The Effects of Line Dancing on Balance and Coordination in the Elderly

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THE EFFECTS OF LINE DANCING ON BALANCE AND COORDINATION IN THE ELDERLY

by

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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

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2001
This Independent Study, submitted by Christa Stelmachuk 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 Line Dancing on Balance and Coordination in the Elderly

Department  Physical Therapy

Degree  Master of Physical Therapy

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And most importantly, to our dancers, for reminding us to live every day of our lives.

“You've got to dance like nobody is watching and love like it's never going to hurt.”

Author Unknown
ABSTRACT

The purpose of this study was to determine if a six-week line dancing program has a significant effect on balance and coordination in a geriatric population. A total of 12 volunteer subjects participated in this study. They were separated into two groups, a control group (n = 6, 4 females and 2 males) and a dance group (n = 6, all female) according to participants' preference. Subjects were in good health, were high functioning, and were found to be at low risk for falls. Age of subjects ranged from 72 to 94 years, with a mean age of 85.67.

The study format involved an initial and final evaluation using the Berg Balance Measure and the coordination assessment from O'Sullivan and Schmitz. Following the initial assessment, the control group was instructed to continue their normal activities during the following six-week period. The dancing group participated in a line dancing exercise program two times per week for the six weeks. Following the six-week period, the Berg Balance Measure and the coordination assessment from O'Sullivan and Schmitz were re-administered.

A Mann-Whitney U-test was used to compare the control group to the dance group using scores from both the Berg and the coordination tests. A Wilcoxon T-test was also used to compare the control group scores before versus after the six-week period and the dancing group scores before versus
after six weeks of dancing. An alpha level of p = .05 was used to determine significance for all tests.

There was no significant difference between the two groups for either test before the six-week period (z = - .165, p = .869 for the Berg; z = -.647, p = .517 for the coordination test). Following six weeks of dancing, there was a significant difference between the control group and the dance group (z = -2.123, p = .034 for the Berg; z = -2.500, p = .012 for the coordination test). The results also show no significant change in scores in the control group (z = -.743, p = .458 for the Berg; z = -1.289, p = .197 for the coordination test), but a significant increase in the scores from the dance group following six weeks of dancing (z = -2.14, p = .027 for the Berg; z = -2.264, p = .024 for the coordination test).

A six-week line dancing program significantly improved scores on the Berg Balance Measure and the coordination assessment from O'Sullivan and Schmitz. Line dancing can be an effective tool for physical therapists to use for balance and coordination training with the elderly.
CHAPTER I
INTRODUCTION

The population of individuals age 65 and older is increasing more rapidly than any other age group.\textsuperscript{1,2} In 1990, the elderly population represented 12.6\% of the total population in the United States, and this number is projected to rise to 22.9\% by 2050.\textsuperscript{1} In addition, the oldest old age group (85 years and older) will increase to over 17 million by 2050, compared to 3 million in 1990.\textsuperscript{2} With age comes an increased risk for falls.\textsuperscript{3} It has been reported that up to 35\% of individuals in the 65 and older age group fall at least one time per year.\textsuperscript{3} Falling can result in serious injury or death and a lack of adequate balance is one of the major contributing factors behind these falls.\textsuperscript{4}

The mechanism of balance involves the integration of information from the visual, somatosensory, and vestibular systems.\textsuperscript{5,6} The information must then be processed via the central nervous system (CNS) and adjustments made through the musculoskeletal system. The aging process can lead to decreased functioning in these systems, resulting in a loss of balance control and an increased risk for falls.\textsuperscript{6,7} Therapists utilize several different techniques to improve balance in the elderly. These include strengthening, stretching, and specific balance training exercises. This study will focus on line dancing as a possible addition to the traditional balance-training program.
Problem Statement

Due to the growing number of elderly in the United States, therapists are being faced with increasingly more patients with balance deficits. There is a need to develop new and effective balance training exercises that can be utilized with the geriatric population. By incorporating activities that are perceived as recreation, patient compliance and motivation can be improved.

Purpose of Study

The purpose of this study is to determine if there is a significant improvement in balance and coordination after a six-week period of regular line dancing. If proven effective, line dancing can be added to the options available to physical therapists for balance and coordination training.

Significance of Study

Research has shown that balance control can be improved with training. This study is important because it provides information regarding the effects of line dancing on balance and coordination in a geriatric population. The use of line dancing as a tool for balance and coordination training may increase patient compliance, resulting in improved treatment outcomes.

Research Questions

1. Is there a significant change in scores on the Berg Balance Measure or the coordination test from O'Sullivan and Schmitz, following six weeks of line dancing?
2. If there are significant changes, are the changes different in the control group versus the dance group?
Hypotheses

The null hypothesis is that a six-week program of line dancing will have no effect on balance or coordination scores. The alternate hypothesis is that line dancing will have a significant effect on balance and coordination scores.
CHAPTER II
LITERATURE REVIEW

Components of Balance

Falls are a major cause of morbidity and mortality in the elderly. In persons over 85 years of age, approximately two-thirds of injury related deaths are due to falls. So the question is, "how does the body maintain adequate balance?" Normal postural control is the ability of keeping the center of gravity over the base of support during both static and dynamic situations. This involves the interaction of various body parts by skeletal muscles with respect to gravity and each other. For stability, the body must be able to respond to translations of the center of gravity whether intentionally imposed through voluntary movement or unexpectedly experienced through slipping or tripping. The overall goals of this balance control system are safety, stability, and function. Balance is a complex, interrelated system requiring interaction of the visual, vestibular, and somatosensory systems.

Vision is responsible for the body's spatial orientation using feedback from the environment. Vision assists with detection of slight postural shifts by relating body position and movement to the external environment through communication with the central nervous system (CNS). Contrast sensitivity, acuity, peripheral vision, and depth perception are additional components of
vision clinically relevant to the outcome of balance. Contrast sensitivity enables us to detect the subtle differences in patterns and shading. For example, this is imperative when dealing with stairs with various patterns. Acuity identifies subtle differences in shapes and letters. When looking straight ahead, peripheral vision includes what you see from the side regions. Finally, depth perception aids in distinguishing between various distances.\(^7\) Contrast sensitivity, acuity, peripheral vision, and depth perception all play an important role in maintaining adequate balance in an assortment of environments which are influenced by lighting, background colors, and terrain.

The vestibular system also provides essential feedback for the control of balance.\(^5,7,8\) This system detects acceleration and deceleration forces acting on the head and identifies the head position in respect to gravity. This information is obtained via the otoliths and semicircular canals and is thus relayed to the CNS.\(^5,7\) Vestibular input helps screen information from conflicting visual images and actual movement. This vestibular function provides compensatory eye movements and postural responses during head movements including righting reactions and regulation of muscle tone throughout the body.\(^5,7\)

The third component for balance control is somatosensation.\(^5,7,8\) Proprioceptive information is provided by joint, tendon, and muscle receptors and relayed back to the CNS. Proprioception thus detects the relative movement and orientation of body parts in relation to the supporting surface.\(^5,7\) In order to assess somatosensory contributions to balance, one must identify cutaneous functions (touch and pressure) as well as proprioceptive interactions, particularly
in the hip, foot, and ankle regions. The proprioceptive input is then utilized to influence musculature to assist with static and dynamic stabilizing movement strategies.

Joints of the lower extremities are essential components in controlling postural sway. The ankle movement strategy was one of the first identified in controlling upright sway. It is most commonly used when the supporting surface is firm and perturbations to equilibrium are smaller. In order for this response to operate intact, range of motion and strength must be available. In contrast, the hip strategy, although having the same requirements and properties of function, produces large and fast movements at the hip joint in association with responses from the supporting surface and ankle joints.

Balance is a complex action requiring sensory input provided by the vision, vestibular, and somatosensory systems. These systems overlap in order for a person to function independently. For example, a person with blindness who is lacking the visual system is still able to stand and walk in an upright position with use of the other systems. However, an impairment in any of these systems is going to impact balance control regardless of compensation strategies. The effects of stressing the visual, vestibular, and somatosensory systems through various treatment techniques has been shown to improve the overall balance control mechanism.

Alterations in sensory function occur as part of the normal aging process. It is imperative to understand how these changes impact the sensory components effecting balance. Understanding the changes associated with the
normal aging process aids clinicians in understanding and identifying appropriate
treatment approaches.

Aging Process

Age-related decline in the elderly population is a complex phenomenon.
The impact on the degradation of sensorimotor performance has been
associated with a decline in balance.\textsuperscript{7} Balance disorders have been found to be
responsible for falls, impaired mobility, and decreased independence in the
elderly.\textsuperscript{10} The controversy lies with whether this alteration in function is the result
of underlying pathology or the natural process of aging.\textsuperscript{7} This section explores
the changes and adaptations that are associated with the aging process,
including visual, vestibular, somatosensory, musculoskeletal, neurological, and
auditory systems, and memory changes.

Vision

Impaired balance may be further complicated by alterations of the visual
system. The visual changes occurring in the geriatric patient become important
during assessment and treatment planning. Modifications and adaptations may
need to be implemented for a successful treatment response to accommodate
these visual impairments.

Prior to the sixth decade, there is a gradual decrease in visual acuity
which is followed by a rapid decline from 60 to 80 years of age. There may be
as much as an 80% loss by the ninth decade of life.\textsuperscript{7} Visual acuity is defined as
a measure of visual discrimination concentrating on fine details and is assessed
with an eye chart. This may be a valid test for reading as this is conclusive for
resolving details of high contrast, small letters on a page with a background. However, this test may not be useful for "functional" vision, such as recognizing a step in a dimly lit hallway or recognizing a larger object such as a tree in a forest.\(^7\)

Also affected is the integrity of the visual fields, dark adaptation (luminance), amplitude of accommodation, and color contrast.\(^7,11,12\) There is a loss across the entire color spectrum, especially blue, by the fourth decade.\(^7,12\) In the older adult, visual spatial sensitivity is decreased especially at low spatial frequencies and slow moving targets.\(^7,13\)

The ocular motor system is also detrimentally affected.\(^7\) Ptosis occurs, convergence and saccades are reduced, and upward gaze is symmetrically restricted. Studies by Paige\(^14\) showed a progressive decline in smooth pursuit and optokinetic nystagmus in the aged population. Many aspects of the visual system are reduced as a result of the aging process in the geriatric population. Careful visual screening must be done for the elderly who are having difficulty functioning and maneuvering in the environment.\(^7,11,13,14\)

Vestibular System

The elderly often experience vestibular symptoms as a result of the aging process.\(^7,15\) The vestibular system is responsible for equilibrium. Taber's defines equilibrium as a state of balance.\(^16\) It is also responsible for position sense (subjects awareness of self in space) and motor reflexes associated with postural and ocular stability.\(^7\) Symptoms of vestibular degeneration present as vertigo, nystagmus, and postural imbalance if other underlying pathology is ruled
out. If no other pathology is found, age-related dysequilibrium is called prebyastasis. Information regarding the incidence of a vestibular disorder in the healthy elderly population in currently not available.\textsuperscript{7}

Somatosensory System

Many articles have been written on the age-dependent changes of the somatosensory system.\textsuperscript{7} The somatosensory system is responsible for proprioception which is a sensation or awareness of body position and movements.\textsuperscript{5} As reviewed in the components of balance section, proprioception input is needed for balance control.\textsuperscript{5,7,8} Nerve cells, roots, peripheral nerves, and specialized nerve terminals undergo morphological changes with aging.\textsuperscript{7} For example, the corpuscles become sparse, scattered, and variable in size and shape. Pacinian corpuscles are responsible for sensing repetitive touch (e.g., vibration) and have a decrease in density with time. In fact, research has shown that vibratory sensibility has the greatest decline in the elderly.\textsuperscript{7} Meissner's corpuscles also detect touch and have been found to decrease in concentration with age.

Results are controversial concerning the affect of aging on proprioception.\textsuperscript{7} Current research suggests that loss of position sense may be joint specific. Furthermore, sensory loss appears greater in the lower extremities versus the upper extremities which may have a detrimental impact on postural sway during standing.
Musculoskeletal System

Deficits in strength and joint motion have also been associated with falls.\textsuperscript{10,17,18} A reduction in muscle mass has been found in association with the aging process.\textsuperscript{7,10} This decrease has been found to be more prominent in the lower extremities and has been a major factor associated with the loss of functional independence.\textsuperscript{7,10,17} The effect of joint limitations on righting reactions and falls is less documented.\textsuperscript{10} However, impaired back extension and the presence of arthritis may be contributing factors.\textsuperscript{10} The integrity of the musculoskeletal system is an important aspect of static and dynamic postural control and a decline results in impaired balance.\textsuperscript{18}

Nervous System

When a decline in balance is present, the body may try to compensate for the loss of stability.\textsuperscript{7} However, the aging process also causes synaptic failure which results in an increase of time at the neuromuscular junction. This delay of an immediate compensatory response may result in a fall and devastating injury. There are many theories that support this decline. Although it has been difficult to identify a cause, denervation is the most common reported pathology associated with the changes.\textsuperscript{7}

There is comprehensive research confirming that aging causes a decrease in speed and in quality of movement.\textsuperscript{7} Although it is not possible to identify one system in relation to this decline, both nervous and muscular tissue are responsible for motor performance.\textsuperscript{7} A study performed by Studenski et al\textsuperscript{10} concluded that the speed of muscle response distally in the healthy older
persons when compared with healthy young adults was latent. It also suggested that this might be related to impaired balance control among fallers.  

Auditory System

The auditory system is affected over time and will influence how one interacts with a patient. If hearing is impaired, patient education for balance retraining will need to be altered in order to compensate for this deficiency. Accommodations include written instructions, family instruction, or altering speech (lower tone, slower speed, increased volume). Changes in the auditory system have been noted as early as the fourth decade. However, functional impairment is usually not evident until the seventh decade. The most common cause of hearing loss in adults is presbycusis, which is an age-related loss of auditory function. This is caused by changes in the peripheral sensory organ, central pathway, or auditory portions of the cerebral cortex. A peripheral loss will have greater impact to hearing sensitivity. The central systems relate more to the understanding of speech, especially when listening conditions are variable.  

The progression of hearing loss associated with age is a slow, progressive, bilateral process first affecting high frequency sensitivity followed by loss over the entire frequency spectrum. The effects of this hearing loss may prevent social interaction and cause difficulty with receptive communication.  

Sleep, Memory, Intelligence

Other aspects of aging that will influence patients’ progress and participation in a balance training program are changes in sleep, memory, and intelligence. Although total sleep time is only slightly reduced, consecutive
sleep time is decreased, awakenings are more often, and less sleep time is spent in levels three and four. Short-term recall information is generally more difficult to retrieve. To aid the memory process, information presented to the elderly should be given at a slower rate and with increased repetitions. It is imperative that the information for balance retraining be presented in a manner that compensates for any sensorimotor changes that may be present (e.g., vision, hearing, etc.). In relation to normal aging and an absence of pathology, "intelligence" has been found to not be affected even in the later years.¹⁹

The rate of change associated with aging and the sensorimotor system is not completely known and cannot be identified within only one system.⁷ More research needs to be done on which factors may predispose or retard the affects of aging on the body's systems. However, one may be hopeful that the quality and quantity of movement may be prolonged with physical activity.⁷ In summation, as clinicians, it is important to be aware of any age related changes associated with the elderly and modify assessments and treatments accordingly.

To combat the effects of the aging process, there are many exercise programs to recede these effects and enhance the elderly patient's current function. The benefits of these traditional exercise programs are numerous and should continued to be explored

Traditional Exercise Training

The impact of the geriatric population participating in an exercise program has numerous benefits encompassing a wide scope of complex body
Many studies have been conducted to identify and measure these advantages.

One study researched the effects of a multifaceted exercise program on balance and mobility in the older adult. Each person received an individualized multidimensional exercise program focusing on specific functional deficits identified during the assessment. Mobility retraining focused on improving stability during a variety of gait tasks. Balance exercises focused on improving postural alignment, developing coordinated movement strategies for the recovery of balance, improving the use of senses for postural orientation, and integrating appropriate sensory and motor strategies for controlling posture and balance into functionally related balance and mobility tasks. Results showed that these exercise programs did indeed improve balance and mobility function in community dwelling older adults. Furthermore, adherence to a structured exercise program reduced the risk for falls among the geriatric population. An encouraging finding of this study was that age was not associated with the adherence to exercise. This concluded that patients in their 80s were just as likely to be adherent and have successful outcomes as those in their 60s.

A retirement community in West Hartford, Conn., advocates exercise to enhance holistic health and keep residents independent and socially active. An on-site fitness counselor develops individualized exercise programs and assists residents to comply with it. Programs range from individual personal training regimens, rehabilitation programs, or group programs such as aerobics and line dancing. Statistics demonstrate a significant decrease in fall risk for those
residents who exercise regularly. In a five-year span, only 0.05% of the falls occurred among the 21% of the residents who exercise regularly.

Another study utilizing multisensory training of standing balance in older adults showed significant improvements in stability. The subjects received a 10-hour balance training program which selectively manipulated the visual, vestibular, and somatosensory systems. Training included standing on a platform system while sensory inputs relative to postural stability were manipulated. Results supported the theory that postural stability can be improved in the older adults involved in a training program targeting the sensory systems.

Walking has been shown to improve balance in the elderly. A study by Roberts evaluated the effects of a walking program spanning three times a week for six weeks. Compared to the control group, the walkers had significant increases in balance scores. However, the subjects who took part in the walking program did not perceive their balance as significantly better than those who did not participate in the physical activity. One possible explanation is that the change in balance was not large enough to be detected by these persons. It is important to note that walking activities are incorporated into a line dancing exercise program directed at improving balance.

Other benefits in addition to improvements in balance can be found in the elderly who participate in an exercise program. One study conducted at the University of Georgia evaluated the effects of exercise in independent older adults and the resulting improvements in physical function. The group
participating in the exercise program which consisted of combined endurance and strength training were found to have increased maximal oxygen consumption (11%) and muscle strength (33%) in comparison to the control group. The results support the theory that several months of exercise enable the geriatric population to not only prevent decline in physical activity, but enhance physical function and maintain general good health. Strength is an essential component of balance in the elderly.

Factors such as menopause, dietary habits, and lifestyle factors, including exercise, can influence bone density throughout life. One of the primary functions of bone, in relation to physical activity, is to provide the body with mechanical support. Exercise has been found to either retard bone loss or to increase bone mass as people age. The incidence of osteoporotic related fractures will increase with age causing a detrimental impact on quality of life issues. Weight bearing exercises have been proven to have a positive influence on the musculoskeletal system. Consequently, this activity is an integral part of dancing activities and thus should be viewed in the maintenance of bone mass.

To take it one step further, researchers and clinicians are using the mode of dance to ascertain the benefits of physical activity. In fact, aerobic dance has been described as one of the most popular forms of non-competitive group exercise, especially among women, to improve fitness. The following section identifies the components of dance and benefits associated with participation in this activity.
Components of Dance

Training specificity is an integral part of any exercise program. In order to have an effective impact on balance, it is important to train with activities that stimulate the areas of the sensory system responsible for coordination and balance. Dynamic activities found to influence balance and gait are sidestepping, cross-over steps, walking forward and backward, high steps, heel-to-toe walking, side gliding, hopping, and jumping in place. See Appendix F for a listing of the movements included in the line dancing program.

The setting of movement to music may enhance the enjoyment of participation in an exercise program. Music is becoming an important tool with many benefits in the world of rehabilitation. Benefits include relaxation of tense musculature, improved coordination, and improved sleep. Listening to music has also been found to invoke an emotional response and relieve pain by distracting patients. Furthermore, it has been used to lower blood pressure and help normalize cardiac arrhythmias.

Dancing may promote wellness by strengthening the immune system through physiological processes and muscular activity. The art of dance helps the patient gain a sense of control and promotes a mastery of movement.

Music and dance has been used in the treatment of patients of all ages but has been found to be particularly helpful for patients with Parkinson and dementia. Parkinson's disease affects the basal ganglia of the brain which is responsible for consecutive movements or sequences. Music allows a substitution, temporarily, for this function and allows organization for
movements. A study on social dancing and its effect on persons with dementia showed that retained abilities were present in dancing and that social dancing seemed to have meaning to both patients and their caregivers. It supported positive feelings, communication, and behavior.  

Music encourages the participating dancer to walk or move rhythmically. Because there is an interaction between auditory rhythm and physical response, music may be therapeutic in the rehabilitation of a patient with a movement disorder. Various rhythms may alter the intensity of the activity. Increasing or decreasing the speed of the exercise as appropriate to achieve the goals will prevent the dancing program from becoming monotonous and mundane. If the beat of music used for dancing is too slow, it is difficult to follow with a dance routine. On the other hand, if the speed is too fast, the aged patient may be unable to follow the instruction, get frustrated, and thus stop participating. Furthermore, safety may be jeopardized. Utilizing an extra strong beat can encourage extra strong exertion when required.

A study performed by Kudlacek et al on the impact of a senior dancing program on bone mass suggested the weight bearing effect of dance movements on the musculoskeletal system has a positive influence on vertebral bone mineral density. In postmenopausal women, the physical activity level correlated with the strength of the back musculature as well as the bone density of the spine and hip. The musculoskeletal component is a critical aspect of balance and treatment of balance deficits.
Improved postural stability reduces the risk for falls, associated injuries, and fractures. The boundaries in which the body can maintain its position and balance without changing its base of support defines limits of stability. Reaching activities are functional in nature and will stress the patient's margin of stability. Another dynamic component of postural control includes balance reactions which would be enhanced with weight shifting activities. This is especially critical for the patient who demonstrates poor balance responses to displacements of the center of mass. Muscles respond differently to various displacements of the center of mass. The contents of a line-dancing program should include activities that enhance balance and function.

Another component that aids in maintaining equilibrium is the displacement of the center of gravity toward the supporting leg during unilateral stance activities. This action is used repeatedly during walking and dancing activities. The shifting of the center of gravity in conjunction with head and trunk orientation are used for reference for organizing any motor act. A study by Mouchnino et al suggests that dancers are able to minimize the center of gravity displacement during unilateral stance. This may be attributed to an improved internal representation of the patient's limits of stability with extended training. Future studies should be directed in this area for the geriatric population.

With the increasing age of our elderly, health care providers need to understand the effects of the aging process. When balance is diminished, the geriatric patient is at risk for falls and a resulting decrease in functional
independence. It is imperative to be aware of the components of balance and find innovative treatment programs to retrain balance. Dance has been found to have many benefits, including improvements in balance, and has been shown to enhance the enjoyment and adherence to an exercise program.
CHAPTER III

METHODOLOGY

This project was approved by the University of North Dakota Institutional Review Board before beginning the research study (Appendix A). The procedure, benefits, and possible risks were explained to all participants. Prior to the start of the study, each subject signed an information and consent form indicating his or her voluntary participation (Appendix B). The following methodology includes subject description, instrumentation, procedure, and data analysis sections.

Subjects

A sample of convenience consisting of a total of 12 volunteer subjects was selected from Parkwood Place independent living center. For inclusion in the study, subjects were required to be over 65 years of age, living independently, and able to ambulate independently without the use of an assistive device. Subjects were excluded if they were found to be at high risk for falls using the Tinetti Assessment Tool.\textsuperscript{35}

The subjects were separated into two groups, a control group and a dance group, according to participants' preference. The control group consisted of six subjects with ages ranging from 79 to 94 years with a mean age of 87.5 years. Of the six subjects in the control group, four were female and two were
male. The dancing group consisted of six subjects with ages ranging from 72 to 90 years with a mean age of 83.83 years. All six of the subjects in the dancing group were female. Originally, there were nine volunteer dancers, but three of the subjects dropped out early and are not reported in the results. Of the three subjects who were lost, one moved, one died, and one developed unrelated health problems that prevented her from participating.

Instrumentation

Subjects were initially screened for fall risk using the Tinetti Assessment Tool\textsuperscript{35} (Appendix C) and they were excluded from the study if they were found to be at a high risk for falls (score of <19). The Tinetti Assessment Tool is used to objectively analyze balance and gait and predict a person's fall risk. Subjects were scored on a three-point ordinal scale with zero identifying the greatest impairment and two being the least. The total possible score is 28, with a score of >23 = low fall risk, 19-23 = increased risk for falls, and <19 high risk for falls.

All subjects who scored greater than 19 on the Tinetti Assessment Tool were given an initial and final evaluation using the Berg Balance Measure\textsuperscript{35} (Appendix D) and a coordination assessment from O'Sullivan and Schmitz\textsuperscript{7} (Appendix E). The Berg has been found to be a valid and reliable tool for assessing balance in elderly patients.\textsuperscript{36} It has been shown to have an overall interrater reliability of .98 and an intrarater reliability of .99, a very high degree of reliability. The test consists of 14 items, each scored on a five-point ordinal scale. Inability to perform the task is scored zero and a four represents independence. The total possible score is 56. The coordination assessment
test consists of two parts, an equilibrium test and a non-equilibrium test. Only the equilibrium test was performed for this study. The equilibrium test consists of 14 items, each scored on a four-point ordinal scale for a total possible score of 56. An individual is given a score of one if the activity is impossible and is given a four if he or she is able to accomplish the activity. The coordination assessment test has not been tested for validity or reliability; however, it can be used as a tool to show clinical improvement. Currently, there is no standardized coordination assessment tool available.

Prior to testing, the researchers performed an inter/intrarater reliability pilot study including six volunteers. The ages of the pilot study participants ranged from 26 to 79 years of age. These volunteers were not used for the control or dance group in the line dancing study. To establish intra-rater reliability, each researcher tested the participants two times with at least 24 to 48 hours between tests. Researchers did not have access to the initial testing results prior to the retest 24 hours later. To establish inter-rater reliability, the researchers separately tested the same volunteers and compared results. The testing by each researcher was completed on the same day with the volunteers given adequate rest between trials. For all inter-rater and intra-rater correlational and reliability tests for the Tinetti, Berg, and coordination tests, the Pearson r values exceeded .967 and the ICC values exceeded .957.

All tests were performed in a well-lit room with tile floors. The researchers closely guarded the subjects against falls and followed standardized protocols.
Procedure

The Tinetti Assessment Tool\textsuperscript{35} was administered prior to the initial evaluation to screen for subjects at high risk for falls. All subjects who scored greater than 19 were tested using the Berg Balance Measure\textsuperscript{35} and the coordination assessment from O'Sullivan and Schmitz.\textsuperscript{5}

After the initial assessment, the control group was instructed to continue their normal daily activities during the following six-week period. The dancing group participated in a 30-minute exercise program two times per week consisting of a five-minute warm-up, 20 minutes of line dancing, and a five-minute cool down. (See Appendix F for specific line dances utilized). The dancing was instructed by the researchers who were trained by an experienced line dancing instructor. The line dances were low impact, low intensity, and modified for safety. Both investigators were present during all line dancing classes, and signs and symptoms of abnormal exertion or stress were closely monitored. Subjects were instructed that they could stop at any time. Following the six-week period, the Berg Balance Measure and the coordination assessment were re-administered.

Data Analysis

The independent variable is the group in which the subject was placed, dancing or control group, and is nominal data. The dependent variables were the scores on the Berg Balance Measure and the coordination assessment from O'Sullivan and Schmitz, and are measured on an ordinal scale. The Mann-
Whitney U and Wilcoxon tests were used to analyze the data. A significance level of $p = 0.05$ was used to determine significance for all tests.
CHAPTER IV

RESULTS

The subject group consisted of 12 elderly volunteers, six in the control group and six in the dancing group. See Table 1 for a description of age and test scores for all subjects (n = 12).

Table 1. Description of Both Groups

<table>
<thead>
<tr>
<th>Variable, Group</th>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Combined</td>
<td>85.67</td>
<td>6.64</td>
<td>72.00</td>
<td>94.00</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>87.50</td>
<td>6.35</td>
<td>79.00</td>
<td>94.00</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>83.83</td>
<td>6.97</td>
<td>72.00</td>
<td>90.00</td>
</tr>
<tr>
<td>Tinetti score,</td>
<td>Combined</td>
<td>25.67</td>
<td>2.46</td>
<td>20.00</td>
<td>28.00</td>
</tr>
<tr>
<td>pre-dance</td>
<td>Control</td>
<td>24.67</td>
<td>3.08</td>
<td>20.00</td>
<td>28.00</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>26.67</td>
<td>1.21</td>
<td>25.00</td>
<td>28.00</td>
</tr>
<tr>
<td>Berg score,</td>
<td>Combined</td>
<td>49.25</td>
<td>3.75</td>
<td>40.00</td>
<td>53.00</td>
</tr>
<tr>
<td>pre-dance</td>
<td>Control</td>
<td>48.83</td>
<td>5.04</td>
<td>40.00</td>
<td>53.00</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>49.67</td>
<td>2.25</td>
<td>48.00</td>
<td>53.00</td>
</tr>
<tr>
<td>Berg score,</td>
<td>Combined</td>
<td>51.17</td>
<td>4.37</td>
<td>42.00</td>
<td>56.00</td>
</tr>
<tr>
<td>post-dance</td>
<td>Control</td>
<td>48.50</td>
<td>4.81</td>
<td>42.00</td>
<td>54.00</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>53.83</td>
<td>1.33</td>
<td>52.00</td>
<td>56.00</td>
</tr>
<tr>
<td>Coordination test</td>
<td>Combined</td>
<td>48.67</td>
<td>3.96</td>
<td>42.00</td>
<td>54.00</td>
</tr>
<tr>
<td>score, pre-dance</td>
<td>Control</td>
<td>47.67</td>
<td>5.47</td>
<td>42.00</td>
<td>54.00</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>49.67</td>
<td>1.51</td>
<td>48.00</td>
<td>52.00</td>
</tr>
<tr>
<td>Coordination test</td>
<td>Combined</td>
<td>52.17</td>
<td>4.55</td>
<td>43.00</td>
<td>56.00</td>
</tr>
<tr>
<td>score, post-dance</td>
<td>Control</td>
<td>49.50</td>
<td>5.24</td>
<td>43.00</td>
<td>54.00</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>54.83</td>
<td>.98</td>
<td>54.00</td>
<td>56.00</td>
</tr>
</tbody>
</table>
A total of 12 dancing sessions were offered over a six-week period. The minimum number of sessions attended was 5 (42%) and the maximum was 11 (92%), with an average of 8 (64%).

Scores from both the Tinetti and the Berg Balance Measure were skewed to the left. This is indicative of the high functioning level of the residents who volunteered for this study.

A Mann-Whitney U-test was used to compare the control group to the dance group using scores from both the Berg Balance Measure and the coordination assessment from O'Sullivan and Schmitz (Table 2). The results from the initial evaluation indicated no significant difference between the two groups for either test. However, following six weeks of dancing, the results indicate a significant difference between the control group and the dancing group for both the Berg and the coordination test.

Table 2. Mann-Whitney U-test: Comparison Between Control and Dance Groups

<table>
<thead>
<tr>
<th></th>
<th>Berg pre-dance</th>
<th>Berg post-dance</th>
<th>Coordination test pre-dance</th>
<th>Coordination test post-dance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mann-Whitney U</td>
<td>17.00</td>
<td>5.00</td>
<td>14.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Z</td>
<td>-.165</td>
<td>-2.123</td>
<td>-.647</td>
<td>-.2500</td>
</tr>
<tr>
<td>Significance (2-tailed test)</td>
<td>.869</td>
<td>.034</td>
<td>.517</td>
<td>.012</td>
</tr>
</tbody>
</table>

Another Mann-Whitney U-test was utilized to compare the change scores (posttest scores minus pretest scores) between the dance and control groups. Following six weeks of dancing, the change scores were significantly different for
the Berg and the coordination test. Results were as follows: Berg score change
- \( U = 4.00, Z = -2.26, p = .024; \) coordination score change - \( U = 6.00, Z = -2.00, \\ p = .046 \). The amount of change was greatest for the dance group.

A Wilcoxon T-test was used to compare the control group scores before versus after the six-week period and the dancing group scores before versus after six weeks of dancing (Table 3). The results show no significant change in scores in the control group on either the Berg Balance Measure or the coordination assessment from O'Sullivan and Schmitz. The results do show a significant increase in both scores from the dancing group after six weeks of dancing.

Table 3. Wilcoxon T-test: Comparison of Pretest and Posttest Scores for the Berg and Coordination Tests for the Dance and Control Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Berg Control</th>
<th>Berg Dance</th>
<th>Coordination Test Control</th>
<th>Coordination Test Dance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>-.743</td>
<td>-2.14</td>
<td>-1.289</td>
<td>-2.264</td>
</tr>
<tr>
<td>Significance (2-tailed test)</td>
<td>.458</td>
<td>.027</td>
<td>.197</td>
<td>.024</td>
</tr>
</tbody>
</table>

If the scores from the Berg Balance Measure and the coordination assessment from O'Sullivan and Schmitz are considered in their raw form, results show that scores for the dance group on the Berg increased by 4.17 points and scores on the coordination test increased by 5.17 points (Table 4). As noted earlier, there was no significant change between pretests and posttests for the control group.
Table 4. Mean Scores on the Berg and the Coordination Test

<table>
<thead>
<tr>
<th></th>
<th>GROUP</th>
<th>MEAN</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berg, pre-dance</td>
<td>Control</td>
<td>48.83</td>
<td>5.04</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>49.67</td>
<td>2.25</td>
</tr>
<tr>
<td>Berg, post-dance</td>
<td>Control</td>
<td>48.50</td>
<td>4.81</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>53.83</td>
<td>1.33</td>
</tr>
<tr>
<td>Coordination test, pre-dance</td>
<td>Control</td>
<td>47.67</td>
<td>5.47</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>49.67</td>
<td>1.51</td>
</tr>
<tr>
<td>Coordination test, post-dance</td>
<td>Control</td>
<td>49.50</td>
<td>5.24</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>54.83</td>
<td>.98</td>
</tr>
<tr>
<td>Berg, total change</td>
<td>Control</td>
<td>-0.33</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>4.17</td>
<td>2.93</td>
</tr>
<tr>
<td>Coordination test, total change</td>
<td>Control</td>
<td>1.83</td>
<td>2.92</td>
</tr>
<tr>
<td></td>
<td>Dance</td>
<td>5.17</td>
<td>1.33</td>
</tr>
</tbody>
</table>
CHAPTER V
DISCUSSION

Balance is controlled by an intermixing of the nervous system, the sensory systems, and the musculoskeletal system. Approximately 50% of falls are thought to be related to a sudden motion of the base of support, such as slips and trips; 35% are due to external displacement of the body’s center of mass; and 10% may be related to spontaneous causes. The purpose of this study was to assess whether a low impact dancing program would improve balance and coordination in the elderly population. Currently, there is a lack of research in the elderly related to the effects of a dance program on balance.

The movements of line dancing which may challenge the sensory and musculoskeletal systems include weight shifting, one-legged stance, rhythmicity, and walking a straight line. Another aspect that provides a sensory challenge is the variation in speed associated with the dances and music, which caused a fluctuation in the level of intensity.

Although there is minimal research published concerning the effects of line dancing on balance and coordination in the elderly, similar studies have shown that stability and balance can be improved with an exercise program for the aged adult.
Shumway-Cook et al. investigated the effects of a multidimensional individualized exercise program addressing balance and mobility. Results suggest that an exercise program could improve balance and mobility function as well as reduce fall risk among the elderly who present with a history of falling. For Shumway-Cook et al, each individual's exercise program addressed impairments and functional disabilities identified in the assessment. Factors associated with the successful response to exercise included the degree of adherence to the training program and pretest scores on the Tinetti Mobility Assessment. However, this study on the effects of individualized exercise programs did not distinguish the amount of exercise required to achieve these results. This information would be utilized in the line dancing study and adherence would be a factor in the improvement of the participants.

There are other exercise programs available with supporting evidence to increase balance in the elderly. Lichtenstein-Burger et al. published a study in 1989 on the effects of exercise on body sway using a biomechanics platform. The subjects were randomized by their place of residence and were required to be 65 years of age or older. The exercises were designed to improve balance, flexibility, and reaction time. The program consisted of a warm-up, static balance exercises (e.g., one legged stance), active balance exercises (e.g., walking along a line), and a cool-down. The participants were asked to participate in three sessions weekly for 16 weeks. Results were inconsistent between the eyes open and eyes closed outcome variables. Testing in unilateral stance with eyes open showed improvements with subjects demonstrating smaller degrees of
sway; greater degrees of sway were present with eyes closed. The researchers suggest that the inconsistent effect on the exercises could be contributed to poor compliance, inadequate duration, or lack of statistical power to detect between-group differences. Also, the balance training exercises were performed with the subject's eyes open, which could have contributed to the difference between scores. However, this study concluded that balance exercises may be effective in the community-dwelling elderly adult.\textsuperscript{38}

In contrast to supporting evidence, a study by Crilly et al\textsuperscript{39} in 1989 evaluated an exercise program consisting of breathing, single and double limb stance, coordination, flexibility, strengthening, and general relaxation exercises. Balance and limits of stability were assessed in order to correlate these effects with the preceding treatments. The subjects were female between the ages of 72 and 92 (mean 82). The duration of the program was 12 weeks. The paired t test results showed no improvement in sway in any group, and in some cases, deterioration actually occurred. No difference was found between the exercise and control group. The researchers suggested the lack of significant change could be because the program was too undemanding. Maintaining interest and compliance with the program proved to be a challenge even with the benign nature of the program. Another factor proposed was that function could not be improved when working with a nonregenerating nervous system of the geriatric population.\textsuperscript{39}

This study investigated the effects of a line dancing exercise program on balance using the Berg Balance Measure and coordination using the
coordination assessment from O'Sullivan and Schmitz. The subjects involved in this study were a homogenous group according to the old age population (mean 85.7), health status, place of residence, and high functioning physical abilities as assessed by the left skew of initial and post testing scores.

Clinical Implications

This study shows that line dancing can improve balance and coordination in the elderly. At the beginning of the study, there was no significant difference between the control and dance group scores of the Berg Balance Measure\textsuperscript{35} and coordination test.\textsuperscript{5} Following the six weeks of dancing, there was a significant difference between the control group and the dance group. The results also demonstrated no significant change in scores in the control group, but a significant increase in the scores from the dance group. This concludes that a six-week line dancing program significantly improved scores on the Berg Balance Measure\textsuperscript{35} and the coordination assessment from O'Sullivan and Schmitz.\textsuperscript{5}

In addition, the line dancing program allowed the subjects to participate in an enjoyable activity with their peers and participate in exercises to enhance their balance. The dances were modified for safety to accommodate for the functioning level of the subjects. All participants were of a high functioning level as indicated by the scores on the Berg Assessment and Coordination tests. Surveys were completed by the volunteers at the end of the dancing program. Results showed that of the six total participants in the training group, five felt their balance had somewhat improved. The majority support the objective measures used by the researchers which also indicated an improvement with all
the dancers. The subject who felt that her balance did not improve could be explained by the degree of improvement not being large enough to be subjectively detected by the dancer, even though all post-test scores resulted in significant improvements. In addition, this subject was at a lower functioning level at the initial testing. It may have been difficult for the subject to see improvement in her daily living activities.

Other benefits were identified by the participants of the dance program through surveys filled out after the six weeks. These included that the dancing provided a challenging activity, balance and rhythm, improved flexibility, and a "little exercise in pleasant company." Other potential assets of this study that should be addressed in future research projects include the possible aerobic, strengthening, emotional, and social effects related to a dancing program with the elderly.

Limitations of Study

Although the results were significant and showed that line dancing did improve balance function according to the scores of the assessment tools, attendance fluctuated per week. The greatest amount of attendance of the 12 possible treatment sessions available was 11 (92%) and the least was 5 (42%). The average attendance of all the dancers was 64%. If attendance had been more consistent, results suggest the increase in scores would have been greater suggesting better balance with more training.

The researchers were responsible for giving the assessment tests measuring balance and coordination and the dance instruction. A potential
limitation related to the researcher's role in the study could have resulted in researcher bias. To minimize this, researchers did not have access to the initial scores until after the post testing was finished. Another more likely cause of improvement may have been the subjects showing increased confidence and comfort with the test and the researchers. This may have increased the motivation of the dancers to excel for them.

Another limitation was the loss of subjects. The original sample size for the dance group was nine subjects. Only six subjects were able to complete the entire six-week training program. Loss of the three subjects was due to relocation of residence, death, and unrelated health problems. However, the fact that 100% of the subjects showed some improvement was very significant.

In summation, this study studied the effects of a six-week line dancing program on balance and coordination in the elderly. There are many components of line dancing that challenge the sensory system and enhance balance. For example, weight shifting is a movement that is commonly used in balance training programs. Dancing also provides proprioceptive input and increased body and space awareness. A maintenance program addressing strength has shown to influence the preservation of balance. Another benefit to a line dancing exercise program is that it can be modified for all ages and levels of function (e.g., modified by incorporating the patient's assistive device into dance), such as a person with a hip fracture or stroke. Finally, with the increase in our aging population, it is important to find enjoyable activities to combat the effects of aging. This form of preventative treatment is proactive, improves
quality of life, and enhances the sensory system responsible for balance and coordination. The use of line dancing as a tool may increase patient compliance and result in improved treatment outcomes. In conclusion, line dancing can be an effective tool for physical therapists to use for balance and coordination training in the elderly.
X EXPEDITED REVIEW REQUESTED UNDER ITEM 7 (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

Please include ALL information and check ALL blanks that apply.

PRINCIPAL INVESTIGATOR: Sara Welder, Christa Stelmachuk, and Renee Mabey TELEPHONE: 777-2831 DATE: 2/25/00

ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT:

SCHOOL/COLLEGE: Medicine DEPARTMENT: Physical Therapy PROJECT DATES: 3/15/00-5/31/01

PROPOSED PROJECT TITLE:
The Effects of Line Dancing on Balance and Coordination in the Elderly

FUNDING AGENCIES (IF APPLICABLE):

TYPE OF PROJECT (Check ALL that apply):
NEW
X PROJECT _____ CONTINUATION _____ RENEWAL _____ DISSERTATION OR

X THESIS RESEARCH _____ STUDENT RESEARCH PROJECT

_____ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER: Renee Mabey

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

X INVOLVES A COOPERATING INSTITUTION

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

☐ MINORS (<18 YEARS) ☐ PREGNANT WOMEN ☐ MENTALLY DISABLED ☐ FETUSES ☐ PERSONS WITH

☐ 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

IF YOUR PROJECT HAS BEEN WILL BE SUBMITTED TO ANOTHER INSTITUTIONAL REVIEW BOARD(S), PLEASE LIST NAME OF BOARD(S):

Status: ___ Submitted; Date ____________ ___ Approved; Date ____________ ___ Pending

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

Loss of balance and coordination in the elderly results in increased falls and subsequent injury. This study will investigate whether a treatment program consisting of line dancing can improve balance and coordination in the geriatric population. Line dancing is a form of movement set to music, which challenges the body's sensory system.

This study requires a group (16-20) of elderly (over 65 years of age) subjects. All subjects will initially undergo a standard balance test, a standard coordination test, and a blood pressure check. Subjects will be assigned to either a line dancing exercise group or to a control group based on subjects' preference. The exercise group will participate in a half-hour line dancing class taught by the researchers, two times per week for 6 weeks. The control group will continue their regular activities during the six-week period. Following this period, the groups will repeat the initial balance and coordination tests. Findings from the two groups will be compared using traditional descriptive and inferential statistics. The results from this study will add to the current body of knowledge regarding balance, coordination, and dance. The information will be reported in an independent study format.
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. Attach any surveys, tests, questionnaires, interview questions, examples of interview questions (if qualitative research), etc., the subjects will be asked to complete.)

Recruitment: Subjects will be recruited from the Parkwood Place assisted living care center in Grand Forks, ND. A total of 16-20 subjects are required for this study.

Selection: Subjects will meet the study requirements if they are over 65 years of age, live independently, and ambulate independently without use of an assistive device. Subjects will be screened for risk of falls using the Tinnetti Assessment Tool, and will be excluded if their score indicates that they are at a high risk for falls. Subjects will also be excluded if they are found to have abnormally high or uncontrolled blood pressure.

Procedures: All subjects will initially complete a standard functional balance test (The Berg), standardized equilibrium coordination testing, and have a baseline resting heart rate and blood pressure recorded. This will take approximately 45 minutes. Subjects will be assigned to either a control group or a line dancing exercise group consisting of movements that are routinely performed by individuals of the geriatric population. The exercise group will participate in a 30-minute line dancing class taught by the researchers, two times per week for 6 weeks. Each session will begin with a 5-minute warm-up and end with a 5-minute cool-down. The control group will continue with their regular activities during the six-week period. Both groups will repeat the initial balance and coordination tests at the end of the six-week period. All testing and line dancing will take place at Parkwood Place.

Informed Consent: Informed consent will be obtained through an information and consent form (see attached form). All individuals participating in this study will be competent and independent in their decision-making and will sign the consent form in relation to participation in this study.

Risk: Line dancing is a form of exercise, which challenges the balance system, therefore there is some degree of risk for personal injury. However, the investigators feel this risk is minimal, as line dancing is routinely performed by the elderly in recreational dancing and many of the same movements are also used in physical therapy treatment programs. In addition, the line dances used will be modified to insure they are low impact and low intensity. Subjects will be excluded if they are at a high risk for falls or have abnormally high blood pressure. Both investigators will be present during all line dancing classes, and signs/symptoms of abnormal exertion/stress will be closely monitored. If a subject presents with these signs or symptoms, heart rate and blood pressure will be evaluated. All subjects will be informed that they may stop activity at any time.

If an injury does occur during a line dancing class, the subject will be encouraged to receive prompt medical attention, as would a member of the general population in a similar circumstance. The subject and the subject's third party payer will provide payment for such treatment. Both researchers are certified in First Aid as well as CPR and would provide treatment as necessary and appropriate until required treatment could be obtained.

Compensation: Neither the researchers nor the subjects will receive any compensation associated with participation in the study.

3. BENEFITS: (Describe the benefits to the individual or society.)
Loss of balance and falls among the elderly is a large health care problem. This study will investigate the effects of line dancing on coordination and balance in the elderly as measured by standard balance and coordination tests. Many of the same movements that are used in line dancing are routinely utilized to increase coordination and balance as a physical therapy treatment. Many elderly men and women currently participate in and enjoy line dancing. Having line dancing as a treatment option may be a way to increase motivation and compliance for a balance and coordination program. This study will add to the body of knowledge regarding line dancing and balance and coordination.

Benefits for the individual subject include a possibility of increased balance and coordination. Also, the subjects will have increased socialization with peers and the opportunity to participate in a line dancing class at no cost.

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 psychological, 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 protect the confidentiality of data obtained, debriefing procedures, storage of data, how long data will be stored (must be a minimum of three years), final disposition of data, etc.)

Line dancing is a form of exercise, which challenges the balance system, therefore there is some degree of risk for personal injury. However, the investigators feel this risk is minimal, as line dancing is routinely performed by the elderly in recreational dancing and many of the same movements are also used in physical therapy treatment programs. In addition, the line dances used will be modified to insure they are low impact and low intensity. Subjects will be excluded if they are at a high risk for falls or have abnormally high blood pressure. Both investigators will be present during all line dancing classes, and signs/symptoms of abnormal exertion/stress will be closely monitored. If a subject presents with these signs or symptoms, heart rate and blood pressure will be evaluated. All subjects will be informed that they may stop activity at any time.

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 the locked office of Renee Mabey at 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: Attach 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 how long (must be a minimum of 3 years), including plans for final disposition or destruction.

All consent forms from this study will be retained in the locked office of Renee Mabey, at the UND physical therapy department for three years following completion of this study. Informed consent will be obtained through an information and consent form (see attached form). All individuals participating in this study will be competent and independent with their decision-making and will sign the consent form in relation to participation in this study.

6. For FULL IRB REVIEW forward a signed original and fifteen (15) copies of this completed form, including fifteen (15) copies of the proposed consent form, questionnaires, examples of interview questions, etc. and any supporting documentation to the address below. An original and 19 copies are required for clinical medical projects. In cases where the proposed work is part of a proposal to a potential funding source, one copy of the completed proposal to the funding agency (agreement/contract if there is no proposal) must be attached to the completed Human Subjects Review Form if the proposal is non-clinical; 7 copies if the proposal is clinical medical. If the proposed work is being conducted for a pharmaceutical company, 7 copies of the company's protocol must be provided.

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, including a copy of the consent form, questionnaires, examples of interview questions, etc. and any supporting documentation to one of the addresses above. In cases where the proposed work is
part of a proposal to a potential funding source, one copy of the completed proposal to the funding agency (agreement/contract if there is no proposal) must be attached to the completed Human Subjects Review Form.

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

[Signature]

Date

3-10-2000

Project Director or Student Adviser

[Signature]

Date

3-10-2000

Training or Center Grant Director

[Signature]

Date

3-10-2000

(Revised 2/2000)
REPORT OF ACTION: EXEMPT/EXPEDITED REVIEW
University of North Dakota Institutional Review Board

Date: April 3, 2000
Project Number: IRB-200004-198

Name: Sara Welder, Christa Steimachuk, Renee Mabey
Department/College: Physical Therapy
Project Title: The Effects of Line Dancing on Balance and Coordination in the Elderly

The above referenced project was reviewed by a designated member for the University's Institutional Review Board on April 20, 2000 and the following action was taken:

☑ Project approved. EXPEDITED REVIEW Category No.
Next scheduled review is on: April 2001

☐ Project approved. EXEMPT REVIEW 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: R. Mabey, Adviser
Dean, Medical School

Signature of Designated IRB Member
UND's Institutional Review Board

4/10/00 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.
Subject Consent Form

THE EFFECTS OF LINE DANCING ON BALANCE AND COORDINATION IN THE ELDERLY

Name of investigators: Sara Welder and Christa Stelmachuk, senior students from the physical therapy department at the University of North Dakota.

________________________ has been asked to participate in a line dancing class, consisting of 20 minutes 2x/week for 6 weeks. The purpose of the line dancing class is to investigate whether line dancing can improve balance and coordination in the geriatric population. Line dancing is a form of movement set to music, which challenges the body's sensory system.

The requirements of the study are as follows: over 65 years of age, live independently, and ambulate independently without the use of an assistive device. If you wish to participate in this study you will be screened for risk of falls, and will be excluded if there is indication that you are at a high risk for falls. Participants will also be excluded if they are found to have abnormally high or uncontrolled blood pressure.

If you meet the requirements you will initially undergo a standard balance and coordination test, which will take about 45 minutes. You will then be assigned either to a control group or a line dancing group. The line dancing group will meet 2 times per week for about 30 minutes for 6 weeks. The control group will continue with their regular activities during the 6 week period. Both groups will complete the initial balance and coordination tests at the end of the 6 week period. The results of these tests will be recorded and will be available to you at any time.

The investigators feel the risk for injury is minimal as the line dances used will be modified to insure they are low impact and low intensity. Both investigators will be present during all line dancing classes, and signs/symptoms of abnormal exertion/stress will be closely monitored. If you present with these signs or symptoms, your heart rate and blood pressure will be evaluated. Participants may stop activity at any time.

If an injury does occur during a line dancing class, you will be encouraged to receive prompt medical attention, as would a member of the general population in a similar circumstance. You and your health insurance organization will provide payment for such treatment. Both researchers are certified in First Aid as well as CPR and would
provide treatment as necessary and appropriate until required treatment could be obtained.

Benefits of participating in the line dancing group include a possibility of increased balance and coordination.

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 to you will remain confidential and will be disclosed only with your permission. All data from this study will be retained in the locked office of Renee Mabey at 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.

Neither the researchers nor the participants will receive any compensation associated with involvement in the study.

Participation in this study is entirely voluntary, and you may withdraw consent and discontinue participation at any time until the final data has been collected, without prejudice.

The investigators may be reached at the University of North Dakota department of physical therapy at (701)777-2831, or at home at (701)746-6069 to answer any questions concerning the study, the procedures, and/or any risks or benefits that may arise from participation in the study.

I understand all of the above information, all of my questions have been answered, and I am voluntarily agreeing to participate in the line dancing program being conducted by Sara Welder and Christa Stelmachuk from the UND physical therapy department. A copy of the consent form has been given to me.

_________________________________________ Date: ______________________
Signature of Subject

_________________________________________ Date: ______________________
Signature of Investigators

_________________________________________ Date: ______________________
Signature of Witness

Thank you for your time and cooperation!!
APPENDIX C
**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

### 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:** $= 16$

APPENDIX D
## BALANCE SCALE

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

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

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

   *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 chair 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 armsrests and one way toward a seat without armsrests. You may use two chairs (one with and one without armsrests) 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 needs one person to assist
   ( ) 1 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 OUSTRETCHED 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 foot.
( ) 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 20 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 remains standing independently
( ) 0 unable to try or needs assist to prevent fall

( ) TOTAL SCORE (Maximum = 56)
### PART II EQUILIBRIUM TESTS

**Key to Grading**

4. Able to accomplish activity.
3. Can complete activity; minor physical contact guarding required to maintain balance.
2. Can complete activity; significant (moderate to maximal) contact guarding required to maintain balance.
1. Activity impossible.

### Grade | Coordination Test | Comments
--- | --- | ---
Standing: normal comfortable posture |  |  
Standing: normal comfortable posture with vision occluded |  |  
Standing: feet together |  |  
Standing on one foot | seconds L( ); R( ) |  
Standing: forward trunk flexion and return to neutral |  |  
Standing: lateral trunk flexion |  |  
Walk: place heel of one foot in front of toe of the opposite foot |  |  
Walk: along a straight line |  |  
Walk: place feet on floor markers |  |  
Walk: sideways |  |  
Walk: backward |  |  
Walk: in a circle |  |  
Walk: on heels |  |  
Walk: on toes |  |  

**Additional comments:**

**NOTE:** Notations should be made under comments section if

1. Lack of visual input renders activity impossible or alters quality of performance.
2. Verbal cuing is required to accomplish activity.
4. An excessive amount of time is required to complete activity.
5. Changes in arm position influence equilibrium tests.
6. Any extraneous movements, unsteadiness, or oscillations are noted in head, neck, or trunk.
7. Fatigue alters consistency of response.
APPENDIX F
LINE DANCE INSTRUCTIONS

Dancers should form lines facing the same direction. Music should include a four count beat. Everyone should start on the same foot at the same time. Repeat dance sequence until the music ends.

SUNNY MOOD

Palomino records@att.net

Basic right (step right, left touch, right step, left touch)
Basic left (step left, right touch, step left, right touch)
Walk forward 4 steps
Vine to the right (step right, left behind right, step right left to right)
Vine left - same as above
Vine right
Vine left
Strut 4 (heel walking) - going in semi circle - end facing the opposite direction

ALLEY CAT

Record No. 45-6226 (Golden Oldie)
Atco Records
Palominorecords@att.net

Vine right
Vine left
Go forward 3, starting with right foot
Turn 1/4 with right foot, doing a little hitch with left foot
Going backward starting with left foot - 4 counts
Start vine again with right foot - dance continues.

ELVIRA

Released: 07/10/1990
MCA Records

Vine right
Vine left
Go backwards 3 steps - right, left, right and forward on left
Rock left, rock right back, rock left forward
1/4 turn to left - dance starts again.
REFERENCES


29. Randall T. Music not only has charms to soothe, but also to aid elderly in coping with various disabilities. *JAMA.* 1991;266(10):1323-1324,1329.


