tests will be recorded in writing by the investigator and will be available to the subject and/or their family at any time.

Participation in this study is entirely voluntary, and the subject may withdraw consent and discontinue participation at any time without prejudice. There is no cost for any part of this study.

No discomfort or risks are expected. All forms of assessment have been proven safe, reliable and effective; and the exercises are safe and easy to perform. Information will be coded anonymously to provide confidentiality and the subject will not be personally identified in any published results of this study. The written results of testing will be kept by the investigator and will be reviewed only by the investigator and her faculty preceptor. The investigator may be reached at the University of North Dakota department of physical therapy at (701) 777-2831 or at home at (701)777-9544 to answer any questions concerning the study, the procedures, and/or any risks or benefits that may arise from participation in the study.

I agree to participate in this research project according to the conditions outline above. A copy of this consent form has been given to me.

Signed _____ Date _____

Subject

_____ Date _____

Investigator

_____ Date _____

Witness

Subject Consent Form (over age sixty)

THE EFFECTS OF AN ANKLE FLEXIBILITY AND STRENGTHENING PROGRAM ON BALANCE IN THE ELDERLY

Name of Investigator: Danielle R. Mongeon

_____ has been asked to take part in a research study on the effects of ankle flexibility and strengthening program on balance in the elderly. The purpose of this study is to determine if flexibility and strength at the ankle are important determinants in improving balance and thus preventing falls in the elderly.

This subject will be assessed for balance with the Berg balance assessment tool consisting of 14 different activities that will determine the subject's balance score. He/she will also have strength tested with a Microfet™ hand-held dynamometer and will have flexibility measured with a goniometer (a protractor-type device that measures the amount of movement at the joint). He/she will then be instructed on how to safely and correctly perform toe raises for strengthening and a heel cord stretch for ankle flexibility. She/he will be asked to perform these exercises three times per day for four weeks. He/she will, after four weeks, be reassessed for balance with the Berg scale, strength using the Microfet™, and flexibility through goniometry measurements. The results of these tests will be recorded in writing by the investigator and will be available to the subject and/or their family at any time.

Participation in this study is entirely voluntary, and the subject may withdraw consent and discontinue participation at any time without prejudice. There is no cost for any part of this study.

No discomfort or risks are expected. All forms of assessment have been proven safe, reliable and effective; and the exercises are safe and easy to perform. Information will be coded anonymously to provide confidentiality and the subject will not be personally identified in any published results of this study. The written results of testing will be kept by the investigator and will be reviewed only by the investigator and her faculty preceptor. The investigator may be reached at the University of North Dakota department of physical therapy at (701) 777-2831 or at home at (701)777-9544 to answer any questions concerning the study, the procedures, and/or any risks or benefits that may arise from participation in the study.

I agree to participate in this research project according to the conditions outline above. A copy of this consent form has been given to me.

Signed _____ Date _____

Subject

_____ Date _____

Investigator

_____ Date _____

Witness

Appendix B

Berg Balance Assessment

1. SITTING TO STANDING

INSTRUCTIONS: Please stand up. Try not to use your hands for support.

- 4 able to stand without using hands and stabilize independently
- 3 able to stand independently using hands
- 2 able to stand using hands after several tries
- 1 needs minimal aid to stand or to stabilize
- 0 needs moderate or maximal assist to stand

2. STANDING UNSUPPORTED

INSTRUCTIONS: Please stand for two minutes without holding.

- 4 able to stand safely 2 minutes
- 3 able to stand 2 minutes with supervision
- 2 able to stand 30 seconds unsupported
- 1 needs several tries to stand 30 seconds unsupported
- 0 unable to stand 30 seconds unassisted

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

3. SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL

INSTRUCTIONS: Please sit with arms folded for 2 minutes.

- 4 able to sit safely and securely 2 minutes
- 3 able to sit 2 minutes under supervision
- 2 able to sit 30 seconds
- 1 able to sit 10 seconds
- 0 unable to sit without support 10 seconds

4. STANDING TO SITTING

INSTRUCTIONS: Please sit down.

- 4 sits safely with minimal use of hands
- 3 controls descent by using hands
- 2 uses back of legs against chair to control descent
- 1 sits independently but has uncontrolled descent
- 0 needs assistance to sit

5. TRANSFERS

INSTRUCTIONS: Arrange chairs(s) for a pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.

- 4 able to transfer safely with minor use of hands
- 3 able to transfer safely definite need of hands
- 2 able to transfer with verbal cuing and/or supervision
- 1 needs one person to assist
- 0 needs two people to assist or supervise to be safe

6. STANDING UNSUPPORTED WITH EYES CLOSED

INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.

- 4 able to stand 10 seconds safely
- 3 able to stand 10 seconds with supervision
- 2 able to stand 3 seconds
- 1 unable to keep eyes closed 3 seconds but stays safely
- 0 needs help to keep from falling

7. STANDING UNSUPPORTED WITH FEET TOGETHER

INSTRUCTIONS: Place your feet together and stand without holding.

- 4 able to place feet together independently and stand 1 minute safely
- 3 able to place feet together independently and stand for 1 minute with supervision
- 2 able to place feet together independently but unable to hold for 30 seconds
- 1 needs help to attain position but able to stand 15 seconds feet together
- 0 needs help to attain position and unable to hold for 15 seconds

8. REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING
 INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the finger reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)
- () 4 can reach forward confidently 25 cm (10 inches)
 - () 3 can reach forward 12 cm safely (5 inches)
 - () 2 can reach forward 5 cm safely (2 inches)
 - () 1 reaches forward but needs supervision
 - () 0 loses balance while trying/requires external support
9. PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION
 INSTRUCTIONS: Pick up the shoe/slipper which is placed in front of your feet.
- () 4 able to pick up slipper safely and easily
 - () 3 able to pick up slipper but needs supervision
 - () 2 unable to pick up but reaches 2-5 cm (1-2 inches) from slipper and keeps balance independently
 - () 1 unable to pick up and needs supervision while trying
 - () 0 unable to try/needs assist to keep from losing balance or falling
10. TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING
 INSTRUCTIONS: Turn to look directly behind you over toward left shoulder. Repeat to the right. Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.
- () 4 looks behind from both sides and weight shifts well
 - () 3 looks behind one side only other side shows less weight shift
 - () 2 turns sideways only but maintains balance
 - () 1 needs supervision when turning
 - () 0 needs assist to keep from losing balance or falling
11. TURN 360 DEGREES
 INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.
- () 4 able to turn 360 degrees safely in 4 seconds or less
 - () 3 able to turn 360 degrees safely one side only 4 seconds or less
 - () 2 able to turn 360 degrees safely but slowly
 - () 1 needs close supervision or verbal cuing
 - () 0 needs assistance while turning
12. PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED
 INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.
- () 4 able to stand independently and safely and complete 8 steps in 20 seconds
 - () 3 able to stand independently and complete 8 steps > 20 seconds
 - () 2 able to complete 4 steps without aid with supervision
 - () 1 able to complete > 2 steps needs minimal assist
 - () 0 needs assistance to keep from falling/unable to try
13. STANDING UNSUPPORTED ONE FOOT IN FRONT
 INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width)
- () 4 able to place foot tandem independently and hold 30 seconds
 - () 3 able to place foot ahead of other independently and hold 30 seconds
 - () 2 able to take small step independently and hold 30 seconds
 - () 1 needs help to step but can hold 15 seconds
 - () 0 loses balance while stepping or standing
14. STANDING ON ONE LEG
 INSTRUCTIONS: Stand on one leg as long as you can without holding.
- () 4 able to lift leg independently and hold > 10 seconds
 - () 3 able to lift leg independently and hold 5-10 seconds
 - () 2 able to lift leg independently and hold = or > 3 seconds
 - () 1 tries to lift leg unable to hold 3 seconds but r remains standing independently
 - () 0 unable to try or needs assist to prevent fall
- () TOTAL SCORE (Maximum = 56)

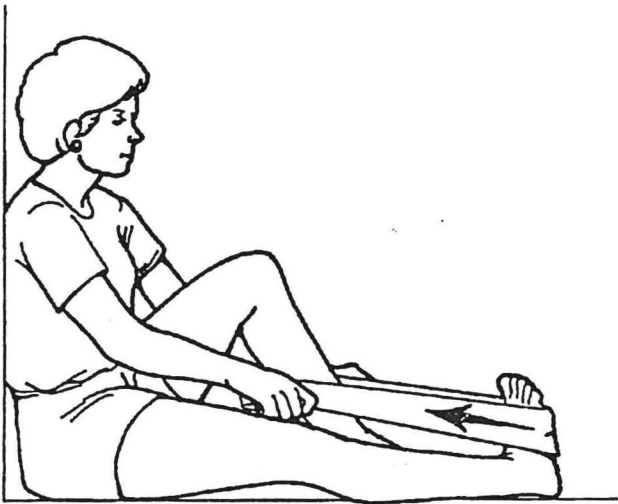
Appendix C

Dorsiflexor Strengthening and Plantarflexor Stretching Exercises

1. Bend ankle up toward your body as far as possible
2. Hold 3 seconds
3. 15 repetitions, 3 times per day



1. Sit on floor with towel or strap around RIGHT foot as shown
2. Pull top of foot toward your body so that you feel a stretch
3. Hold 30 seconds
4. Repeat with LEFT foot
5. Perform stretch 3 times per day
6. Stretch may also be performed sitting in a chair with foot up on another chair



Appendix D

UNIVERSITY OF NORTH DAKOTA'S
INSTITUTIONAL REVIEW BOARDDATE: June 14, 1996 PROJECT NUMBER IRB-9606-246NAME: Danielle Renee Mongeon DEPARTMENT/COLLEGE Physical TherapyPROJECT TITLE: The Effects of an Ankle Flexibility and Dorsiflexor Strengthening
Program on Balance in the ElderlyThe above referenced project was reviewed by a designated member for the University's Institutional Review Board on June 18, 1996 and the following action was taken:

- Project approved. **EXPEDITED REVIEW NO.** 3.
Next scheduled review is on June 1997.
- Project approved. **EXEMPT CATEGORY NO.** _____. No periodic review scheduled unless so stated in REMARKS SECTION.
- Project approved **PENDING** receipt of corrections/additions in ORPD and approval by the IRB.
This study may NOT be started UNTIL IRB approval has been received. (See REMARKS SECTION for further information.)
- Project approval **deferred**. **This study may not be started until IRB approval has been received.** (See REMARKS SECTION for further information.)
- Project **denied**. (See REMARKS SECTION for further information.)

REMARKS: Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRB Chairman or ORPD.cc: M. Green, Adviser
Dean, Medical School

Jim Cooley MD 6/18/96
Signature of ~~Chairperson~~ or designated IRB Member Date
UND's Institutional Review Board

If the proposed project (clinical medical) is to be part of a research activity funded by a Federal Agency, a special assurance statement or a completed 596 Form may be required. Contact ORPD to obtain the required documents.

(7/93)

Appendix E

EXPEDITED REVIEW REQUESTED UNDER ITEM 3 (NUMBER(S)) OF HHS REGULATIONS
 EXEMPT REVIEW REQUESTED UNDER ITEM _____ (NUMBER(S)) OF HHS REGULATIONS

UNIVERSITY OF NORTH DAKOTA
HUMAN SUBJECTS REVIEW FORM
FOR NEW PROJECTS OR PROCEDURAL REVISIONS TO APPROVED
PROJECTS INVOLVING HUMAN SUBJECTS

PRINCIPAL

INVESTIGATOR: Danielle Renee Mongeon TELEPHONE: (701) 772-0891 DATE: 4-15-96

ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT: 2205 S. 17th St. #206 Grand Forks, ND 58201

SCHOOL/COLLEGE: UND DEPARTMENT: P.T. PROPOSED PROJECT DATES: 5/15/96 - 12/1/96

PROJECT TITLE: The Effects of an Ankle Flexibility and Dorsiflexor Strengthening Program on Balance in the Elderly

FUNDING AGENCIES (IF APPLICABLE): N/A

TYPE OF PROJECT:

___ NEW PROJECT ___ CONTINUATION ___ RENEWAL ___ DISSERTATION OR THESIS RESEARCH STUDENT RESEARCH PROJECT
___ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER: Meridee Green

PROPOSED PROJECT: ___ INVOLVES NEW DRUGS (IND) ___ INVOLVES A COOPERATING INSTITUTION
___ INVOLVES NON-APPROVED USE OF DRUG

IF ANY OF YOUR SUBJECTS FALL IN ANY OF THE FOLLOWING CLASSIFICATIONS, PLEASE INDICATE THE CLASSIFICATION(S):

___ MINORS (<18 YEARS) ___ PREGNANT WOMEN ___ MENTALLY DISABLED ___ FETUSES ___ MENTALLY RETARDED
___ PRISONERS ___ ABORTUSES ___ UND STUDENTS (>18 YEARS)

IF YOUR PROJECT INVOLVES ANY HUMAN TISSUE, BODY FLUIDS, PATHOLOGICAL SPECIMENS, DONATED ORGANS, FETAL MATERIAL, OR PLACENTAL MATERIALS, CHECK HERE ___

1. ABSTRACT: (LIMIT TO 200 WORDS OR LESS AND INCLUDE JUSTIFICATION OR NECESSITY FOR USING HUMAN SUBJECTS.)

Today, falls have become the most common life-threatening hazard in seniors. Falls have been associated with a number of disabilities including muscular weakness, decreased flexibility, vestibular deficiencies, environmental factors, and poor balance. One study has shown a specific relationship between ankle dorsiflexor power and increased risk of falling. Another has shown that ankle flexibility was significantly decreased in those patients that the researchers classified as fallers when compared to a control group of non-fallers. Several other studies have shown an association between decreased strength, decreased balance, and increased incidence of falls. It has been proposed that exercise may work to improve balance and thus, decrease falling in the elderly population. It is the purpose of this research project to test the effects of an ankle flexibility and strengthening program on balance in the elderly. It is hypothesized that, because the ankle has been shown to play an important role in balance, those subjects who undergo an exercise program for the ankle will have an increased balance score at the end of a six week period when compared to a control group of non-exercisers. The need for human subjects in this study is centered around the transferability of the results to a geriatric population in the clinic and the need for subjects to be able to understand and follow through with instructions during the balance testing and the exercise program.

PLEASE NOTE: Only information pertinent to your request to utilize human subjects in your project or activity should be included on this form. Where appropriate attach sections from your proposal (if seeking outside funding).

2. PROTOCOL: (Describe procedures to which humans will be subjected. Use additional pages if necessary.)

This study will utilize healthy, community-dwelling subjects between the ages of 65 and 80. They will be divided into two groups: a group of exercisers and a group of non exercisers. All subjects will be tested for balance according to the Berg balance assessment tool, which has been found to be both reliable and valid for the elderly population. This tool consists of fourteen different activities that the subjects will be asked to perform in order for a total balance score to be assigned. These activities are: sitting to standing, standing unsupported, sitting with the back unsupported but feet supported on the floor or on a stool, standing to sitting, transfers (chair to chair), standing unsupported with eyes closed, standing unsupported with feet together, reaching forward with outstretched arm while standing, picking up an object from the floor from a standing position, turning to look behind over left and right shoulders while standing, turning 360 degrees, placing alternate foot on a step or stool while standing unsupported, standing unsupported with one foot in front, and standing on one leg. After the balance scores have been determined, the exercise group will be instructed on an exercise program consisting of dorsiflexor strengthening and achilles tendon stretching. The dorsiflexors are those muscles located on the front of the lower leg that are responsible for bending the ankle up, bringing the toes towards the knees. These muscles will be exercised by having the subject stand near a stable surface, like a table or countertop that will provide support, and bring their toes up off the floor. Each raise will be held for 6 seconds and repeated in sets of 15 on each foot three times per day. The achilles tendon will be stretched by having the subject sit with his or her legs outstretched in front. This can be done on the floor or sitting on a chair with the legs supported on another chair. A towel or strap will be placed around the foot and the ankle will be bent so that the toes are coming up towards the knees. This position will be held for 30 seconds, and the stretch will be repeated three times per day. These two exercises are diagramed in an attachment at the end of this form. These exercises will be done each day for a period of three weeks as a home exercise program. At the end of the six weeks, both the exercising and non-exercising group will have their balance re-assessed and a post-experimental Berg balance score will be recorded.

3. BENEFITS: (Describe the benefits to the individual or society.)

Studies have shown that exercise and correction of even a few of the risk factors associated with falling can decrease a person's risk. By trying to improve motion at the ankle, the subjects should benefit through improved balance and decreased risk of falling. Society will benefit through the information that will be provided concerning the importance of the ankle in balance. This may affect the nature of future exercise programs that are concerned with balance improvement, and if the hypothesis is confirmed, this study will provide a safe and relatively simple exercise program that can easily be done at home. At the end of the six week test period, the non-exercisers will be offered the opportunity to learn the exercise program so that they may also enjoy any benefits that the program might prove to provide.

4. RISKS: (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject's dignity and self-respect, as well as psycho-logical, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to insure the confidentiality of data obtained, including plans for final disposition or destruction, debriefing procedures, etc.)

No risks are anticipated. The exercises to be shown are relatively safe and simple. Although the subjects will be in a standing position during the toe raises and this is not a position of maximum stability, they will be shown how to use a stable support during these exercises and therefore should not be in danger of physically injuring themselves. The personal data collected will be kept confidential and will be reviewed only by the researcher and her student advisor. All records will be kept in a locked room in the department of physical therapy at the University of North Dakota. Records will be kept for a period of 2 years post-study for the purpose of review for accuracy and litigation purposes. None of the subjects will be personally identified in any part of the final paper.

- 5. **CONSENT FORM:** A copy of the **CONSENT FORM** to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no **CONSENT FORM** is to be used, document the procedures to be used to assure that infringement upon the subject's rights will not occur.

Describe where signed consent forms will be kept and for what period of time.
The signed consent forms will be kept with the rest of the subject's records in a locked room in the department of physical therapy for a period of two years.

- 6. For **FULL IRB REVIEW** forward a signed original and thirteen (13) copies of this completed form, and where applicable, thirteen (13) copies of the proposed consent form, questionnaires, etc. and any supporting documentation to:

Office of Research & Program Development
 University of North Dakota
 Box 8138, University Station
 Grand Forks, North Dakota 58202

On campus, mail to: Office of Research & Program Development, Box 134, or drop it off at Room 101 Twamley Hall.

For **EXEMPT** or **EXPEDITED REVIEW** forward a signed original and a copy of the consent form, questionnaires, etc. and any supporting documentation to one of the addresses above.

.....
 The policies and procedures on Use of Human Subjects of the University of North Dakota apply to all activities involving use of Human Subjects performed by personnel conducting such activities under the auspices of the University. No activities are to be initiated without prior review and approval as prescribed by the University's policies and procedures governing the use of human subjects.

SIGNATURES:


 Principal Investigator

DATE: 5-22-96

 Project Director or Student Adviser

DATE: _____

 Training or Center Grant Director

DATE: _____

REFERENCES

1. Perkins-Carpenter B. *How to Prevent Falls*. New York, NY: St. Martin's Press, 1991:1-2.
2. Robbins AS, Rubenstein LZ, Josephson KR, et al. Predictors of falls among elderly people: results of two population-based studies. *Arch Intern Med*. 1989;149:1628-1633.
3. Campbell AJ, Borrie MJ, Spears GF. Risk factors for falls in a community-based prospective study of people 70 years and older. *J Gerontol*. 1989;44:M112-M117.
4. Prudham D, Evans JG. Factors associated with falls in the elderly: a community study. *Age Ageing*. 1981;10:141-6. In: Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. *New Engl J Med*. 1988;319:1701-1707.
5. Campbell AJ, Reinken J, Allan BC, Martinez GS. Falls in old age: a study of frequency and related clinical factors. *Age Ageing*. 1981;10:264-70. In: Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. *New Engl J Med*. 1988;319:1701-1707.
6. Nickens H. Intrinsic factors in falling among the elderly. *Arch Intern Med*. 1985;145:1089-1093.
7. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. *New Engl J Med*. 1988;319:1701-1707.
8. Waller JA. Falls among the elderly: human and environmental factors. *Accid Anal Prevent*. 1978;10:21-23. In: Nicken H. Intrinsic factors in falling among the elderly. *Arch Intern Med*. 1985;145:1089-1093.
9. Nevitt MC, Cummings SR, Hudes ES. Risk factors for injurious falls: a prospective study. *J Gerontol*. 1991;46(5):M164-M170.
10. Lord SR, Clark RD, Webster IW. Physiological factors associated with falls in an elderly population. *J Am Geriatr Soc*. 1991;39:1194-1200.

11. Whipple R, Wolfson L. Abnormalities of balance, gait, and sensorimotor function in the elderly population. In: Duncan P, ed. *Balance: Proceedings of the APTA Forum (1989)*. American Physical Therapy Association, 1990:61-68.
12. Wollacott M. Postural control mechanisms in the young and old. In: Duncan P, ed. *Balance: proceedings of the APTA Forum (1989)*. American Physical Therapy Association, 1990:23-28.
13. Lord SR, Caplan GA, Ward JA. Balance, reaction time, and muscle strength in exercising and nonexercising older women: a pilot study. *Arch Phys Med Rehabil*. 1993;74:837-839.
14. Lord SR, Castell S. Physical activity program for older persons: effect on balance, strength, neuromuscular control, and reaction time. *Arch Phys Med Rehabil*. 1994;75:648-652.
15. Shephard RJ. Management of exercise in the elderly. *Can J Appl Sport Sci* 1984;9:109-20. In: Gehlsen GM, Whaley MH. Falls in the elderly: part II, balance strength, and flexibility. *Arch Phys Med Rehabil*. 1990;71:739-741.
16. Gehlsen GM, Whaley MH. Falls in the elderly: part II, balance strength, and flexibility. *Arch Phys Med Rehabil*. 1990;71:739-741.
17. Larsson L, Grimby G, Karlsson J. Muscle strength and speed of movement in relation to age and muscle morphology. *J Appl Physiol*. 1979;46:451-6.
18. Danneskiold-Samsøe B, Kofod V, Munter J, et al. Muscle strength and functional capacity in 78-81-year-old men and women. *Eur J Appl Physiol*. 1984;52:310-4.
19. Whipple R, Wolfson LI, Amerman PM. The relationship of knee and ankle weakness to falls in nursing home residents: an isokinetic study. *J Am Geriatr Soc*. 1987;35:13-20.
20. Wolfson L, Whipple R, Judge J, et al. Training balance and strength in the elderly to improve function. *J Am Geriatr Soc*. 1993;41:341-343.
21. Lord S, Castell S. Effect of exercise on balance, strength and reaction time in older people. *Australian Physiotherapy*. 1994;40:83-88.

22. Judge JO, Lindsey C, Underwood M, Winsemius D. Balance improvements in older women: effects of exercise training. *Phys Ther.* 1993;73:254-262.
23. Sauvage LR, Myklebust BM, Crow-Pan J, et al. A clinical trial of strengthening and aerobic exercise to improve gait and balance in elderly male nursing home residents. *Am J Phys Med Rehabil.* 1992;72:333-341.
24. Topp R, Mikesky A, Wigglesworth J, Holt W, Edwards J. The effect of a 12-week dynamic resistance strength training program on gait velocity and balance of older adults. *Gerontologist.* 1993;33:501-506.
25. Berg K, Wood-Dauphinee S, Williams JI, Gayton D. Measuring balance in the elderly: preliminary development of an instrument. *Physiotherapy Can.* 1989;41:304-310.
26. Mohr T. PT 412: Muscle function course notes. University of North Dakota department of physical therapy. Spring 1995.
27. Williams Andrews A, Thomas MW, Bohannon RW. Normative values for isometric muscle force measurements obtained with hand-held dynamometers. *Phys Ther.* 1996;76(3):248-259.
28. Hoppenfeld S. *Physical Examination of the Spine & Extremities.* East Norwalk, CT: Appleton-Century-Crofts;1976:223.
29. Bogle Thorbahn LD, Newton RA. Use of the berg balance test to predict falls in elderly persons. *Phys Ther.* 1996;76(6):576-583.
30. Berg KO, Wood-Dauphinee SL, Williams JT, Maki B. Measuring balance in the elderly: validation of an instrument. *Can J Public Health.* 1992;83:S7-S11.
31. Mohr T. PT 413: Therapeutic exercise I course notes. University of North Dakota department of physical therapy. Summer 1995.
32. Bandy WD, Irion JM. The effect of time on static stretch on the flexibility of the hamstring muscles. *Phys Ther.* 1994;74(9): 845-850.
33. Duncan PW, Weiner DK, Chandler J, Studenski S. Functional reach: a new clinical measure of balance. *J Gerontol.* 1990;45(6):M192-197.

34. Tinetti ME. Performance-oriented assessment of mobility problems in elderly patients. *JAGS*. 1986;34(2):119-127.