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The Effect of T’ai Chi Chih on Balance in the Elderly

Justin Berry
University of North Dakota

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THE EFFECT OF T'AI CHI CHIH
ON BALANCE IN THE ELDERLY

by

Justin Wayne Berry
Bachelor of Science in Physical Therapy
University of North Dakota, 2000

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

Grand Forks, North Dakota
May
2000
This Independent Study, submitted by Justin W. Berry 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 Effect of T'ai Chi Chih on Balance in the Elderly

Department Physical Therapy

Degree Master of Physical Therapy

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Date 12/30/94
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I would also like to thank Heather Helgeson for donating her time and knowledge by instructing the T'ai Chi Chih classes.

Finally, I would like to thank my parents, Wayne and Sharon Berry, for their love and support; and my wife, Whitney Berry, for her love, patience and understanding over the past three years.
ABSTRACT

Loss of balance and falls among the elderly is a large health care problem, annually causing thousands of injuries and millions of dollars in health care costs. This study investigates whether T’ai Chi Chih can influence balance in the elderly. T’ai Chi Chih is a gentle form of exercise that originated as a martial art.

Fifteen subjects (T’ai Chi Chih, n = 9; control, n = 6) initially underwent two standard functional balance measures (Berg and Tinetti measures), were tested for eyes open single leg stance, and had their blood pressure taken. Subjects were randomly assigned to either a T’ai Chi Chih group or to a control group. The T’ai Chi Chih group participated in a weekly one hour T’ai Chi Chih class taught by a certified instructor for ten weeks. This group was also asked to practice T’ai Chi Chih independently for a minimum of 15 minutes a day. The control group continued with their regular activities during the ten week period.

Both groups repeated the initial balance tests and again had their blood pressure recorded. Statistical analysis showed a significant decrease in systolic blood pressure and a significant increase in time for right leg eyes open single leg stance for the T’ai Chi Chih group over the control group. These findings provide a foundation for an alternative exercise option for the elderly and may help with further research investigating the effects of T’ai Chi Chih on the elderly.
Chapter I
Literature Review

"The Prevention of falls in later life has not received adequate attention from health care professionals".1

Falls among the elderly is a major problem, annually involving approximately one of every three senior citizens. Each year, 28 to 35% of community dwelling adults over the age of 65 fall.2,3 This percentage increases to 40% for those over the age of 80.3

Injuries are frequently the result of falls, with fall related fractures usually coming to mind. The percent of falls that result in fractures has been found to be five to six percent.1,4 A study by Tinetti and Speechley4 found that 20-25% of fall related fractures occur at the hip. A study by Baker5 found that in falls among those over 65, less than one percent resulted in hip fractures.

The percent of fractures that occur with falls may be low, but the absolute numbers are high. Annually, 200,000 Americans sustain a fall related hip fracture.6 A study by Perlin7 found that three out of four nursing home residents who fractured a hip died within eight months. "Hip fractures also are a leading cause of disability among the elderly; roughly half of the survivors never recover normal functioning".1

Physical injuries other than fractures may also result from falls. Soft tissue injuries result from 10% of falls1. King8 has found that 30-55% of falls among
community dwelling elderly people result in minor injuries, such as bruises and abrasions. Death may also be the result of a fall among the elderly. Falls make up the majority of unintentional injuries, which are the sixth leading cause of death in those over 65. King has also found that 2.2% of elderly falls are fatal.

Even though a fall may not result in a fracture or major physical injury, the impact can still be significant for the individual and society. In France and the United Kingdom, falls that do not result in fractures are among the most common reasons for elderly admissions to nursing homes, geriatric hospitals, and rehabilitation hospitals. Falls are also a contributing factor in 40% of nursing home admissions.

The aftermath and injuries from falling is not only physical, but psychological as well. Fear of falling effects 25 to 50% of community dwelling elderly adults. "Fear of falling can lead to a debilitating spiral marked by loss of confidence and reduced activity, resulting ultimately in loss of independence." Also, 40% of those with a fear of falling have said the fear has led them to restrict their basic daily activities.

"Fear of falling is a major component of the "post-fall syndrome", but this fear can also develop in individuals who have not experienced any falling episodes." Between 40 and 73% of older persons who have experienced a recent fall, and 20 to 46% of those who have not, acknowledge fear of falling. Fall survivors also have a functional decline in activities of daily living, physical activities, and social activities.

Fall related costs are expensive to society. Acute care costs associated with fall related fractures are estimated at $10 billion a year. There is a mean charge of $11,800 per hospitalization for fall-related injuries among adults 65 years old or older. "Approximately 30 to 40% of older persons treated in an emergency room for a fall injury are subsequently hospitalized, with an average length of stay of 8 to 15 days".

Why exactly do elderly people fall and sustain fall related injuries? Many physiological changes occur during the aging process. With age, one has decreased muscle mass and strength. Stalbert et al discovered that there is a 20 to 40% decrease
in strength in people from their 20's to their 70's. This decrease in strength may limit functional capacity and contribute to increased falls in the elderly. In a study comparing muscle strength in elderly fallers to nonfallers, it was found that there was a significant decrease in strength in the muscle groups of the ankles and knees in the elderly falling group. Proprioception is also decreased in the elderly, as is vision, mental alertness, reaction time, and flexibility. Decreased postural balance and control also takes place with aging.

The elderly frequently have physical disabilities that may also increase their chance for falls. "Dementia, visual impairments, neurological and musculoskeletal disabilities, and postural hypotension" have been shown to be fall risk factors. All of these physiological changes work in combination to increase the risk of falls.

Tinetti has shown a linear relationship between number of fall risk factors, and risk of falling. Over a one year period, 8% of those with no risk factors fell, while 78% of those with four or more risk factors experienced at least one fall.

Medications, which the elderly are commonly prescribed, may also increase the risk for falls. Hypnotic and antidepressant drugs may increase the risk, as may antihypertensives, sedatives, vasodilators, anticholinergics, and antiarrhythmics. In a study of 74 nursing home residents who had fallen, it was found that 81% had been taking medication that affected the central nervous system. Cardiovascular drugs made up 51% of the total, with diuretics making up the other 30%.

A study by Sheldon found "drop attacks" responsible for one-quarter of all falls. In a drop attack, the individual suddenly falls without warning, has no loss of consciousness, and the legs feel as if they are dead and weak. Sheldon postulated they may be caused by "acute vertobasilar artery occlusion producing brain stem ischaemia." Although in a study by Blake, only 9.5% of fallers reported the reason for their fall was their legs giving way.
Environmentally, among community dwelling elderly people, 77% of falls occur at home. Tripping over an object is the cause of 50.2%; dizziness, 6.4%; blackout, 3.9%; and "don't know", 21.8%. As the numbers show, more needs to be done to prevent falls, but the best way to accomplish this is still unknown. "There is wide acceptance of the need for prevention, but little agreement on how this is to be achieved".

Dr. Elliot Perlin, in his article "Preventing Falls in the Elderly, a practical approach to a common problem", has some suggestions. His approach covers many fall risk factors: have the patient inspect their home for environmental risks, review their medication use, have an exam of their sight and hearing, and make sure the patient has safe footwear and appropriate assistive devices. Perlin also states, "test the patient for balance and/or mobility, those who fail must not ambulate unsupervised". Nowhere does he state any exercise or balance training, and it is here his approach falls short.

"Empirical evidence provides justification for use of therapeutic exercise to reduce falls in elderly patients by improving balance and mobility." Province et al states, "If falls occur at least in part because of physical deficits in balance, strength, reaction time, and flexibility, then it is plausible to believe that exercise targeted to improve these deficits might result in fewer fall and/or injury events."

However, the best type of exercise for reducing falls is still in question. "Although support for the role of therapeutic exercise is mounting, the most effective type and intensity of exercise is unclear." One possible intervention that is gaining popularity in western countries is T'ai Chi. T'ai Chi is a traditional soft form of martial arts, that originated in China hundreds of years ago.

"T'ai Chi Chaun has been performed by Chinese of all ages for centuries and the People's Republic of China officially recognizes T'ai Chi Chaun as a national cultural activity; however, it has only recently become a target of modern scientific investigation." To understand T'ai Chi, one must look to Chinese medicine. In Chinese
medicine "all elements in the universe are contained in primordial, potential energy, known as Tao. Tao is believed to be a universal, unifying principle from which emerged bipolar energy forces, called Yin and Yang."25

"The ancient teaching is that the yin (feminine) and yang (masculine) elements separate when in motion, and come together again in quiescence. So, when we begin the motions of T'ai Chi Chih, we are dividing the two forces; then we balance them as we practice. Finally, when we are still again, they reunite."23 "Health is contingent upon the balance of Yin and Yang"25. "In accordance with the symbols of Yin and Yang, Tai Chi movements are circular. The movements are designed to balance the Chi, or vital energy, in the meridian of the body; moreover, they strengthen the Chi and thus prevent illness."26

"Although there are various Tai Chi schools, all emphasize three essential features: 1) the body is naturally extended and relaxed, giving priority to lissomeness; 2) the mind is tranquil but alert, with consciousness commanding the body (mind-body relationship); and 3) body movements are slow, smooth, and well-coordinated throughout the exercise period."27

"Tai Chi is an exercise and art, performed in a slow, relaxed and graceful manner. The mind is concentrated on relaxation or on the psych center, Tan Tien, which is a spot two inches below the naval."26 The circular, graceful movements of T'ai Chi Chuan have also been compared to "swimming in air".28 "The movements of T'ai Chi Chuan are gracefully fluent and consummately precise because specificity of joint angles and body position is of critical importance in accurately and correctly performing each form. All forms require replication of body and limb positions linked together by fluid sustained movements which are highly dependent on body balance, posture, precise respiration, and muscle contraction."24

Wolf et al25 identified seven therapeutic elements found in ten selected T'ai Chi Chuan forms:

1) Continuous, slow movement may be slightly increased once mastered.
(2) Small to larger degrees of motion are undertaken, depending on the ROM and strength characteristics of the individual.

(3) Progressive flexion of the knees is performed to varying degrees with 70% of body weight generally on one leg, then shifting to the other leg so that the majority of lower extremity muscle strengthening would be expected during loading onto that limb.

(4) Straight and extended head and trunk positioning is developed, a necessary prerequisite for promoting a less flexed posture. Consequently, rigorous attention is needed to prevent leaning of the trunk or protrusion of the sacrum.

(5) Trunk, head, and extremity rotation is emphasized in all but the first and last exercise forms. Movements are done in circles, especially in the upper extremities, and requires a strong rotational component. The eyes often follow the hand movements, thus promoting head and trunk rotation through eye movements.

(6) Symmetrical and diagonal arm and lower extremity movements are used as a major part of the selected forms, not only to promote arm swing in gait but also to increase trunk rotation around the waist.

(7) Constant shifting to and from the right and left legs emphasizing progressively more displacement of body mass

T'ai Chi is known as the highest form of martial art. As an act of self-defense it is effective only after many years of practice. It is claimed that with force of four taels (Chinese ounces) Tai Chi can deflect a force of 4000 pounds. However, its significance in the martial arts is not emphasized these days.

Justin Stone, a T'ai Chi Chaun master, has developed a new form of T'ai Chi, T'ai Chi Chih. Stone noted that T'ai Chi Chuan, with its 108 forms, can take years to learn. T'ai Chi Chih consists of only 20 movements and one ending pose. An advantage of tai chi chih is that its simpler form may be much more appealing to western cultures. In most programs it can be taught in eight to ten lessons taking approximately 30 minutes to perform the whole sequence.

Schaller has found that a T'ai Chi Chih intervention resulted in a significant improvement in the eyes open single leg stance test. The T'ai Chi Chih group improved their mean score by 50%. This improvement was shown despite wide variations in home practice compliance. This increase in one legged stance time test is significant, as it has been shown "that static balance as measured by a one-leg stance is a factor which
distinguishes elderly nonfallers from fallers.\textsuperscript{15} "Single stance balance training, such as Tai Chi, may be key to decreasing the incidence of falls, by intensifying ability and confidence without risk of losing balance."\textsuperscript{32} Another study using single leg stance was completed by Judge et al\textsuperscript{33} who found an improvement of 17\% in mean displacement of pressure for single leg stance by elderly Tai Chi Chaun practitioners.

In the 1990 Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT) trials by the National Institute of Aging, Tai Chi Quan was used as an intervention at the study site in Atlanta, Georgia. The study concluded Tai Chi did not improve measures of postural stability, but it did delay the onset of first or multiple falls by 47.5\%. Tai Chi was also shown to decrease the fear of falling in subjects. The Tai Chi group reported a greater decrease for fear-of-falling status post intervention than the computerized balance training group or control group.\textsuperscript{34}

There have been several other studies investigating T'ai Chi's effect on balance. Tse and Bailey\textsuperscript{35} have shown that T'ai Chi practitioners had improved balance compared to a control group. "It has been suggested that the practice of T'ai Chi Chuan may enhance the repertoire of motor programs stored in the brain and therefore may serve to train the various balancing systems to promote greater steadiness."\textsuperscript{24} "In theory, a relaxed mind improves control of physical movement. Balance therefore improves with Tai Chi when relaxation is combined with the training stimulus to the neuromuscular reflex pathway".\textsuperscript{36}

A study by Shih\textsuperscript{37} had participants take a Basic Beijing twenty four forms of T'ai Chi class, and practice the forms taught in the class. During the 16 week intervention, participants worked with an instructor three times a week for 50 minutes, and were asked to practice outside of class a minimum of 15 minutes daily. By using a strain gauge force platform, it was shown that the Tai Chi participants had a significant decrease in average velocity of sway in a dynamic condition.
Judge et al\textsuperscript{38} found T'ai Chi to be an effective exercise for elderly adults that improves normal gait velocity, balance, and shows a trend for improving maximal gait velocity. Jacobson et al\textsuperscript{24}, found "that positive changes in kinesthetic sense, balance, and knee extension strength may be achieved by the slow, guided, and precise movement demanded by the practice of T'ai Chi Chuan." Koh\textsuperscript{26} has shown that Tai Chi practitioners of one year have a faster reaction time than non Tai Chi practitioners. A faster reaction time would have a positive effect on balance.

T'ai Chi has also been shown to have a positive effect on strength. From a Chinese study in the People's Sports and Exercise Publication, it was reported that "grip strength in TC practitioners, aged 70 to 79, was 32.8\% greater than identical measures taken from a non-tai chi practice group ranging in age from 50 to 59 years."\textsuperscript{25} This study is significant, as a study of elderly fall predictors by Blake has shown. Blake\textsuperscript{2} found handgrip strength to be "the most important factor which best distinguished fallers from non-fallers." In a study by Lan et al\textsuperscript{39}, subjects practiced Tai Chi Chuan daily for one year. At the end of one year, T'ai Chi Chaun participants showed increased knee extensor and flexor strength of 15 to 20\%. This study also found T'ai Chi Chaun training increased trunk flexibility.

T'ai Chi is also a beneficial and safe exercise for the elderly cardiovascular system. It has been questioned whether T'ai Chi exercises are of "adequate vigorousness to produce appreciable physical training effects",\textsuperscript{24} "Tai Chi Chaun may have substantial therapeutic application in conditions with increased tension or diminished range of motion activities. However, the metabolic intensity of the activity seems insufficient to generate improvements of cardiorespiratory fitness in healthy young adults."\textsuperscript{40} "Tai Chi has been shown to have positive effects in delaying cardiorespiratory function decline in older persons."\textsuperscript{32}

A study by Zhou et al\textsuperscript{40} has determined the energy equivalents of T'ai Chi Quan. Long-form T'ai Chi Quan has been found to have the energy equivalent of 4.1 METS,
while that of simplified T'ai Chi Chaun is 2.9 METS. The long form does not exceed 50% of the individual's VO$_2$ MAX, and the short form does not exceed 40% of the individual's VO$_2$ MAX. "In older subjects aged (46-80 years), the simplified form of T'ai Chi Chuan induced a heart rate averaging 104 beats per minute."$^{40}$

The energy expenditures of T'ai Chi Chaun are found to be equal to walking 3.5 miles/hour for the long form, and 3.0 miles/hour for the simplified form.$^{41}$ In a study by Jin$^{29}$, changes in heart rate and blood pressure during T'ai Chi were comparable to that of brisk walking, but greater than that of a meditation group or a reading group.

T'ai Chi is also a safe and beneficial exercise option for elderly adults with arthritic conditions. "For osteoarthritis and rheumatoid arthritis patients, Tai Chi has been shown to have significant effects in lessening pain and tenderness and improving upper and lower body joint flexibility."$^{32}$ "It is an exercise with low impact and low velocity, and the orthopedic complication is minimal".$^{39}$

Kirsteins and Dietz$^{42}$ found that T'ai Chi participants who practiced once or twice a week showed no joint deterioration compared to a control group. Study participants also showed improvements in joint tenderness, joint swelling, hand grip strength, and their time to walk 50 feet. T'ai Chi may also improve performance for functional activities in the elderly. In a Chinese study, after one year of Tai Chi training, 83.2% of elderly participants could accomplish "house chores" that they were unable to perform prior to training.$^{25}$

T'ai Chi has also been shown to have several stress relieving and mental benefits. "In today's world of fast living and stress, the unique and ancient Chinese exercise may be a source of relaxation and peace of mind"$^{26}$ A study by Jin$^{43}$ found mood states became more positive during T'ai Chi, and remained more positive for up to an hour after T'ai Chi practice. The same study also found T'ai Chi decreased tension, depression, anger, and fatigue. In a study by Brown et al,$^{44}$ T'ai Chi was found to decrease tension, depression, anger, and confusion in women. A pilot study by Gibb et al$^{45}$ found T'ai Chi, when used
in combination with structured reminiscence, improved sociability and orientation among people with moderately advancing dementia. A study by Slater and Hunt\textsuperscript{46} found T'ai Chi Chaun training was associated with reduced nightmares compared to a control group.

T'ai Chi is also a cost effective treatment option. Wolf et al\textsuperscript{47} have stated, "TC (Tai Chi) is a low technological, inexpensive group activity." The practice of T'ai Chi for beginners requires only an instructor and a safe area to practice. T'ai Chi is a "low technology approach to conditioning that can be implemented at relatively low cost in widely distributed facilities throughout the community".\textsuperscript{48} "First, it does not require any special clothing or equipment, and therefore is less expensive. Second, once the movements are learned, it can be practiced individually at home or in a group setting. Finally, the simple, soft, and fluid movements are ideal for elders regardless of previous exercise experience."\textsuperscript{31}

Because of its gentle nature, T'ai Chi may also be used as a transitional exercise. "In certain instances of joint disease, maladies associated with post-trauma and weak elderly individuals, many types of exercise may not be appropriate or conducive to the condition, or may be too strenuous. T'ai Chi Chaun may bridge the gap for these individuals as a therapeutic form of exercise"\textsuperscript{24}

T'ai Chi has been shown to decrease several fall risk factors by increasing strength, balance, and reaction time. It has also been shown to be a safe and beneficial exercise option for patients with cardiovascular and arthritic limitations. Although more research into T'ai Chi is needed, it may turn out to be an effective, safe, and cost effective solution to the epidemic of falls among the elderly.

The purpose of this study is to investigate the effects of T'ai Chi Chih on balance for community dwelling elderly adults. This study will add to the growing body of research regarding T'ai Chi and balance.
Chapter II

Methods

Subjects

Volunteers were recruited through local senior citizen centers, independent living centers, the local YMCA, flyers, and by word of mouth. Inclusion criteria included: 1) over the age of 60, 2) live independently, 3) no need of an assistive device for ambulation, 4) no history of a major cardiac problem or event, 5) blood pressure within normal limits (controlled hypertension was allowed). All subjects read and signed a written consent form approved by the University of North Dakota Institutional Review Board (Appendix A).

Eighteen subjects participated in the study (14 females and 4 males). Three subjects, all female, dropped out during the course of the study, one due to a non-study related injury, and two due to disinterest. Two of the subjects who dropped out were assigned to the control group, and one was assigned to the T'ai Chi Chih group. The age range of subjects \(n = 15\) was 62 to 91 years, with a mean age of 76.0 years. Three subjects reported at least one fall in the past year.

Instrumentation

Data collection consisted of testing performance for the Berg balance measure, the Tinetti Balance measure, and for open eye single leg stance on both legs. Blood pressure testing was also performed for each subject.

Blood pressure was assessed with a manual sphygmomanometer according to American Heart Association guidelines for brachial artery blood pressure. The same arm was used for assessing blood pressure on each subject on subsequent testings. The
Berg and Tinetti balance measures were used to obtain objective balance scores for the subjects before and after intervention. The same commands were used for each subject for all balance testing. Both the Berg and Tinetti measures are provided in Appendix B.

The Berg balance measure consists of 14 balance tasks which are scored on a five point ordinal scale (0-4); with zero indicating the subject unable to perform the task, and four indicating the subject independent with the task. The 14 task scores were then summed to obtain a total score, with 56 being the maximum score possible. Berg et al. found that a subject with a score of 45 or lower has an increased risk of falling.

Equipment used for the Berg balance measure included: two chairs, one with and one without armrests, a stool, a meter stick, a watch with a second hand, and a shoe. The shoe was used for task number nine, where the subject is asked to pick up an object from the floor. The interrater reliability for the Berg balance measure is high, the intraclass coefficients ranges from .71 to .99. The total test intraclass coefficient is .98.

The Tinetti balance measure consists of two parts, a gait and balance component. The balance portion consists of nine separate tasks, and the gait portion consists of seven separate tasks. Scoring is on a three point ordinal scale (0-2); with zero representing dependence or an inability to perform the task, and two indicating independence with the task. Scores are then summed to obtain three measures: a gait score, a balance score, and a total score (gait score plus and balance score).

The maximum score possible is 28, a score below 19 indicates a high risk for falls, while a score in the range of 19-24 demonstrates a risk for falls. The Tinetti balance measure has good interrater reliability. Agreement has been found on over 85% of the items, and the items that did differ did so less than 10%.

Single leg stance with eyes open was also used to assess the balance of each subject before and after intervention. Each subject was measured (in seconds) for the amount of time they could maintain their balance on one foot with no external support. A chair was placed in front of each subject for safety in the event they lost their balance.
The test was stopped and a time recorded when the subject: 1) placed their unsupporting foot on the floor, 2) touched the chair in front of them or another object for support, 3) kept their balance for over 30 seconds, at which point they were given a score of 30+ seconds.

For single leg stance, internal consistency reliability coefficients are .85 to .95. Single leg stance has been found to be a good predictor of injurious falls. Vellas et al have found "one leg standing balance was a reasonably good single clinical marker to predict those who have greater risk of injurious falls and who are possibly more likely to benefit from an intervention trial."

**Intervention**

Subjects were randomly assigned to one of two groups, a T'ai Chi Chih group (n = 9) or to a control group (n = 6). The T'ai Chi Chih group participated in a ten week T'ai Chi Chih class. The class met once a week for one hour, resulting in ten hours of class. The class was taught by a certified T'ai Chi Chih instructor with experience teaching the elderly. The class was held in a well lit room with hardwood floors where T'ai Chi and yoga classes are regularly held. Subjects were either barefoot or wore socks and no shoes during the class. Soft background music was played during the class.

T'ai Chi Chih consists of 19 forms (movements) and one pose. The 19 forms and one pose were progressively taught during the ten week class period. Table 1 contains a list of the T'ai Chi Chih forms. During each class, approximately half of the class time was devoted to learning new forms, with the other half devoted to review. The T'ai Chi Chih group was also asked to practice the forms learned in class a minimum of 15 minutes a day. A T'ai Chi Chih instructional video was also available for the subjects to take home for practice.

The control group continued with their everyday activities during the ten week intervention. The control group was not asked to discontinue or add any activities during
the intervention. After the ten week intervention, both the T'ai Chi Chih and the control group repeated the balance tests and had their blood pressure recorded.

Several subjects in the control group expressed interest in participating in the T'ai Chi Chih class. Also, the University of North Dakota Institutional Review Board recommended a class be provided for members of the control group who were interested in T'ai Chi. After all testing was completed, members of the control group were given the opportunity to take a ten week T'ai Chi Chih class from the same instructor. Some members of the T'ai Chi Chih group also joined members of the control group for the after-intervention class.
### Table 1. T'ai Chi Chih Forms

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Rocking motion</td>
</tr>
<tr>
<td>2.</td>
<td>Bird flaps its wings</td>
</tr>
<tr>
<td>3.</td>
<td>Around the platter</td>
</tr>
<tr>
<td>4.</td>
<td>Around the platter variation</td>
</tr>
<tr>
<td>5.</td>
<td>Bass drum</td>
</tr>
<tr>
<td>6.</td>
<td>Daughter on the mountain top</td>
</tr>
<tr>
<td>7.</td>
<td>Daughter in the valley</td>
</tr>
<tr>
<td>8.</td>
<td>Carry the ball to the side</td>
</tr>
<tr>
<td>9.</td>
<td>Push pull</td>
</tr>
<tr>
<td>10.</td>
<td>Pulling in the energy</td>
</tr>
<tr>
<td>11.</td>
<td>Pulling taffy</td>
</tr>
<tr>
<td>12.</td>
<td>Pulling taffy - 1st variation - anchor step</td>
</tr>
<tr>
<td>13.</td>
<td>Pulling taffy - 2nd variation - wrist circles</td>
</tr>
<tr>
<td>14.</td>
<td>Pulling taffy - 3rd variation - perpetual motion</td>
</tr>
<tr>
<td>15.</td>
<td>Working the pulley</td>
</tr>
<tr>
<td>16.</td>
<td>Light at the top of the head/light at the temple</td>
</tr>
<tr>
<td>17.</td>
<td>Joyous breath</td>
</tr>
<tr>
<td>18.</td>
<td>Passing clouds</td>
</tr>
<tr>
<td>19.</td>
<td>Six healing sounds</td>
</tr>
<tr>
<td>20.</td>
<td>Cosmic consciousness pose</td>
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</table>
Chapter III
Results

Statistical Analysis

Statistical analysis was performed using Statistical Power for the Social Sciences (SPSS 8.0™). All analysis used a two-tailed design and a level of significance of p < .05. An independent measures t-test using the amount of change (post intervention score - pre intervention score) was used to analysis changes in systolic blood pressure and diastolic blood pressure.

A Wilcoxin signed ranks test using the amount of change (post intervention time - pre intervention time) was used for analysis of: right open eyes single leg stance, left open eyes single leg stance, the Berg balance measure, and the Tinetti balance measure. The Wilcoxin test was used after all balance scores were converted to ordinal data. For statistical purposes, all single leg stance scores of 30 seconds or more were recorded as 30 seconds.

Results

Means for pre and post intervention scores, and mean change (post intervention score - pre intervention score) were computed for the T'ai Chi Chih group (see Table 1) and the control group (see Table 2).

A significant decrease in systolic blood pressure (p = .009) was found for the T'ai Chi Chih group over the control group (see Table 3). The mean decrease was found be to be 7.67 mm HG. Statistical analysis also revealed a significant increase in right open eyes single leg stance for the T'ai Chi Chih group over the control group (see
were found for the T'ai Chi Chih group, the control group, or for differences between the two groups.

Table 1. T'ai Chi Chih Group Measurements

<table>
<thead>
<tr>
<th>Test</th>
<th>Pre Mean</th>
<th>Pre S.D</th>
<th>Post Mean</th>
<th>Post S.D.</th>
<th>Mean Change</th>
<th>Change S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic blood pressure</td>
<td>150.00</td>
<td>11.61</td>
<td>142.33</td>
<td>10.03</td>
<td>-7.67</td>
<td>9.50</td>
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<tr>
<td>Diastolic blood pressure</td>
<td>77.78</td>
<td>7.63</td>
<td>78.44</td>
<td>6.67</td>
<td>0.67</td>
<td>4.87</td>
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<tr>
<td>Berg balance measure</td>
<td>54.11</td>
<td>2.15</td>
<td>54.67</td>
<td>1.94</td>
<td>0.56</td>
<td>1.24</td>
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<tr>
<td>Tinetti balance measure</td>
<td>25.89</td>
<td>2.09</td>
<td>26.44</td>
<td>1.67</td>
<td>0.56</td>
<td>0.73</td>
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<tr>
<td>right open eyes single leg stance</td>
<td>12.33</td>
<td>10.99</td>
<td>17.00</td>
<td>11.63</td>
<td>4.67</td>
<td>6.50</td>
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<tr>
<td>left open eyes single leg stance</td>
<td>13.67</td>
<td>12.77</td>
<td>15.11</td>
<td>11.91</td>
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Table 2. Control Group Measurements

<table>
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<tr>
<th>Test</th>
<th>Pre Mean</th>
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<th>Post Mean</th>
<th>Post S.D.</th>
<th>Mean Change</th>
<th>Change S.D.</th>
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<tr>
<td>Systolic blood pressure</td>
<td>134.83</td>
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<td>140.17</td>
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<td>Berg balance measure</td>
<td>52.00</td>
<td>3.90</td>
<td>52.00</td>
<td>4.43</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Tinetti balance measure</td>
<td>25.00</td>
<td>2.61</td>
<td>25.17</td>
<td>2.64</td>
<td>0.17</td>
<td>0.41</td>
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<td>right open eyes single leg stance</td>
<td>11.50</td>
<td>14.37</td>
<td>11.67</td>
<td>14.24</td>
<td>0.17</td>
<td>0.41</td>
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<td>8.67</td>
<td>11.52</td>
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<td>10.05</td>
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Table 3. Blood Pressure Statistical Analysis

<table>
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<tr>
<th>Test</th>
<th>t</th>
<th>df</th>
<th>sig. (2 tailed)</th>
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<tbody>
<tr>
<td>Systolic blood pressure</td>
<td>3.052</td>
<td>13</td>
<td>.009</td>
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<tr>
<td>Diastolic blood pressure</td>
<td>1.348</td>
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<td>.201</td>
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Table 4. Balance Test Statistical Analysis

<table>
<thead>
<tr>
<th>Test</th>
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<th>Asymp. sig. (2 tailed)</th>
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<tbody>
<tr>
<td>Left open eyes single leg stance</td>
<td>-0.948</td>
<td>0.343</td>
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<tr>
<td>Right open eyes single leg stance</td>
<td>-2.201</td>
<td>0.028</td>
</tr>
<tr>
<td>Berg balance measure</td>
<td>-1.289</td>
<td>0.197</td>
</tr>
<tr>
<td>Tinetti balance measure</td>
<td>-1.890</td>
<td>0.059</td>
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</table>

Although a significant increase was found for right open eyes single leg stance in the T'ai Chi Chih group, this statistic is not very strong. Stopping the open eyes single leg stance test at 30 seconds resulted in a large number of ties, which tends to weaken the results of a Wilcoxin statistical analysis.

As stated in the methods, subjects in the T'ai Chi Chih group were to attend class weekly for ten weeks. They were also asked to practice the T'ai Chi Chih forms daily for at least 15 minutes. At the end of the ten week intervention, all subjects in the T'ai Chi Chih group were asked how many days a week outside of class they practiced, and how many classes they were absent. The mean number of practices per week outside of class
was 3.67 with a range of two to six. The mean number of classes absent during the ten week intervention was 1.00 with a range of zero to three.
Chapter IV

Discussion

The purpose of this study was to determine if T'ai Chi Chih has an effect on balance in the elderly. A significant increase was found for right open eyes single leg stance. Subjects in the T'ai Chi Chih group improved their right open eyes single leg stance time from a mean of 12.33 seconds to a mean of 17.00 seconds, for a total of 4.67 seconds. This is an increase of 37.8% from pre intervention to post intervention.

This is concurrent with the findings of Judge et al\textsuperscript{33} and of Schaller\textsuperscript{31}. Judge and associates found "a 17% improvement in mean displacement of pressure for single leg stance by elderly subjects presented T'ai Chi Chaun exercises". Schaller found that after a T'ai Chi Chih intervention, subjects improved their eyes open single leg stance mean score by 50%.

There was another interesting correlation with the study by Schaller. Schaller found an improvement in single leg stance "despite wide variations in home practice compliance".\textsuperscript{31} The T'ai Chi Chih participants in this study also had a wide variation in practice compliance. Subjects practiced an average of 3.67 days per week with a range of two to six days per week.

As stated in Chapter III, the findings for single leg stance are not conclusive, as there were limitations with the statistical analysis and how single leg stance was scored and recorded. Beyond the statistical analysis, it is interesting to note the number of subjects from each group that improved their time for right and left leg eyes open single leg stance. As Graph 1 shows, out of seven subjects that improved their time for right leg open eyes single leg stance, six were in the T'ai Chi Chih group. Also, out of the six
subjects that improved their time for left leg open eyes single leg stance, four were in the T'ai Chi Chih group.

The functional application of single leg stance has been demonstrated. "Single stance balance training, such at Tai Chi, may be key to decreasing the incidence of falls, by intensifying ability and confidence without risk of losing balance." Gehlson has shown that single leg stance is an important factor distinguishing elderly fallers from non-fallers Several functional activities involve single leg stance, getting in and out of an automobile or bathtub, and walking are a few examples.

Figure 1 - Single leg stance improvements

The other significant finding in this study was a decrease in systolic blood pressure for subjects in the T'ai Chi Chih group. A change in blood pressure was not a
part of the initial research question. However, this finding is consistent with past research. Jin\(^{29}\) has found that changes in blood pressure during T'ai Chi were comparable to that with brisk walking. T'ai Chi Chih has also been shown to "have positive effects in delaying cardiorespiratory function decline in older persons."\(^{32}\)

Some positive subjective comments from members of the T'ai Chi Chih group were also voiced. One female subject stated she enjoyed T'ai Chi Chih because it was an exercise she could participate in for one hour without a break. She also reported that she was unable to walk for one hour. This comment is significance, as it has been shown that the energy equivalent of simplified T'ai Chi has been found to be equal to walking 3.0 miles/hour.\(^{41}\)

Another female subject from the T'ai Chi Chih group commented on her blood pressure. She stated she had her blood pressure checked weekly by a nurse at a local senior citizen center. During the course of the intervention the nurse noticed a significant decrease in the subject's blood pressure.

One male subject who required a chair for support during the first few classes did not require any external support by the end of the ten week intervention. Visually, one could see improved performance in many of the subjects for the T'ai Chi Chich forms which challenged balance. All of the subjects stated they enjoyed the social aspects of the class, and several stated they found the class very calming and relaxing.

**Limitations**

The small number of subjects in the study was a limitation, especially after three of the subjects dropped out. If this study were to be replicated, a sample size of 20 for each group would be recommended.

The lack of findings with the Tinetti and Berg balance measurements may also be attributed to the subject population. The subject population was very healthy and several subjects were very active. Most subjects scored high on both the Berg and Tinetti balance measures, and during initial testing several had perfect scores, giving the subjects small
room for improvement. For future studies, either a subject population with decreased balance, or a more sensitive balance measurement, such as using computerized balance equipment, could be used to offset this limitation.

The measurements for open eyes single leg stance were also a limitation. Stopping the measurements at 30 seconds left no room for improvement for many subjects and several ties, which weakened the Wilcoxin findings. For future studies, measuring single leg stance up to 120 seconds would solve this limitation. Testing for closed eyes single leg stance up to 120 seconds should also be included.

The large range in T'ai Chi Chih practice time was also a limitation. This could possibly have been prevented by giving each subject a practice log, or by having a daily practice session at a set time and location.

This study also did not show whether the significant results could have been obtained with another exercise program, such as a walking or a more traditional exercise class. Future studies should include not just a control group, but one or two groups performing other exercise programs. This design would not only test balance, but cardiovascular function, and possibly even strength and flexibility.

Although there were limitations in this study, the findings have shown that T'ai Chi Chih has a positive effect on balance and blood pressure in the elderly. More research on T'ai Chi is needed, and more research T'ai Chi Chih may emerge as an important tool for the prevention of falls and improvement of cardiovascular function in the elderly.
Appendix A
INFORMATION AND CONSENT FORM

You are invited to participate in a research study conducted by Justin Berry, a physical therapy student at the University of North Dakota. The purpose of this study is to see if t'ai chi chih can influence balance in individuals over 60.

To participate, we ask that you are over 60 years of age, live independently, do not use an assistive device for walking (crutches, cane, walker, etc), and do not have a history of heart problems, such as a heart attack, coronary artery disease, or a pacemaker. Also, if your blood pressure is found to be abnormally high or uncontrolled, you will not be able to participate in this study.

At the start of this study, you will perform two balance tests and your blood pressure will be taken. This will take approximately 30 minutes. Following this, you will be randomly assigned to one of two groups, a t'ai chi chih group or a control group. If you are assigned to the t'ai chi chih group, following the initial tests, you will take part in a t'ai chi chih class taught by a certified instructor. The classes will be 60 minutes long, and will meet once a week. You will also be asked to practice the t'ai chi chih forms you learn in class for a minimum of 15 minutes daily. At the end of the ten week class session, you will again perform the initial balance tests and will have your blood pressure taken. If you are assigned to the control group, following the initial tests you will continue your normal activities and will again perform the balance tests and will have your blood pressure taken at the end of ten weeks.

T’ai chi chih is a gentle form of exercise commonly practiced by senior citizens, requiring physical exertion relative to that of walking. Soreness and other discomfort related to exercise may result. The researcher believes the possibility of risk is minimal.

There are several benefits to participating in this study. Taking part in t’ai chi has been shown to increase flexibility, lower blood pressure, and to increase relaxation. T’ai chi chih classes are usually offered for a fee. If you are randomly assigned to the exercise group, you will be participating in the class for free. Also, you will be participating in research that could be helpful in decreasing loss of balance and falls in the elderly.

Your name will not be used in any reports of the results of this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. All data from this study will be retained in a locked office in the UND physical therapy department for three years following completion of this study.

The investigator or participant may stop the experiment at any time. Your decision whether or not to participate will not prejudice your future relationship with the
physical therapy department or the University of North Dakota. If you decide to participate, you are free to discontinue participation at any time without prejudice.

If you have any questions regarding this study, feel free to contact Justin Berry at 775-6614 or Bev Johnson at 777-2831. Copies of this consent form are available upon request.

In the event that physical injury should occur, medical assistance will be available, as it is to a member of the general public in similar circumstances. Payment for any such treatment must be provided by you and your health insurance.

"All of my questions have been answered and I am encouraged to ask any questions that I may have concerning this study in the future. I have read all of the above and willingly agree to participate in this study explained to my by the research investigator."

<table>
<thead>
<tr>
<th>Participant's Signature</th>
<th>Date</th>
<th>Witness (not investigator)</th>
<th>Date</th>
</tr>
</thead>
</table>
Appendix B
**TINETTI ASSESSMENT TOOL**

**Balance Tests**

Initial Instructions: Subject is seated in hard, armless chair. The following maneuvers are tested.

1. **Sitting balance**
   - Leans or slides in chair = 0
   - Steady, safe = 1

2. **Arises**
   - Unable without help = 0
   - Able, uses arms to help = 1
   - Able without using arms = 2

3. **Attempts to arise**
   - Unable without help = 0
   - Able, requires > 1 attempt = 1
   - Able to arise, 1 attempt = 2

4. **Immediate standing balance (first five seconds)**
   - Unsteady (swaggers, moves feet, trunk sway) = 0
   - Steady but uses walker or other support = 1
   - Steady without walker or other support = 2

5. **Standing balance**
   - Unsteady = 0
   - Steady but wide stance (medial heels > 4 in. apart) and uses cane or other support = 1
   - Narrow stance without support = 2

6. **Nudged (subject at max. position with feet as close together as possible, examiner pushes lightly on subject's sternum with palm of hand 3 times)**
   - Begins to fall = 0
   - Staggers, grabs, catches self = 1
   - Steady = 2

7. **Eyes closed (at maximum position No. 6)**
   - Unsteady = 0
   - Steady = 1

8. **Turning 360 degrees**
   - Discontinuous steps = 0
   - Continuous = 1
   - Unsteady (grabs, staggers) = 0
   - Steady = 1

9. **Sitting down**
   - Unsafe (misjudged distance, falls into chair) = 0
   - Uses arms or not a smooth motion = 1
   - Safe, smooth motion = 2

Balance score: _______ /16

## TINETTI ASSESSMENT TOOL

### Gait Tests

**Initial Instructions:** Subject stands with examiner, walks down hallway or across room, first at "usual" pace, then back at "rapid, but safe" pace (using usual walking aids)

10. Initiation of gait (immediately after told to "go")
   - Any hesitancy or multiple attempts to start = 0
   - No hesitancy = 1

11. Step length and height
   - a. Right swing foot
     - does not pass right stance foot with step = 0
     - passes right stance foot = 1
     - right foot does not clear floor completely with step = 0
     - left foot completely clears floor = 1
   - b. Left swing foot
     - does not pass right stance foot with step = 0
     - passes right stance foot = 1
     - left foot does not clear floor completely with step = 0
     - left foot completely clears floor = 1

12. Step Symmetry
   - Right and left step length not equal (estimate) = 0
   - Right and left step appear equal = 1

13. Step Continuity
   - Stopping or discontinuity between steps = 0
   - Steps appear continuous = 1

14. Path (estimated in relation to floor tiles, 12-inch diameter; observe excursion of 1 foot over about 10 ft. of the course)
   - Marked deviation = 0
   - Mild/moderate deviation or uses walking aid = 1
   - Straight without walking aid = 2

15. Trunk
   - Marked sway or uses walking aid = 0
   - No sway but flexion of knees or back or spread arms out while walking = 1
   - No sway, no flexion, no use of arms, and no use of walking aid = 2

16. Walking stance
   - Heels apart = 0
   - Heels almost touching while walking = 1

**Gait Score:** /12
**Balance + Gait Score:** /28

## BALANCE SCALE

**Name** ____________________________  **Date** ____________________________

**Location** ____________________________  **Rater** ____________________________

### ITEM DESCRIPTION

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Score (0-4)</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>Sitting to standing</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Standing unsupported</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Sitting unsupported</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Standing to sitting</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Transfers</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Standing with eyes closed</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Standing with feet together</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Reaching forward with outstretched arm</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Retrieving object from floor</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Turning to look behind</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Turning to 360 degrees</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Placing alternate foot on stool</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Standing with one foot in front</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Standing on one foot</td>
<td></td>
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</tbody>
</table>

**TOTAL** ____________________________

### GENERAL INSTRUCTIONS

Please demonstrate each task and/or give instruction as written. When scoring, please record the lowest response category that applies for each item.

In most items, the subject is asked to maintain a given position for specific time. Progressively more points are deducted if the time or distance requirements are not met, if the subject’s performance warrants supervision, or if the subject touches an external support or receives assistance from the examiner. Subjects should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring.

Equipment required for testing are a stopwatch or watch with a second hand, and a ruler or other indicator of 2.5 and 10 inches. Chairs used during testing should be of reasonable height. Either a step or a stool (of average step height) may be used for item #12.
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 unsupervised

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 chair(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 cueing 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 (4 inches)
   - 2 can reach forward 5 cm safely (2 inches)
   - 1 reaches forward but needs supervision
   - 0 loses balance while trying/requires external support

*If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.*
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 2-3 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 < 3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently
( ) 0 unable to try or needs assist to prevent fall

TOTAL SCORE (Maximum = 56)

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

Loss of balance and falls among the elderly is a large health care problem causing thousands of injuries a year. This study will investigate whether t’ai chi chih can influence balance in the elderly. T’ai chi chih is a gentle form of exercise that originated as a martial art.

This study requires a group (20-25) of elderly (over 60 years of age) subjects. All subjects will initially undergo two standard functional balance tests and will have their blood pressure taken. Subjects will be randomly assigned to either a t’ai chi chih exercise group or to a control group. The exercise group will participate in a weekly one hour t’ai chi chih exercise class taught by a certified instructor for ten weeks. The exercise group will also be asked to practice t’ai chi chih independently for a minimum of 15 minutes daily. The control group will continue with their regular activities during the ten week period. Both groups will repeat the initial balance tests and will again have their blood pressure taken at the end of the ten week period. Statistical analysis will be performed to see if there is a significant difference between exercise group and the control group.
PROTOCOL: (Describe procedures to which humans will be subjected. Use additional pages if necessary.)

Recruitment: Subjects will be recruited by the investigator through flyers and contacts at local senior citizen centers and at the YMCA. A total of 20-25 subjects are required for this study.

Selection: Subjects will meet the study requirements if they are over 60 years of age, live independently, and ambulate independently without an assistive device. Subjects will be excluded from the study if they have a history of cardiac health problems, such as coronary artery disease, myocardial infarction, or have a pacemaker. Subjects will also be excluded if they are found to have abnormally high or uncontrolled blood pressure.

Procedures: All subjects will initially complete two standard functional balance tests (The Berg and Tinetti tests), and will have their blood pressure taken. This will take approximately 30 minutes. Subjects will be randomly assigned to either a t'ai chi chih exercise group or a control group. The exercise group will participate in a weekly one hour t'ai chi chih exercise class taught by a certified instructor for ten weeks. The exercise group will also be asked to practice t'ai chi chih independently for a minimum of 15 minutes a day. The control group will continue with their regular activities during the ten week period. Both groups will repeat the initial balance tests and will again have their blood pressure taken at the end of the ten week period. The t'ai chi chih class and all testing will take place on the campus of the University of North Dakota.

Informed consent: Informed consent will be obtained through an information and consent form (See attached form).

Risk: T'ai chi chih is a form of exercise, consequently, there is risk of personal injury. The investigator believes the risk to be minimal, since t'ai chi chih is a very gentle form of exercise and is commonly practiced by senior citizens. Subjects will be excluded if they have a history of cardiac health problems, such as myocardial infarction, coronary artery disease, or a pacemaker. The investigator and a certified instructor will be present during all t'ai chi chih classes. In addition, subjects will be informed they may stop the activity at any time.

If per chance, a subject does have a personal injury during an exercise class, they will be encouraged to receive prompt medical attention, as it is customary to a member of the general public in similar circumstances. Payment for such treatment will be provided by the subject and the subject's third party payer.

Compensation: Subjects will receive no compensation for participating in the study.

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

Lose of balance and falls among the elderly is a large health care problem, each year causing thousands of injuries and millions of dollars in health care costs. This study will investigate the influence t'ai chi chih may have on balance in the elderly as measured by standard functional balance tests. Although there has been some research on the effects of t'ai chi, the number of studies relating t'ai chi and balance is lacking. This study will add to the body of knowledge regarding t'ai chi and balance.

There are several benefits for the subjects in this study. T'ai chi has been shown to decrease blood pressure, increase flexibility, and to increase relaxation. T'ai chi classes are usually offered at a fee, the subjects in the study will be able to participate in a class for free.
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.)

Since t’ai chi chih is a form of exercise, there is some risk of personal injury. The investigator believes the risk to be minimal, since t’ai chi chih is a very gentle form of exercise and is commonly practiced by senior citizens. Subjects will be excluded if they have a history of cardiac health problems, such as myocardial infarction, coronary artery disease, or a pacemaker. The investigator and a certified instructor will be present during all t’ai chi classes.

The subjects' names will not be used in any reports of the results of this study. Any information that is obtained in connection with this study and that can be identified with the subjects will remain confidential and will be disclosed only with their permission. All data from this study will be retained in a locked office in the UND physical therapy department for three years following completion of this study. At the end of the three year period, all data will be disposed of.

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.

All consent forms from this study will be retained in a locked office in the UND physical therapy department for three years following completion of this study. A copy of the consent form to be used is attached.

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  
Grand Forks, North Dakota 58202-7134

On campus, mail to: Office of Research & Program Development, Box 7134, or drop it off at Room 105 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 

Project Director or Student Adviser 

Training or Center Grant Director  

(Revised 3/1996)
The above referenced project was reviewed by a designated member for the University's Institutional Review Board on 5-15-99 and the following action was taken:

☑ Project approved. EXPEDITED REVIEW No. 7
Next scheduled review is on March 2000

☐ Project approved. EXEMPT CATEGORY No. ____________ No periodic review scheduled unless so stated in the Remarks Section.

☐ Project approved PENDING receipt of corrections/additions. These corrections/additions should be submitted to ORPD for review and approval. This study may NOT be started UNTIL final IRB approval has been received. (See Remarks Section for further information.)

☐ Project approval deferred. This study may not be started until final 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 Chairperson or ORPD.

PLEASE NOTE: Requested revisions for student proposals MUST include adviser's signature.

cc: B. Johnson, Adviser
Dean, Medical School
Signature of Designated IRB Member
UND's Institutional Review Board

Date

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 310 Form may be required. Contact ORPD to obtain the required documents.
REFERENCES


