2004

The Effects of the "Get Off Your Rocker" Exercise Class on Balance for Patients following a CVA: A Case Study Approach

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THE EFFECTS OF THE "GET OFF YOUR ROCKER" EXERCISE CLASS ON BALANCE FOR PATIENTS FOLLOWING A CVA: A CASE STUDY APPROACH

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A Scholarly Project
Submitted to the Graduate School 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, 2004

This Scholarly Project, submitted by Michele Jackson and Kimberly Lindemann 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 Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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PERMISSION

Title	The Effects of the "Get Off Your Rocker" Exercise Class on Balance for Patients Following a CVA: A Case Study Approach
Department	Physical Therapy
Degree	Master of Physical Therapy

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

We would like to express our gratitude to several individuals for their contribution to this project. First, we would like to thank Cindy Flom-Meland, our advisor, for her inspiration, guidance, and continued support throughout this study. We would also like to express our appreciation to Renee Mabey for her wisdom and encouragement. Thank you to HealthSouth for allowing us to utilize their facility and equipment and to Jill Bisson, the Fitness Director at HealthSouth, for instructing us in the "Get Off Your Rocker" exercise class. Finally, a special thank you to the subjects who volunteered to help us with this study. Their enthusiasm and commitment inspired us and taught us more than we thought possible.

ABSTRACT

Background and Purpose: Cerebral vascular accident (CVA) is the leading cause of serious, long-term disability and the third leading cause of death in the United States. It is estimated that approximately 75% of people who have a stroke survive, many of whom live with some level of impairments that impact their activities of daily living and quality of life. One of the results of these impairments can be decreased balance. Limitations in balance may impact an individual's risk of falls, ability to ambulate, and performance of functional activities. Exercises emphasizing balance training play a significant role in improving postural control. The purpose of this study is to determine if the six-week "Get Off Your Rocker" balance exercise class improves balance and quality of life in people who have had a CVA and who live in the community. If the "Get Off Your Rocker" exercise class is found to be effective for this population, it can be an additional tool for physical therapists in improving balance. **Subjects:** The two subjects who participated in the study had a neurological diagnosis of CVA. Both subjects were older than 20 years of age, lived in the community, and ambulated independently. **Methods:** Four measures were used to gather data regarding balance and quality of life. During the initial testing session, subjects completed the Timed Up and Go, Functional Reach, Berg Balance Measure, and Short Form 36 Health Survey. Subjects then participated in the "Get Off Your Rocker" balance exercise class three times a week for six consecutive weeks. Following the exercise class, the assessment measures were repeated. **Results:** Subjects demonstrated both quantitative and qualitative improvements. Both participants showed improvements on all four of the measures. **Conclusion:** Following participation in the six-week "Get Off Your Rocker" balance exercise class, we concluded that it was beneficial in improving balance for people following a CVA. This class can be an effective tool for balance training and increasing functional capacities leading to enhanced quality of life.

CHAPTER 1

INTRODUCTION

A cerebral vascular accident (CVA) is a sudden, focal neurological deficit due to ischemic (lack of oxygen) or hemorrhage (ruptured blood vessels) lesions in the brain. It is also know as a stroke.[1] CVA is the leading cause of serious, long-term disability and the third leading cause of death in the United States.[2] It is estimated that approximately 75% of people who have a stroke survive, many of whom live with some level of impairments that impact their activities of daily living and quality of life. Ongoing impairments lead to partial or total dependence in activities of daily living in 25 to 50% of people who have survived a stroke.[3]

Clinically, a wide variety of deficits are possible following a CVA, including impairments of sensory, motor, cognitive, perceptual, and language functions. The severity of the deficit(s) is dependent upon the location of the lesion, the extent of the lesion, the amount of collateral blood flow, early intervention management, and the stage of recovery.[4] One of the results of these impairments can be impaired balance, which leads to an increased risk of falling. Research has found that people who have had a CVA are at an increased risk of falling compared to people in the general population.[5] Of people who have had a stroke and live in the community, 50% are classified as fallers. These falls resulted in minor injury 24% of the time and serious injury 6% of the time.[6]

Exercises emphasizing balance training have been shown to improve balance in patients with neurological deficits.[7-9] However, more research is needed on balance programs that focus on people who have had a CVA who live in the community and who are several months or years post-initial rehabilitation. This study will focus on the efficacy of the "Get Off Your Rocker" balance exercise class as a tool for improving balance in community-dwelling individuals who have had a CVA.

Problem Statement

Limited research has been conducted exploring the benefits of a group style balance exercise class with community-dwelling individuals who have had a stroke. Given the prevalence of and potential deficits following a CVA, physical therapists are in need of effective means to treat balance issues in a cost efficient manner. A group format can meet these needs, as well as promote increased adherence due to the social interactions among participants. Individuals may also experience improved confidence in performing activities of daily living and enhanced general health and well-being.

Purpose

The purpose of this study is to determine if the six-week "Get Off Your Rocker" balance exercise class improves balance and quality of life in people who have had a CVA and who live in the community. If the "Get Off Your Rocker" exercise class is found to be effective for this population, it can be an additional tool for physical therapists in improving balance.

Significance

Decreased balance is a common impairment following a CVA. Limitations in balance may impact an individual's risk of falls, ability to ambulate, and performance of functional activities. Exercises emphasizing balance training play a significant role in improving postural control. A physical therapist with varied treatment options is more likely to be able to individualize a program for a person following a CVA in order to maximize benefit to the individual. The "Get Off Your Rocker" balance exercise class, if effective, will be one more tool available for balance training.

Research Questions

1. What is the effect of the six-week "Get Off Your Rocker" balance exercise class on balance measures, including the Timed Get Up and Go, the Functional Reach, and the Berg Balance Measure, in participants with a diagnosis of CVA?
2. What is the effect of the six-week "Get Off Your Rocker" balance exercise class on quality of life, as measured by the Short Form 36 Health Survey, in participants with a diagnosis of CVA?

Hypothesis

H_O: The "Get Off Your Rocker" balance exercise class will have no effect on balance and quality of life in participants with a diagnosis of CVA.

H_A: The "Get Off Your Rocker" balance exercise class will have an effect on balance and quality of life in participants with a diagnosis of CVA.

CHAPTER 2

LITERATURE REVIEW

Cerebral Vascular Accident

A cerebral vascular accident (CVA) is a sudden, focal neurological deficit due to ischemic (lack of oxygen) or hemorrhage (ruptured blood vessels) lesions in the brain. It is also known as a "brain attack" or stroke. When a CVA occurs, the supply of blood to the brain is disrupted and brain cells are destroyed, with effects lasting hours to days to years. Clinically, a wide variety of resulting deficits are possible.[1] Disease states, such as a CVA, can be described using the Nagi Model. The following section will discuss the pathology, impairment, functional limitation, and disability of a CVA using the Nagi Model.[10]

Incidence and Prevalence

Stroke is the third leading cause of death, with 700,000 new or recurrent strokes occurring each year. It is the leading cause of serious, long-term disability in the United States. The incidence of CVA increases dramatically with age, doubling every ten years after 55 years of age. The care and services following CVA's can be staggering, and the financial costs are estimated to be 30 billion each year in the United States. Direct costs, such as reimbursements to hospitals, physicians, and rehabilitation, accounted for 17 billion, and indirect costs, such as lost productivity, accounted for 13 billion. Of the estimated 4.7 million people who survive a CVA, 1.1 million reported difficulty with functional limitations and activities of daily living.[2]

Pathology of a CVA

Pathology is the interruption or interference of normal bodily processes or structures.[10] As noted above, a CVA is a sudden, focal neurological deficit resulting from ischemic or hemorrhage lesions in the brain. The brain consists of more than 10 billion cells, which represents only 2% of the total body weight, yet it requires 25% of the oxygen the body receives. A stroke disrupts the blood delivery and starves brain cells of oxygen, consequently causing cell death.[1]

Secondary injury to surrounding brain cells also occurs as dead brain cells release chemical messengers that set off a "chain reaction." The cascade of chemicals includes release of glutamate, an excitatory neurotransmitter, which causes changes in calcium ion distribution that leads to activation of destructive enzymes. The overall effect is one of additional neuronal death. Additionally, there may be accumulation of fluid that causes cerebral edema within hours of the CVA and reaches maximal damage in four days, resulting in widespread membrane and tissue destruction.[1]

Clinically, a wide variety of deficits are possible, including impairments in sensory, motor, mental, perceptual, and language functions. The symptoms that result correspond to the area of the brain affected by the abnormal blood flow and tissue death. The location and extent of the lesion and the amount of collateral blood flow determine the severity of the neurological deficits.[4] These resulting impairments following a CVA will be further discussed later in the chapter. The American Stroke Association[11] states that warning signs of a CVA include sudden numbness or weakness especially on one side of the body, sudden confusion or difficulty speaking or understanding, vision problems, trouble walking, dizziness, loss of balance or coordination, and sudden severe headaches.

Cerebral vascular accidents can be classified into two types: (a) ischemic and (b) hemorrhage. Approximately 80% of strokes are ischemic and occur when there is a lack of blood supply to the brain due to an obstruction, which decreases the oxygen delivered to the brain cells. The most common cause of ischemia is atherosclerosis, the buildup of fatty deposits inside the arteries, which blocks the flow of blood. These fatty deposits can cause obstruction in two different ways. One way is through cerebral thrombosis, which occurs when a blood clot forms at the clogged part of the blood vessel in the brain resulting in decreased blood flow to the brain. Less frequently, a cerebral embolism can occur in which a blood clot forms in another part of the body and breaks loose. The clot is swept through larger blood vessels into the smaller vessels in the brain where it lodges and obstructs blood flow to that area of the brain.[1,4,12]

Hemorrhage stroke is the second type of stroke, which occurs when a weakened artery leaks or ruptures. The blood puts pressure on the surrounding tissues and damages brain cells even beyond the rupture. The hemorrhage stroke is perpetuated by high blood pressure, which weakens the vessel walls. Aneurysms, weak spots in the blood vessels, could cause a hemorrhage when the vessel bulges and the thin and stretched vessel ruptures in the brain.[1,4,12]

Transient ischemic attacks (TIAs), or mini strokes, are a temporary interruption of blood flow to parts of the brain. The etiology and symptoms of a TIA are the same as for a CVA; however, the duration is shorter, symptoms are more focal, and the individual recovers rapidly (within 24 hours) with no permanent damage. The occurrence of a TIA indicates a serious underlying risk that a CVA could follow. A person who has had a TIA is almost ten times more likely to have a CVA than a person who has not.[12,13]

All types of CVA share common risk factors. The American Stroke Association[14] states that the risk factors include:

1. Age – risk increases as an individual gets older – doubles each decade after 55
2. Family history – risk increases for people who have a family history of CVA
3. Gender – incidence and prevalence are equal for men and women, but more women die following a stroke
4. Ethnicity – African Americans have a greater risk
5. High blood pressure – CVA risk varies directly with high blood pressure – thought to be the most important risk factor
6. Prior CVA – risk increases many times over a person who has never had a CVA
7. Cigarette smoking – increases risk by 50% and is directly related to the number of cigarettes smoked per day
8. Diabetes mellitus – increases risk
9. Carotid artery disease – increases risk
10. Heart disease – risk is doubled
11. High red blood cell count – increases risk

Other factors are considered secondary risk factors because they affect the risk of a CVA indirectly by increasing the risk of heart disease. These include high blood cholesterol, obesity, and physical inactivity.[14]

Impairments Accompanying a CVA

Impairments are defined as the loss or abnormality of mental, emotional, physiological, or anatomical structures or functions.[10] Depending on the location of the CVA impairments vary and can affect many parts of the body, including sensory, motor, language, cognitive, and affective functions. Impairments can be either direct or indirect. Direct impairments are the natural consequence of the pathology or disease. Indirect impairments are secondary complications that occur as a result of the primary condition. They are often multisystem and can result from prolonged inactivity, ineffective management, or lack of rehabilitation services.[4,10]

Direct Impairments

Somatosensory deficits are one type of direct impairment that can occur with a CVA. These deficits can take the form of numbness, dyesthesias (abnormal sensation), hyperesthesia (increased sensation), proprioception deficits, and loss of superficial touch, deep touch, pain, and temperature sensation. Sensation is often impaired but rarely completely absent on the hemiplegic side. The extent and exact nature of the sensory loss is dependent upon the location and severity of the CVA.[4] Fifty-three percent of patients who had a CVA report sensory deficits.[3] Forty-four percent of patients who had a stroke were found to have proprioceptive losses, which impacted their motor control, posture, and balance.[15]

Motor deficits are another type of direct impairment. The early stages of a CVA typically consist of flaccidity with no volitional movement. Flaccidity is then replaced by the development of spasticity, hyperreflexia, and synergies (mass patterns of movement). Spasticity occurs in about 90% of people who have had a CVA and is found primarily on the side of the body opposite the lesion. In addition to the hyperreflexia, primitive and tonic reflex patterns may emerge. Synergy patterns can be either flexion or extension and can be classified for both upper and lower extremities. As the person who had the CVA recovers, spasticity and synergies decline, and advanced and more volitional movement patterns become possible. Motor deficits can be characterized by paralysis (hemiplegia) or weakness (hemiparesis) in the body opposite the site of the lesion. The nature and severity of the motor deficits reflect the type, location, and extent of the vascular lesion. Other motor impairments include incoordination, apraxia (deficits in motor planning), bradykinesia (slow movements), and disturbances in balance and postural control. Disruption of a person's postural control and balance can lead to falls or other injuries that further complicate recovery.[3,4]

Visual deficits are another type of direct impairment that can result following a CVA. Homonymous hemianopsia, the loss of vision in the contralateral half of each visual field, is the most common type of visual deficit. Visual field deficits can lead to lack of awareness of the hemiplegic side. Other impairments include visual neglect, depth perception difficulties, problems with spatial relationships, diplopia, vertigo, and disturbances in color vision.[3,4]

Speech and language deficits can be found in people who had a lesion involving the cortex of the language-dominant hemisphere and can result in disturbances in comprehension, speech, verbal expression, reading and writing.[4] Aphasia, an impairment in language comprehension, formulation and use, occurs in 30-36% of people who have had a CVA. Aphasia can be receptive (person is able to speak but has difficulty comprehending), expressive (ability to speak is affected but comprehension is good), or global (combination of receptive and expressive deficits).[3]

Visual-perceptual deficits are another type of direct impairment that can occur with lesions to the cortex. Most commonly they occur with right-sided lesions and left hemiparesis. Examples of visual-perceptual deficits include body image disorder (distortions in the visual and mental image of one's body), spatial relations syndrome (difficulty in perceiving the relationship between the self and two or more objects in the environment), agnosia (inability to recognize incoming information despite intact sensory function), and apraxia (lack of voluntary, controlled movement). Ipsilateral pushing, also known as pusher syndrome, occurs when the person demonstrates a strong lateral lean toward the hemiplegic side.[3,4]

Cognitive and affective deficits are also considered direct impairments of a CVA. Cognitive deficits can take the form of difficulties with attention, memory, ability to learn, and other executive functions. A wide range of emotional problems may be experienced depending upon the area of the brain damaged. However, depression is common among patients who have experienced a CVA, occurring in one-third of the cases. Depression appears to be more frequent and severe among patients who have lesions in the left-hemisphere compared to right-hemisphere.[3,4]

Indirect Impairments

As noted above, indirect impairments are secondary complications that occur as a result of the primary condition.[10] Indirect impairments can include deep venous thrombosis, skin breakdown, loss of range of motion, and shoulder pain and subluxation. Deep venous thrombosis is a complication of immobilization and occurs in approximately 47% of patients with CVA. Skin breakdown and pressure sores can develop when there has been ischemic damage and subsequent necrosis of the skin. If a person has spasticity and/or contractures, this may lead to increased friction and tearing of the skin. Decreased range of motion may result from loss of voluntary movement and immobilization and is most common in the shoulder, elbow, wrist, fingers, and ankle.[3,4] Shoulder pain occurs in 70 to 84% of patients who have had a CVA. Restricted movements, poor handling and positioning may contribute to subluxation.[16]

Functional Limitations Accompanying a CVA

Functional limitations are the restriction or lack of ability to perform an action or task in the manner considered normal.[10] Various functional limitations can result following a CVA, including difficulty with bed mobility, transfers, ambulation, and activities of daily living. Difficulties experienced by individuals vary considerably depending on the severity of the stroke, location of the lesion, and the stage of recovery.

Rozzini et al[17] investigated the effect of chronic conditions, including stroke, on physical function. Participants included 549 community-dwelling subjects aged 70 and over. Subjects were assessed on two self-reported measures of activities of daily living and one physical performance based test. The Katz Basic Activities of Daily Living (Katz BADL) is a self-report scale that assesses six functions, including bathing, dressing, toileting, mobility, continence, and feeding. The Lawton and Brody Instrumental Activities of Daily Living (Lawton and Brody IADL) is a self-report scale that assesses eight functions, including using the telephone, using transportation, managing money, shopping, taking drugs, cooking, housekeeping, and doing laundry. Subjects were also tested on the Physical Performance Test (PPT), which assesses multiple domains of physical function by observing and timing the performance of tasks that simulate ADL activities, including writing a sentence, eating, lifting a book from a table, putting a jacket on and off, picking up a coin on the floor, turning around 360°, and walking 15 meters. Scores on the PPT range from zero (worst performance) to 28 (best performance). On the Katz BADL scale, results indicated that 12% of the subjects were dependent in one function and 15% were dependent on two or more functions. On the Lawton and Brody IADL scale, results showed that 21% were dependent on one function and 31% were dependent on two or more functions. On the PPT, results demonstrated that 47% scored over 20, 36% scored between 11 and 20, and 15% scored less than 11. Statistical analysis indicated that several chronic conditions, including a stroke, Parkinson's, heart disease, poor vision, and cancer, were associated with the PPT score but not with the self-reported ADL scales. Thus, these conditions cause a degree of functional limitation as measured by a standardized physical performance task, but those subjects did not report problems with their ADL's on the self-report scales. The authors suggest that people may develop compensatory strategies to accomplish tasks that they need to perform. While it may take them longer to perform these tasks, the fact that they are able to complete them in some fashion is indicative of self-sufficiency to them.

Mayo et al[18] compared functional limitations and quality of life of people who have had a CVA to people who have not. Participants were all community-dwelling and included 434 people with a diagnosis of CVA and 486 controls who were matched by age and city district. Subjects were interviewed by telephone at six-month intervals for two years; however, this study only reported the six-month post-stroke findings.. Six measures were used to assess basic activities of daily living, instrumental activities of daily living, reintegration into normal community living, cognitive status, health related quality of life and general quality of life. Subjects who had a diagnosis of a CVA scored significantly poorer on all six measures. At six months post-stroke, 39% of subjects who had a stroke experienced difficulty with basic activities of daily living, such as self-cares (bathing, dressing, grooming), 21% had trouble walking 50 meters, and 24% had problems with negotiating stairs. Higher-level activities were measured by instrumental activities of daily living, and 54% of subjects had limitations in at least one category. Most problematic included housework (48%), shopping (36%), and meal preparation (29%). Reintegration into normal community life looked at an individual's involvement in 11 aspects of life that requires interaction with the external environment. Sixty-five percent of subjects who had experienced a stroke reported restrictions. Most challenging areas were travel, social activities, recreational activities, moving around the community, and having an important activity to fill the day. The authors conclude that the most frequent limitations of persons who have had a CVA can be summarized into four broad categories: basic activities of daily living, household tasks, travel, and having a meaningful activity. They believe that these difficulties can put people who have had a CVA at risk for diminished activity level, social isolation, and further negative health events.

Disability Resulting from a CVA

Disability is defined as the inability or limitation in performing socially defined activities and roles expected of individuals within a social and physical environment.[10] These could include difficulties meeting expectations in family roles, social life, community activities, and occupation. Various impairments and functional limitations discussed above can result in disability in a person who has had a CVA. For example, if a person is unable to perform basic activities of daily living, they may not be able to live in their own residence independently. Also, a person who had difficulty with ambulation and uses a wheelchair may not be able to attend a community event if it is not wheelchair accessible.

Teasell et al[19] studied the social factors and outcomes of patients under the age of 50 who had a stroke. Using a retrospective chart review, the authors examined marital status and employment status at admission and at three months after discharge, discharge destination and primary caregiver, and psychosocial difficulties. Participants included 83 patients under the age of 50 who had experienced a CVA. Results indicated that following rehabilitation, 82% of subjects were discharged to their premorbid living arrangements, 10% to a parent's home, 5% to an institution, and 4% to someone else's home. Within three months of discharge, 15% of subjects were separated from their spouse; however, in the majority of cases, marital stress was noted prior to the onset of the CVA. Of the patients who were employed or studying at the time of the stroke, only 20% were able to return within three months of discharge. Only 9% of those working full-time were able to return to full-time status. Predominant psychosocial issues included anxiety and depression. The authors concluded that younger persons who have a CVA experience some important social issues, such as marital relationships and return to work issues, that may have significant impact on quality of life and need to be addressed during rehabilitation.

Clarke et al[20] studied the patterns of well-being in community-dwelling people who have had a stroke to determine factors that restrict and enhance well-being. Subjects were taken from the second wave of the Canadian Study of Health and Aging study. For the current study, analyses were run on the 339 subjects who indicated that they had a history of a CVA, and comparisons were made to community-dwelling individuals who had not experienced a CVA. Subjects were administered the Ryff Measure of Psychological Well-Being, which included dimensions on self-acceptance, autonomy, environmental mastery, purpose in life, personal growth, and positive relations with others. Other measures included a demographic form, Modified Mini-Mental State Exam, and measures of basic and instrumental activities of daily living. Results indicated that subjects who had experienced a stroke reported a lower sense of well-being compared to individuals who had not experienced a stroke. Those who had experienced a stroke reported significantly more difficulties with basic and instrumental activities of daily living, a greater number of comorbid health conditions, and lower scores on a mental health scale. While physical disabilities, cognitive difficulties, and mental health issues were found to be associated with a reduced sense of well-being in individuals who had a stroke, social support and educational resources tended to moderate the impact of functional status on well-being.

Balance

Many individuals who have had a CVA experience ongoing neurological impairments that affect balance and mobility.[21-23] Residual sensory, motor, perceptual, and cognitive deficits can interfere with the brain's ability to coordinate the lower extremities during gait and stance, which can result in decreased balance and postural control. The extent of the dysfunction depends on the area of the brain affected and the severity. When balance is impaired, the risk of falls increase. Falls are considered a major complication following stroke[21] and can result in further difficulties such a fracture and/or soft tissue trauma.[23] Unfortunately, many people who sustain a hip fracture do not regain their premorbid level of functioning. Cumming[24] reported that within a year of experiencing a hip fracture approximately 20% of people die and another 20% become institutionalized. Studies indicate that a CVA can cause increased postural sway,[25, 26] decreased area of stance stability,[27] decreased weight bearing on the involved leg,[27] abnormal lower extremity postural responses to displacement,[22] and impairment to any of the systems utilized in maintaining balance.[27] Hellstrom et al[28] discussed several other CVA induced impairments, including: abnormal tilt of the internal representation of one's orientation in space, impaired proprioception, loss of anticipatory reactions, decreased range of motion, and high muscle tone accompanied by increased joint stiffness, muscular weakness, and muscle shortening.

Balance is described as the ability to maintain the body's center of gravity over its base of support.[29] It can also be thought of the ability to maintain stability and move in a weight-bearing posture without falling. Within any given base of support, there is a limit to the distance a body can move without either falling or establishing a new base of support, which is called the limit of stability. Postural stability is dependent on the positional control of body parts through muscular activity. Therefore, postural control can be described as the act of maintaining, achieving, or restoring a state of balance during any posture or activity.

Huxham et al[30] stated that balance is a function of two things: the attempted task and the environment in which the action is attempted. Balance is required for simple tasks such as reaching, cleaning a window, or walking across a street. The degree of balance required for different activities varies according to the task and the environment. For example, reaching on your toes requires greater balance than reaching with a wide base of support. The environmental factors that affect balance include: lighting, familiarity, smoothness, sloped ground, and sturdiness of the surface. These factors can cause an individual to alter different aspects of their gait, such as step length.

The task and the environment can alter the biomechanical features of an activity, which changes the effects of forces on the skeletal and muscular systems. They also affect the amount of information that must be processed to achieve and sustain balance and postural control. To attain postural and balance control, an individual must have intact predictive, reactive, and proactive mechanisms. Predictive mechanisms maintain stability between the segments of the body and between the body and the supporting surface. Therefore, an individual requires accurate proprioceptive information from the body, as well as knowledge of how to maintain postural and functional balance. This knowledge is not based on sensory input, but rather on learned experiences and prior feedback on how to rectify balance disturbances. Reactive balance mechanisms consist of motor responses that include ankle, hip, and stepping strategies. Proactive balance mechanisms are based on the visual system and consist of input from the eyes.[30]

Balance is a highly complex process and involves the integration of the somatosensory, visual, vestibular, and musculoskeletal systems. A state of equilibrium is achieved when all components are functional and integrated.[22, 29] The central nervous system is only able to process information from one input at a time, and in healthy adults, the preferred input is somatosensory. However, due to the plasticity of the brain, it is capable of using the visual or vestibular systems as input when the somatosensory system is not working properly. Balance is a complex process that requires the central nervous system and musculoskeletal system to make postural adjustments to internal and external changes.[25, 31] In order to understand balance, it is necessary to take a more detailed look at the four component systems: somatosensory, visual, vestibular, and musculoskeletal systems.

Components of Balance

Somatosensory Component

Somatosensory information is the preferred input to maintain balance control in healthy individuals and comes from contact information between the feet and supporting surface. Bennett and Karnes[29] stated that somatosensation is information from the receptors in the joints and muscles that travel to the cortex and the cerebellum. Proprioceptive input arises from joint mechanoreceptors, muscle and tendon receptors, and pressure receptors in the feet. Somatosensory information is processed the fastest, followed by visual and vestibular input.

Proprioceptive information can be carried through either the dorsal columns/medial lemniscus pathway or the spinocerebellar tracts. The proprioceptive information carried through the dorsal columns/medial lemniscus pathway is sent to the thalamus and eventually to the cortex. This includes touch, vibration, joint position and joint movement. The spinocerebellar tracts contain information from the Golgi tendon organs, muscle spindles, joint receptors, and cutaneous receptors. These receptors affect balance by changing the movement patterns.[29]

When an individual experiences a CVA, the processing portions of the brain may be affected. Therefore, somatosensory information may be impacted because the data cannot get processed and integrated by the brain. This prevents the individual from determining joint position and motion, which can affect balance and mobility. When the somatosensory system is impaired, the central nervous system will attempt to use an alternate component to gage joint position and limb motion.[29]

Visual Component

The visual system is an important component in maintaining balance as it provides information on obstacles, surface, placement, and proprioception. This allows an individual to maneuver and react to his/her environment. Input from the environment enters through the eyes and is sent to the brain where it is processed based on previous experiences. In response to this input, a course of action is chosen and a signal is sent to the nerves and muscles in the body to execute the action. There are other systems involved in maintaining balance, but the visual system is most often used when one of the other systems is impaired.[29, 32] The visually based proactive mechanism is one of the key contributors to balance.[30]

When an individual experiences a CVA, the visual system may be impaired. Examples of visual impairments include vision loss, changes in vision field, distortions in spatial relationships, peripheral vision loss, perceptual deficits, hemianopsia (loss of one half of the visual field), and ischemic optic neuropathy. Ischemic optic neuropathy occurs if the location of the CVA is in the area of the optic nerve. With ischemic optic neuropathy, the level of visual impairment depends on the amount of the optic nerve affected and on the location of the brain affected (i.e. visual processing areas). If the visual processing area of the brain has been injured, an individual will not be able to "see" correctly even if the eye itself has not been damaged. For normal vision to occur, the eye and the optic nerve must work in conjunction with the brain. For those who have visual impairments, visual rehabilitation may include a variety of services including: low vision aides, rehabilitation teaching, and orientation/mobility training.[29]

Vestibular Component

The vestibular system works in conjunction with the visual and somatosensory systems to maintain balance.[32] When the visual and proprioceptive systems give conflicting information or are not working properly, the vestibular system serves as an internal reference.[25] This system provides sensory information about the position and motion of the head.[22]

The vestibular system is made up of three components: the peripheral sensory component, the central processing component, and the motor control component.[32] The semicircular canals and otolith organs are located in the inner ear and make up the sensory component. The hairs in the semicircular canals and the otolith organs detect head movements, as well as its orientation in space.

The central processing component of the vestibular system consists of the pons and the cerebellum. This component processes information from the inner ear, combines the information with visual and proprioceptive input, and finally sends the information down to the spinal cord and ocular muscles.[32]

The motor control component consists of the spinal cord and ocular muscles, which respond by regulating posture through the vestibulo-ocular reflex and the vestibulospinal reflex. The vestibulo-ocular reflex allows the eyes to remain stable, which allows for the maintenance of a stable visual field with head motion. The vestibulospinal reflex influences muscles in the body and maintains head and body control through compensatory motions during a perturbation in balance.[32]

Following a CVA, an individual may have impairments in the vestibular system that follows a similar mechanism of the visual system. The central processing portion or the motor planning portion of the brain may be affected.

Musculoskeletal Component

The motor/efferent aspect of balance is referred to as the musculoskeletal component. After sensory input has been analyzed and integrated by the brain, a signal or course of action is sent to the skeletal and ocular muscles. Based on the signal that is sent, the body responds with appropriate movement and balance strategies to maintain or regain balance. Tideiksaar[32] explained that during unexpected balance displacements muscle activation occurs from distal to proximal. For example, during sudden anterior displacements, the muscle activation would have the following sequence: plantarflexors, knee flexors, hamstrings, and trunk muscles. In a healthy individual, these muscles are rapidly activated in approximately 100 milliseconds after a loss of stability. This reaction time is generally fast enough to prevent loss of balance.

The postural control mechanisms for maintaining balance in the musculoskeletal system include: the ankle strategy, hip strategy, stepping strategy, and suspensory strategy.[29] The ankle strategy is used with small balance disturbances (or when a weight shift is experienced with the feet on a stable solid surface). An individual uses the muscles around the ankle joint to restore equilibrium, while the feet are kept in place. Motions include anterior-posterior, side-to-side, and rotating about the ankle joint with minimal motion at the hip and knee joints.[32]

The hip strategy is used with larger perturbations or on less stable surfaces.[29] This strategy involves flexion and extension of the hip joint in order to restore balance. Contrary to the ankle strategy, the hip muscles are activated proximal to distal. During forward displacement, trunk flexors, knee extensors, then ankle dorsiflexors are activated.[32]

The stepping strategy is used when the center of gravity is displaced outside the base of support, and an individual must take a step to prevent falling and realign the base of support over the center of gravity. In such cases, neither the ankle nor the hip strategies are sufficient to regain balance. The suspensory strategy is utilized when the body is lowered to provide stability by bringing the center of gravity closer to the base of support.[29]

When an individual experiences a CVA, the musculoskeletal processing portions of the brain may be affected. Therefore, the efferent reactions may not occur, and the individual may have difficulty maintaining and regaining balance. Nerve damage may also result in muscle atrophy and weakness.

Balance Assessment

Tests are available to assess the origin of the balance dysfunction, as well as quantify and qualify the degree of balance disturbance. Balance can be assessed through general clinical tests and laboratory methods.[31] Laboratory methods generally require expensive equipment and are performed by a physician or otolaryngologist. By determining the origin of the balance impairment, it is possible to identify the internal systems (visual, vestibular, somatosensory, and musculoskeletal) that contribute to the dysfunction and to develop an appropriate treatment program.

Balance assessment includes evaluation of many areas including the musculoskeletal, sensory, visual, and vestibular systems. Prior to assessment of these areas, a thorough patient history is necessary (i.e. onset of balance dysfunction, past medical history, dizziness, functional limitations, etc.).[29]

The first system to be assessed should be the musculoskeletal system to rule out weakness and decreased range of motion as the primary cause of the balance problem. Areas of focus include body segment alignment, tone, tremors, coordination, and involuntary movement.[29]

Following the musculoskeletal assessment, the sensory evaluation should include the somatosensory, visual, and vestibular systems. As discussed earlier, the somatosensory system contains two important tracts: the dorsal column/medial lemniscus and the spinocerebellar tracts. The dorsal column/medial lemniscus tract is assessed by testing an individual's ability to localize touch on their body, determine body position, and determine the amount of body sway (Romberg test).[29]

Testing of the visual system includes assessing an individual's ability for near vision, far vision, and peripheral vision. The presence of double vision or nystagmus can also be evaluated.[29]

The vestibular system is tested through an interaction between the visual and vestibular systems in an individual. This is performed through assessment of the following: smooth pursuits, saccadic eye movements, vestibular ocular reflex, head thrust, rapid head shaking, and the Hallpike maneuver. A smooth pursuit is the ability to track a moving object while the head remains stationary. Saccadic eye movement is the ability to look back and forth between objects in the horizontal and vertical planes.

Vestibular ocular reflex is the ability to move the head in all planes while the eyes remain fixed on an object. Head thrusts are passive movements of the head 30 degrees off center to neutral while actively shaking the head back and forth 10 times quickly. The Hallpike maneuver is a passive extension and rotation of the cervical spine performed in supine.[29]

General clinical balance tests assess the ability to maintain balance. These tests evaluate static balance (no motion) and dynamic balance (motion), as well as ability to perform activities of daily living. Examples include the Romberg Test, Clinical Test for Sensory Interaction in Balance, Fregly and Graybrel Quantitative Ataxia Test, Berg Balance Scale, Get Up and Go, Timed Get Up and Go, Clinical Balance Assessment, Functional Reach, Tinetti Tests, Fakuda Stepping and Postural Stress Test.[29, 30, 31]

Laboratory balance testing requires equipment not normally found in clinics and is not routinely performed by physical therapists. Examples include platform perturbation tests, caloric tests, and rotational tests.[29, 31]

Determining the cause of balance dysfunction can assist the physical therapist in determining an effective treatment plan. Such treatment plans usually include a regimen of balance training.

Balance Training

When the central nervous system is injured following a CVA, balance is often impaired which increases the risk of falls.[21] Falls can cause secondary injury, such as hip fractures, and lead to difficulties with activities of daily living.[21, 25] Therefore, a thorough assessment and effective treatment of balance dysfunction is essential during rehabilitation following a CVA. Treatment of balance dysfunction is called balance training and involves a program of exercises aimed at retraining the nervous system for movement. An effective balance training program develops the necessary postural strategies,[29, 9] provides an adequate challenge to the body systems that affect balance, considers motor control and motor learning principles, incorporates previous research results, and addresses compliance issues.[25, 33]

Balance training retrains the residual peripheral and central nervous systems to develop movement strategies (hip, step, ankle, and suspensory strategies) and coordinate movement behavior within the limitations imposed by the CVA.[34] Balance training is multifaceted and can include: oscillatory platform movements,[34] biofeedback,[9, 36] conventional balance training,[7] and visual feedback training.[7] Conventional balance training is based on progression through activities. It begins with symmetrical weight distribution and progresses to weight shifting, reaching, and eventually performing functional activities that challenge balance.[16] An important component of balance training is the development and preservation of effective postural strategies in order to maintain upright posture and in static and dynamic functional activities. In order to train and improve these postural strategies, an individual's center of gravity must be moved outside the base of support. Activities that promote this include obstacles, weight shifting, reaching, catching and throwing, and activities on a Swiss ball.[33]

Pollock et al [35] stated that early work with balance training was based primarily on orthopedic principles, and in more recent years this work was enhanced through neurophysiological principles. Today, therapists include principles of motor learning and motor control in their treatment. Orthopedic principles focus on the strengthening techniques, while neurophysiological principles focus on the therapist moving the patient through patterns of motion. The motor learning approach emphasizes the importance of active motion by the individual.

Different therapeutic approaches for rehabilitation exist and include: the remediation facilitation approach, compensatory training approach, functional task oriented approach, and motor relearning program for stroke. The primary goal of the remediation facilitation approach is to increase motor recovery and function and decrease impairments through therapeutic exercise and neuromuscular facilitation. The focus is on the involved segments to decrease compensation by the unaffected side and to prevent learned non-use of the involved segments. On the other hand, the compensatory training approach does not concern itself with the involved side. Rather, the goal is to become functionally independent as soon as possible with the uninvolved side. This technique is rarely used for patients who have experienced a CVA, unless there is little hope of recovery. The preferred approach is the functional task oriented approach and is sometimes referred to as the motor control and motor learning approach. This approach integrates the systems theory of motor control (which states that the neural, behavioral, and physical aspects of movement are the result of interacting systems) with aspects of the motor learning approach. The focus is on ensuring that an individual practices difficult tasks in random order, receives appropriate feedback (visual, verbal, intrinsic, extrinsic), and becomes a problem solver and an active participant in goal setting.[4] Finally, the motor relearning program for stroke focuses on retraining motor control with functional activities and transference of learning. Practice in varying environments and appropriate feedback is required, as well as the ability to self-monitor and make necessary corrections.[4,36]

According to various research studies there is uncertainty in regard to which training procedures are the most effective for improving balance. Consequently, research continues to evaluate the most effective means of balance and mobility training in patients who have had a CVA. A systematic review of the literature was done by Gillespie et al [23] comparing different interventions for preventing falls in the elderly. The study assessed randomized trials aimed at decreasing the risk factors for falling in the elderly. The authors concluded that individualized strengthening and balance retraining programs, Tai Chi, home hazard assessment and modification, and risk factor screening and intervention programs were effective in improving balance.

Several studies have investigated balance training for individuals who have had a stroke. One question in the literature is whether conventional physical therapy methods versus other methods of instruction are more effective. Grant et al[7] assessed whether providing visual feedback in addition to conventional therapy provided greater improvements in balance compared to conventional therapy alone. Subjects with hemiplegia secondary to acute stroke were randomly assigned to either a conventional group or an experimental group with visual feedback training. The experimental group received regular physical therapy along with an additional 30 minutes of balance training per day. Treatment following the stroke was initially inpatient 5 days per week for a minimum of three weeks followed outpatient two days per week for a maximum of eight weeks. The authors concluded that although there was improved postural stability and balance over time, there was no indication of differential benefits due to the additional visual feedback.

Walker et al[8] investigated whether visual feedback regarding center of gravity or conventional balance training improved balance compared to regular physical therapy sessions. Subjects consisted of 46 individuals with a history of a recent CVA and unilateral hemiparesis. They were randomly assigned to one of three groups: visual feedback group, conventional balance therapy group, and control group. All subjects received two hours per day of physical and occupational therapy; however, the two experimental groups received an additional 30 minutes per day of balance training. During the balance training time, the visual feedback group used the Balance Master and received information regarding the location of their center of gravity during various weight shifting activities, and the conventional balance therapy group received verbal and tactile cues to encourage symmetrical stance and weight shifting. Outcome measures included postural sway from the Balance Master, the Berg Balance Scale, the Timed "Up and Go," and gait speed prior to treatment, at the end of treatment, and one month following the end of treatment. All three groups demonstrated marked improvement in balance; however, neither the visual feedback nor the verbal and tactile cues provided extra benefit over regular physical therapy during the early stages of rehabilitation.

Geiger et al[9] studied whether visual feedback/forceplate training in addition to conventional physical therapy interventions enhanced balance and mobility. Subjects included a sample of convenience of 13 individuals with hemiplegia secondary to a stroke who were referred by their physician for outpatient physical therapy. Subjects were assigned to either an experimental group or control group. All subjects received physical therapy intervention for 50 minutes two to three times per week. The control group received 50 minutes of regular physical therapy intervention techniques aimed at improving muscle force, range of motion, mobility, and balance. The experimental group received 35 minutes of regular physical therapy intervention and 15 minutes of training on the Balance Master. All subjects were assessed using the Berg Balance Scale and the Timed "Up and Go" before and after four weeks of treatment. Both groups demonstrated improved scores after four weeks of physical therapy; however, no differences were found between the two groups. The authors concluded that visual feedback/forceplate training combined with regular physical therapy did not enhance the effects of regular physical therapy on subject's balance and functional mobility.

When designing a balance training program, it is important to incorporate several components, some of which have been previously discussed. It is vital to train and improve effective ankle, hip, and stepping strategies. Activities that cause the center of mass to sway are used to develop coordination of muscles involved in these strategies. The natural environment is filled with everyday hazards that challenge balance, such as narrow hallways, uneven ground, and slippery surfaces. Activities such as tandem walking, obstacle courses, and sidestepping provide an opportunity to practice these skills. Many functional activities, such as stair climbing and gait, require balance during unilateral stance. A variety of activities can be incorporated into a treatment program to provide repeated practice in this skill. One of the key components of a balance program is that the activities must be functional and allow the individuals to practice movements they perform everyday.[33, 36]

As previously discussed, the sensory systems necessary for balance control can be impacted following a CVA. Providing challenges to the somatosensory, visual, and vestibular systems is a key component in improving balance and postural control for those who have deficits in these areas. Activities that aid the visual system through challenging depth perception and coordination of movement can assist individuals in successfully encountering obstacles in their daily life. The vestibular system can be trained by including activities that require head movements during gait and walking on uneven surfaces. The somatosensory system can be challenged by activities that involve walking on a variety of surfaces, such as tile, carpet, and foam. Hand-eye coordination and visual acuity can be improved through tossing and catching a ball.[33, 36]

In addition to the components discussed above, it is important that a comprehensive balance training program consider adherence and motivational factors. A group exercise format can be effective in that it promotes social interaction, as well as being time and cost efficient. Research has shown that working in dyads or groups enhances training efficiency and effectiveness as compared to individual training.[37, 38] Benefits of a dyad or group approach include observing another partner, opportunities to rest, and motivational factors. Group balance exercise training offers many advantages and would be appropriate in working with individuals who have had a CVA, as long as necessary safety issues are addressed.

Bethard et al[33] utilized a group format approach to determine whether a six week "Get Off Your Rocker" balance exercise class had a significant effect on balance in a geriatric population. Subjects included 22 elderly individuals who were high functioning and at a low risk for falling. They were randomly assigned to either a control group or an exercise group. All subjects were tested during an initial and final evaluation using the Berg Balance Measure, Timed Get Up and Go Test, Functional Reach Test, and ankle range of motion. After the initial testing, the exercise group participated in the "Get Off

Your Rocker" balance exercise class three times per week for six weeks. A variety of exercises were performed including single leg stance activities, Swiss ball exercises, tandem walking, and other activities that challenged base of support. The control group continued their normal daily activities during this six week period. Results indicated that the exercise group showed significantly improved balance on the Balance Berg Measure and the Functional Reach. The authors concluded that the "Get Off Your Rocker" exercise class could be an effective tool to increase balance in the elderly. Subjects in the study showed good adherence and reported that the group interactions served as a motivator to their efforts.

In summary, a CVA may result in various impairments including balance dysfunction. If a balance disturbance is identified, an appropriate balance training program must be created. Considerations of a comprehensive balance training program include training postural strategies, the four systems involved in maintaining balance, as well as incorporate motor control and motor learning principals and adherence and interest issues. Activities that challenge the base of support and help an individual improve postural control mechanisms that are necessary to achieve, maintain, and restoring balance are integral parts of any balance training program. Finally, the program must be functional and allow an individual to practice activities they perform daily.

CHAPTER III

METHODOLOGY

Authorization and approval was obtained from the University of North Dakota Institutional Review Board (IRB) for the use of human subjects prior to the start of this study (Appendix A). HealthSouth in Grand Forks, ND agreed to provide space and equipment for the "Get Off Your Rocker" exercise class.

Subjects

Subjects were recruited from Grand Forks, ND and surrounding communities. Cindy Flom-Meland, a faculty member at the University of North Dakota Department of Physical Therapy, was responsible for recruitment of subjects through her contacts within the area. Given that this study follows a case study approach, two subjects were recruited. The criteria required to participate in this study consisted of the following:

1. Subject must have a past medical history of a CVA.
2. Subject must be older than 20 years of age.
3. Subject must be living in the community and have the ability to ambulate independently.
4. Subject must have his/her own transportation and be able to attend a majority of the exercise classes.
5. Subject's blood pressure must be within normal limits. During the blood pressure screen, a blood pressure of 160/90 mmHG or less was used as the guideline for acceptance.

Prior to participation in the study, subjects were given a copy of an information and consent form (Appendix A) to read. Subjects were able to read and understand the document and were independent in their decision-making. Subjects were informed that their participation was strictly voluntary and that they were free to withdraw at any time. Both subjects signed the information and consent form and agreed to participate in the study.

Both subjects were asked to continue with their normal daily activities throughout the six weeks of the exercise class but not to add any new exercise routines. A history was obtained from the two subjects (Appendix B).

Instrumentation

Data was collected from each subject before and after the six-week exercise class and three months following completion of the exercise class. Each subject completed the Timed Up and Go (Appendix C), the Functional Reach (Appendix D), the Berg Balance Measure (Appendix E), and the Short Form 36 Health Survey (Appendix F) during the pre- and post-testing sessions. During the pre-testing session, subjects also completed the informational and consent form, a blood pressure screen, and a history questionnaire (Appendix G). Three months following completion of the exercise class, subjects were mailed the Short Form 36 Health Survey, and they returned the completed survey.

Timed Up and Go

The Timed Up and Go is a test of dynamic balance that assesses a person's physical mobility including his/her balance, gait speed, and functional capacity.[39] Time, in seconds, was measured for each subject to stand up from a standard armchair, walk a distance of three meters, turn around, walk back to the chair, and sit down. Subjects wore regular footwear and used their customary assistive devices. They were instructed to walk at a safe pace and a gait belt was used for safety. Before the timed trial, subjects participated in a one-time practice trial to familiarize themselves with the task.

Podsiadlo and Richardson[39] reported that the Timed Up and Go has good intra-rater (ICC, 0.99) and inter-rater (ICC, 0.99) reliability and correlates well with log-transformed scores on the Berg Balance Measure (r, -0.81), gait speed (r, -0.61), and Barthel Index of ADL (r, -0.78). These authors stated that this measure would be useful in determining clinical change over time.

Functional Reach

The Functional Reach is a test of dynamic postural control and margin of stability, measured during forward maximal reach.[40] To measure this, a yardstick was secured to the wall at the height of the subject's shoulder. Each subject removed his/her shoes and assumed a normal stance on a sheet of white paper with his/her shoulder close to the wall. Subject's feet were traced to ensure that identical stance was used during post-testing. Subjects were asked to make a fist and raise their arm to 90° of shoulder flexion. A ruler was used to intersect the most advanced position of the distal third phalange with the yardstick to obtain accurate readings. Subjects were then asked to reach as far forward as possible without losing their balance and without touching the wall. Again, the position of the distal third phalange was recorded. A gait belt was used for safety and a spotter was available. Subjects were given one practice trial and three measured trials. The mean difference between the two positions was recorded.

Duncan et al[40] reported high inter-rater reliability (ICC, 0.98), high test-retest reliability (ICC, 0.92) and normative data by age for men and women. The authors suggest that the Functional Reach is a useful clinical tool to assessing balance impairments and change in balance performance over time.

Berg Balance Measure

The Berg Balance Measure consists of 14 tasks involved in daily functional activities that require maintenance of balance.[41,42] Each item is scored on a five-point ordinal scale (0-4), with a possible total of 56 points. Higher scores indicate the ability to complete the tasks more independently and a decreased risk of falls. Each subject completed the Berg Balance Measure. For item 13, standing in tandem, subjects were asked to stand in tandem with the leg of their choice in front and then with the opposite leg in front. For item 14, single leg stance, subjects were asked to stand on the leg of their choice and then to stand on the opposite leg. Both scores were recorded but the lowest score for each item was used in the total score. A gait belt and spotter were used for safety.

The Berg Balance Measure has been shown to have good inter-rater reliability and test-retest reliability (ICC, 0.98) and good internal consistency (Cronbach's Alpha, 0.96). It is also correlated with other tests of balance and mobility, including the Tinetti mobility index (r, -0.91) and the Get Up and Go test (r, -0.76).[41,42]

Short Form 36 Health Survey

The Short Form 36 Health Survey consists of 36 items and was designed as an indicator of general health-related quality of life.[43] It measures eight health and well-being domains including, physical functioning, social functioning, bodily pain, role limitations due to physical health, role limitations due to emotional problems, vitality, mental health, and general health perceptions.

Alpha internal consistency coefficients for the eight domains exceed .80, except for the social functioning scale. The Short Form 36 Health Survey demonstrated significant and consistent association with criterion validation criteria of ability to return to work, symptoms, health care utilization, and mental health.[44]

Procedure

After recruiting the two subjects, they were asked to attend a pre-testing session. During this session, they read and signed the information and consent form, completed a blood pressure screen and filled out a history questionnaire. Each subject also completed the Timed Up and Go, the Functional Reach, the Berg Balance Measure, and the Short Form 36 Health Survey. Following this initial testing session, subjects participated in the six-week "Get Off Your Rocker" exercise class. This class will be described below. Following the exercise class, each subject repeated the Timed Up and Go, the Functional Reach, the Berg Balance Measure, and the Short Form 36 Health Survey. The Short Form 36 Health Survey was again repeated three months following the end of the exercise class. The survey was mailed to each subject, and they returned the completed survey in a self-addressed stamped envelope. Pre- and post-testing was held within the University of North Dakota Department of Physical Therapy and the exercise classes were held at HealthSouth in Grand Forks, ND.

The "Get Off Your Rocker" exercise class was a low intensity, low impact class that emphasized challenges to static and dynamic balance including a variety of activities including single leg stance, Swiss ball movements, and tandem walking. These were typical exercises that would be incorporated into physical therapy treatment programs. Subjects participated in the class three times per week for six consecutive weeks. Each class lasted approximately 30 minutes. Different exercises were used each of the three days of the week to ensure variety and continued interest in the class. To provide greater challenges to balance, many of the exercises were progressed over the course of the six weeks (i.e. changing the color of theratubing, decreasing the base of support, and increasing the range the subject is asked to shift their trunk in reaching activities). A variety of equipment was used in the balance activities including Swiss balls, tightropes, floor ladders, zoom balls, mirrors, balloons, and assorted sized balls. Pictures and descriptions of the exercises and exercise equipment are included (Appendix H). The HealthSouth fitness director trained the researchers in the exercises utilized in this class. The researchers lead the class and served as spotters for safety of subjects.

Data Analysis

Simple descriptive statistics were used to analyze the data for this study. Comparisons were made between the scores from the pre- and post-testing sessions and the three-month follow-up. Simple addition and subtraction were used to determine if subject's scores changed over time, and results were reported in percentages. Qualitative results, based on observation, were also reported.

CHAPTER 4

RESULTS

Both subjects demonstrated better scores in all of the tests after the six-week exercise class. Initial test scores for each subject on the balance measures are reported in Table 1. Test scores after the six-week exercise class are reported in Table 2. Degree of improvement on the three tests, reported as percentages, is reported for each subject in Table 3. The subjects' SF-36 scores and means for the general population by age group and gender are reported in Tables 4-6.

Table 1. Test Scores Prior to Six-Week Exercise Class

Measure	**Subject A**	**Subject B**
Timed Up and Go	13.5 seconds	22.5 seconds
Functional Reach	15.2 inches	5.6 inches
Berg Balance Measure	46/56	41/56

Table 2. Test Scores After Six-Week Exercise Class

Measure	**Subject A**	**Subject B**
Timed Up and Go	12.4 seconds	16.2 seconds
Functional Reach	16.1 inches	9.5 inches
Berg Balance Measure	52/56	48/56

Table 3. Percent Change of Improvement

Measure	**Subject A**	**Subject B**
Timed Up and Go	8%	38%
Functional Reach	6%	41%
Berg Balance Measure	12%	15%

Table 4. Test Scores on the SF-36 Prior to Six-Week Exercise Class

	Subject A		**Subject B**	
	Subject Score	Mean*	Subject Score	Mean*
PCS†	52.72	50.81	37.02	45.13
MCS‡	35.03	50.85	56.57	53.66

*Mean score for the general US population by age group and gender
†PCS = Physical Component Summary
‡MCS = Mental Component Summary

Table 5. Test Scores on the SF-36 After Six-Week Exercise Class

	Subject A		**Subject B**	
	Subject Score	Mean*	Subject Score	Mean*
PCS†	50.84	50.81	46.25	45.13
MCS‡	46.54	50.85	59.80	53.66

*Mean score for the general US population by age group and gender
†PCS = Physical Component Summary
‡MCS = Mental Component Summary

Table 6. Test Scores on the SF-36 Three Months After Exercise Class

	Subject A		**Subject B**	
	Subject Score	Mean*	Subject Score	Mean*
PCS†	39.24	50.81	42.55	45.13
MCS‡	48.78	50.85	56.11	53.66

*Mean score for the general US population by age group and gender
†PCS = Physical Component Summary
‡MCS = Mental Component Summary

Subject A showed greatest improvement on the Berg Balance Measure, with an increase of twelve percent. He also demonstrated an eight percent increase on the Timed Up and Go, which was a difference of 1.1 seconds, and a six percent increase on the Functional Reach, which was a difference of 0.9 inches.

Subject B exhibited greatest improvement on the Functional Reach, with an increase of forty-one percent, which was a difference of 3.9 inches. He also displayed a thirty-eight percent increase on the Timed Up and Go, which was a difference of 6.3 seconds. A fifteen percent increase was noted on the Berg Balance Measure.

Results of this study also demonstrated qualitative improvements as well as the quantitative gains described above. Qualitative improvements made by each subject will be discussed in the following section.

Qualitative Results: Subject A

Subject A demonstrated moderate qualitative improvements in several areas important in the effective maintenance of balance during the course of the six-week exercise class. These included single leg stance activities, coordinated movement strategies, postural sway strategies, and the ability to walk on uneven surfaces. Researcher support was also decreased over the course of the six weeks.

The subject's ability to maintain a stable unilateral stance markedly improved by the end of the six weeks. During the hang time activity, the subject was able to progress from using blue theratubing to help maintain balance to no theratubing by the last week. He was also able to hold the activities for a longer time, progressing from ten seconds to thirty seconds. For the partner dancing, he and his partner were able to hold the single leg stance for longer periods of time and were able to move more fluidly from one position to another. During the block walking, the subject was able to move his block across the floor much more rapidly and in multiple directions. He also advanced to a larger block by the end of the second week, which meant he had to lift the non-stance leg higher in order to move the block.

Subject A showed improvement in activities that involved coordination of movement and postural sway strategies. At the beginning of the six-week class, the subject was able to effectively perform the zoom ball and net toss activities; however, his balance was continually challenged throughout the six weeks by decreasing his base of support (i.e. standing with feet together or standing in tandem) and by decreasing the stability of the surface he was standing on (i.e. having him stand on foam). During the balloon walk and the ball toss activities, he was able to increase the range and speed of movements, which further challenged his balance. Postural control of trunk muscles was also enhanced as demonstrated by his ability to perform the Swiss ball activities without having his hands on the ball by the end of the exercise class and by increasing the number of repetitions he was able to do.

Subject A also improved his ability to walk on uneven surfaces. The obstacle course was made more difficult as the weeks progressed, and the subject was able to complete it with minimal loss of balance. He was able to advance his skills during the tightrope walking by fully walking in tandem by the end of the second week and by walking the tightrope with an egg in a spoon in his right hand by the end of the sixth week. He was also able to achieve more uniform step length during forward, backward, and sidestepping ladder walking.

Support given by the spotter was decreased over the course of the six-week exercise class. Initially, support was minimal assist of one for some activities and stand by assist for other activities. By the end of the six weeks, subject was independent in most activities with stand by assist for a few. Initially, the subject was observed to hip hike during many activities, including gait and several single leg stance activities, which was thought to interfere with a normal gait pattern and his ability to maintain balance in certain instances. Through verbal and physical cues, the subject demonstrated less hip hiking by the end of the exercise class, and he was also able to develop some self-monitoring strategies to decrease this substitution.

Qualitative Results: Subject B

Subject B demonstrated significant qualitative improvements in many aspects important in maintaining balance over the course of the six-week exercise class. Improvements were made in single leg stance activities, tasks that involved coordination of movement, postural sway strategies, step length, and walking on uneven surfaces. During the course of the six weeks, support of the spotter was reduced for many of the activities performed.

The subject made considerable gains in activities requiring single leg stance over the course of the six-week exercise class. For the hang time activity, the subject progressed from using blue theratubing initially to using yellow theratubing during the final week. He was also able to increase the number of repetitions of hip abduction, flexion, and extension exercises from ten to fifteen, as well as increase the length of time he stood on a single leg from 10 seconds to 30 seconds. At the beginning of the class, he tended to lean forward during these activities which resulted in some instances of loss of balance, but at the end of the six weeks, the subject maintained a more upright posture with minimal cues while performing the exercises. During the star walk activity, the subject increased the length of time he stood on his right leg from zero seconds to approximately five seconds. For the partner dancing, the subject and his partner were able to hold the single leg stance positions for longer periods of time, as well as transition more easily from one position to the other. During the block walking, the subject was able to move his block more rapidly and maneuver it not only backward but to each side as well as the weeks advanced.

Subject B also showed marked improvement in activities that involved coordination of movement and postural sway activities. He demonstrated a dramatic change in his ability to perform the net toss activity. The subject tossed the ball approximately one foot at the beginning of the six-week class and approximately four feet by the end of the class. As the weeks progressed, he developed skills to better utilize his right arm in tossing the ball. In addition, he was able to coordinate stepping forward with alternate feet with each toss. During the zoom ball, he showed similar improvement in his ability to coordinate his upper and lower extremities in a rhythmical, reciprocal motion. Initially, during the balloon walk, the subject would typically take two steps forward tapping the balloon twice and then stop and catch the balloon. However, by the end of the six weeks, he would often make it at least halfway across the length of the room before stopping and catching the balloon. The subject displayed greater comfort in allowing his center of mass to travel further and further outside his base of support. Similar observations were made with the ball tossing activity. Initially, if the ball did not return directly in front of his chest or within arm reach, he would often not make an attempt to catch it. However, by the end of the class, the subject was taking steps to catch the ball, leaning to each side, and bending down to retrieve the ball.

Subject B also showed significant gains in his ability to walk on uneven surfaces and in increasing his step length. During the ladder walk, he was able to walk with a more normal gait pattern, increasing his step length and using equal length steps with each foot. By the end of the class, he was able to perform this task with only minimal cues to maintain an upright head posture. The subject showed increased skills and confidence in walking the obstacle course as the weeks progressed. Initially, he would stop and get himself ready to advance over difficult obstacles (i.e. hurdles). By the end of the class, he was able to maintain a more constant speed and displayed less instances of catching his right toes on obstacles. During the tightrope activity, the subject improved his ability to walk in tandem both forward and backward. Initially, he was not able to get one foot directly in front of the other, but this improved markedly by the end of the six weeks.

Support given by the spotter reduced over the course of the six weeks. Initially support was minimal to moderate assist of one for many activities. By the end of the six weeks, assist was hand held assist to minimal assist of one. Overall, the subject showed increasing confidence and skill in using postural sway strategies. He became much more comfortable challenging the limits of his balance and allowing his center of mass to travel outside his base of support.

CHAPTER V

DISCUSSION

Individuals who have experienced a CVA are at risk for falls due to the potential for several neurological impairments that can result in balance dysfunction. Possible consequences of falls include soft tissue injuries, fractures, decreased activity, fear of falling, and death.[21] As mentioned earlier, the components of balance include the following systems: somatosensory, visual, vestibular, and musculoskeletal. All of these systems are required to work together as an integrated system for the maintenance of balance. Because impaired balance is an issue for people who have had a CVA, studies have focused on determining the most effective treatment strategies.

The purpose of this study was to determine if the six-week "Get Off Your Rocker" balance exercise class improved balance and quality of life in people who have had a CVA and live in the community. The study followed a case study design, and subjects consisted of two individuals with a diagnosis of CVA. The six-week balance exercise class used a group format, and the structure of the balance training program was previously utilized in a study with a subject population of elderly individuals.[33] The balance training program consisted of various static and dynamic balance activities (unilateral stance, catching, throwing, walking on unsteady surface) that were chosen to challenge the mechanisms of balance and reflect a variety of situations and environments that occur in daily life. The results of the current study demonstrated that the six-week

"Get Off Your Rocker" exercise class can improve balance, as measured by the Timed Up and Go, Functional Reach, and Berg Balance Measure. These results are consistent with the Bethard et al [33] study that showed significant improvement in balance on the Berg Balance Measure and Functional Reach; however, this study included only elderly individuals. In addition, results are consistent with other studies that explored balance training programs in individuals with a diagnosis of CVA that demonstrated improved balance through various interventions.[7, 8, 9]

Subjects in the present study were community dwelling individuals with a neurological diagnosis of a non-recent CVA. It was hoped that because the CVA was non-recent, this would limit the influence of improvements made by spontaneous recovery. It has been documented that a large part of recovery occurs six months from the onset of stroke.[45] Also, it was hoped that subjects would not be participating in any concomitant therapeutic interventions so that this would not interfere with results of the exercise class. However, due to circumstances we were not able to control, Subject B was undergoing physical therapy throughout the course of the study. All efforts were made to ensure that the physical therapy interventions were not directly balance related.

The two subjects demonstrated increased balance performance following the six-week training program as measured by the Berg Balance Measure, the Timed Up and Go, and the Functional Reach. These results are consistent with previous studies evaluating balance training and individuals with a diagnosis of CVA and balance dysfunction. Subject A demonstrated less improvement on the balance measures than Subject B, but both subjects had longer reach span, faster ambulation, and increased stability.

The mean improvement for both subjects in the Berg Balance Measure was 13.5%. This improvement was considered significant in our study; however, careful interpretation of this result is required. Miller et al[46] stated that the Berg Balance Measure for community dwelling elderly predicts a lower probability of falling with better scores. Therefore, as scores increase, the probability of falls decreases slowly. However, they also discussed that the scores on the measure and the risk of falling are related in a non-linear fashion. So a significant increase in scores may represent only a small percentage change in risk of fall.

In regard to impact on quality of life, Subject A's SF-36 Physical Component Summary score dropped by approximately ten points (indicating increased impact of physical health on quality of life) at the three-month follow-up compared to his two previous scores, placing him about one standard deviation below the general population mean for his age. Since we did not have contact with Subject A in person or by telephone following completion of the exercise class, we do not if he experienced any changes in his physical status that may have accounted for this drop in his score. In contrast, Subject A's SF-36 Mental Component Summary score was approximately one and a half standard deviations below the general population mean for his age prior to the exercise class, and this score increased by about 17 points (indicating decreased impact of mental health on quality of life) on the last two testing times placing him much closer to the general population mean. Thus, although it appears that his quality of life was impacted by his physical status at the three-month follow-up, this change did not affect his mental health.

In regard to impact on quality of life, Subject B's SF-36 Physical Component Summary score prior to the exercise class was approximately one standard deviation below the general population mean for his age, indicating that his physical health had a greater impact on his quality of life compared to the general population. On the last two testing times, his scores increased by about 8-10 points placing him closer to the general population mean for his age and indicating that physical health had less impact on his quality of life. For Subject B, his SF-36 Mental Component Summary score remained fairly steady across all three testing times and was slightly above the general population mean for his age.

Limitations

Several limitations should be considered when interpreting the findings in this study. Subjects were not observed or assessed in their natural environment in order to determine learning and transferability of the skills to daily life. It is not known if improvements made on the standardized balance measures translate to improved ability to perform activities of daily living. We did not perform any long-term post-assessment to determine if the gains made in balance were retained six months or a year following the exercise class. Another limitation was the age difference between the two subjects and the limited number of subjects. Wade et al[47] found that age was one of the variables that had the greatest predictive value for stroke. There was a significant age difference between the two subjects in this study. One subject was younger with a child and had a more active lifestyle. Finally, during the post-testing session, the subjects had developed a level of comfort with the researchers. This may have allowed them to perform better due to more confidence in the researchers and a decreased fear of falling. Thus, they may have made more of an effort on the balance measures during the post-testing than the pre-testing session.

Suggestions for Future Research

Ideas for future studies include a larger sample that would allow for a control group and an experimental group. Subjects with a variety of neurological diagnoses that affect balance could be included in the subject sample. Logistics of this may be challenging due to the need for a spotter for each subject due to safety concerns. Further studies could also incorporate post-testing to include whether the balance exercise class produced transfer of learned skills to the subject's natural environment and daily life. Studies could explore whether improved balance made an impact on functional activities in the individual's life.

Conclusion

The results of this study demonstrated that the "Get Off Your Rocker" balance exercise class resulted in considerable improvements in balance. These activities challenged the component systems required for balance through repeated practice and appropriate feedback. The findings of this study suggest that the "Get Off Your Rocker" balance exercise class can be a beneficial tool to improve balance in individuals who have had a CVA.

APPENDIX A

University of North Dakota Human Subjects Review Form

Please Note: The policies and procedures of the University of North Dakota apply to all activities involving the use of Human Subjects performed by faculty, staff and students 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 procedure governing the use of human subjects. When preparing your Human Subjects Review Form, use the attached "IRB Checklist".

Please provide the information requested below:

Principal Investigator: Cindy Flom-Meland, Michele Jackson, Kim Lindemann

Telephone: 777-4130 Address: PO Box 9037 PT

E-mail address: cfmeland@medicine.nodak.edu

School/College: School of Medicine and Health Sciences Department: Physical Therapy

Student Adviser (if applicable): Cindy Flom-Meland

Telephone: 777-4130 Address: PO Box 9037 PT

E-mail address: cfmeland@medicine.nodak.edu

School/College: School of Medicine and Health Sciences Department: Physical Therapy

Project Title: The Effects of the "Get Off Your Rocker" Exercise Class on Balance for Patients Following a CVA: A Case Study Approach

Proposed Project Dates: Beginning Date: March, 2003 Completion Date: May, 2004

Funding agencies supporting this research: N/A

(A copy of the funding proposal for each agency identified above MUST be attached to this proposal when submitted.)

___ YES or _X_ NO Does the Principal Investigator or any researcher associated with this project have a financial interest in the results of this project? If yes, please submit, on a separate piece of paper, an additional explanation of the financial interest (other than receipt of a grant)

If your project has been or will be submitted to another Institutional Review Board(s), please list those boards below along with the status of each proposal.

N/A Date submitted: ______ Status: ___ Approved ___ Pending

______ Date submitted: ______ Status: ___ Approved ___ Pending

Type of Project: Please check "Yes" or "No" for each of the following.

_X_ YES or ___ NO New Project

___ YES or _X_ NO Dissertation/Thesis

___ YES or _X_ NO Continuation/Renewal

_X_ YES or ___ NO Student Research Project

___ YES or _X_ NO Protocol Change for previously approved project (resubmit "Human Subjects Review Proposal" with changes bolded or highlighted and signed)

___ YES or _X_ NO Does your project include Genetic Research? If yes, refer to Chapter 3 of the Researcher's Handbook for additional guidelines regarding your topic.

___ YES or _X_ NO Does your project include Internet Research? If yes, refer to Chapter 3 of the Researcher's Handbook for additional guidelines regarding your topic.

___ ___

___ YES or _X_ NO Will subjects or data be provided by Altru Health Systems?If yes, submit two copies of the proposal. A copy of the proposal will be provided to Altru.

_X_ YES or ___ NO Will research subjects be recruited at another organization (e.g., hospitals, schools, YMCA) or will assistance with the data collection be obtained from another organization If yes, please list all institutions: HealthSouth at Grand Forks, ND

Letters from each organization must accompany this proposal. Each letter must illustrate that the organization understands their involvement in that study, and agrees to participate in the study. Letters must include the name and title of the individual signing the letter and, if possible, should be printed on letterhead.

Subject Classification: This study will involve subjects who are in the following special populations: Check all that apply.

- ____ Minors (< 18 years)
- ____ UND Students
- ____ Prisoners
- ____ Pregnant Women/Fetuses
- ____ Persons with impaired ability to understand their involvement and/or consequences of participation in this research
- _X_ Other: Patients with a medical diagnosis of CVA

For information about protections for each of the special populations please refer to the protected populations section on the Office of Research and Program Development website.

This study will involve: Check all that apply.

- _____ Deception
- _____ Stem Cells
- _____ Radiation
- _____ Discarded Tissue
- _____ New Drugs (IND)
- _____ Fetal Tissue
- _____ Non-approved Use of Drug(s)
- _____ Human Blood or Fluids
- _____ Recombinant DNA
- _____ Other
- __X__ None of the above will be involved in this study

I. Project Overview

Please provide a brief explanation (limit to 200 words or less) of the rationale and purpose of the study, introduction of any sponsor(s) of the study, and justification for use of human subjects and/or special populations (e.g., vulnerable populations such as minors, prisoners, pregnant women/fetuses).

Decreased balance is a common functional limitation following a neurological incident, such as a stroke or traumatic brain injury. Limitations in balance may impact an individual's risk of falls, ability to ambulate, and performance of functional activities. Exercises emphasizing balance training have been shown to improve balance in patients with neurological dysfunction. This study will investigate the effects of the "Get Off Your Rocker" exercise class, a class that incorporates balance training, on balance for patients following a cerebral vascular accident (CVA).

This study will follow a case study format, requiring two participants over the age of 20 who have a history of CVA. Initially, participants will be required to complete a blood pressure screen, a history questionnaire, three standardized balance measures, and a quality of life questionnaire. Each participant will take part in the "Get Off Your Rocker" exercise class for 30 minutes three times per week for six weeks. The initial standardized balance measures and the quality of life questionnaire will be repeated following the six-week class. The quality of life questionnaire will again be repeated three months following the end of the class. Findings within each subject will be compared using traditional descriptive statistics. The expected outcome of this study is to measure an improvement in balance following the exercise class.

II. Protocol Description

Please provide a succinct description of the procedures to be used by addressing the instructions under each of the following categories. Individuals conducting clinical research please refer to the "Guidelines for Clinical-Research Protocols" on the Office of Research and Program Development website.

1. **Subject Selection.**

a) Describe recruitment procedures (i.e., how subjects will be recruited, who will recruit them, where and when they will be recruited and for how long) and include copies of any advertisements, fliers, etc., that will be used to recruit subjects.

Participants will be recruited from Grand Forks, ND and surrounding communities. Cindy Flom-Meland will be responsible for recruitment of participants through her contacts within the area. Contact will be made via in person or a telephone call. A total of two participants will be recruited for this study.

b) Describe your subject selection procedures and criteria, paying special attention to the rationale for including subjects from any of the categories listed in the "Subject Classification" section above.

Participants must be older than 20 years of age and have a past medical history of a CVA. Participants must be living in the community and have the ability to independently ambulate. They must have their own transportation and be able to attend the majority of the exercise classes.

c) Describe your exclusionary criteria and provide a rationale for excluding subject categories.

Participants will be excluded if they are found to have uncontrolled blood pressure or abnormally high blood pressure, as noted by a blood pressure screen (using 160/90 mmHg or less as the guideline for acceptance).

d) Describe the estimated number of subjects that will participate and the rationale for using that number of subjects.

Given that this study will follow a case study format, a total of two participants will take part in this study. One participant will be assigned to each of the student researchers.

e) Specify the potential for valid results. If you have used a power analysis to determine the number of subjects, describe your method.

Two participants will be involved in this study given that it follows a case study approach. Research has shown that balance training can improve an individual's score on instruments measuring balance. All of the balance instruments used in this study are standardized and will provide an objective measure to evaluate changes in balance.

2. **Description of Methodology.**

a) Describe the procedures used to obtain informed consent.

Prior to participation in the study, subjects will be given a copy of an information and consent form (see attached form) to read, and then they will be asked to sign the form. Participants will be able to read and understand the document and will be competent and independent in their decision-making. Participants will be provided with a copy of the information and consent form to keep.

b) Describe where the research will be conducted.

The pre and post-testing will be conducted within the UND Department of Physical Therapy. The "Get Off Your Rocker" exercise classes will be held at HealthSouth in Grand Forks, ND. The quality of life questionnaire repeated three months following completion of the exercises classes will be mailed to the participants, and they will be asked to return the completed form via an enclosed self-addressed stamped envelope.

c) Indicate who will carry out the research procedures.

The two student researchers will conduct the pre and post-testing of participants. The "Get Off Your Rocker" exercise classes will be led by the principal investigators. The HealthSouth Fitness Director will train the principal investigators in the "Get Off Your Rocker" exercise class.

d) Briefly describe the procedures and techniques to be used and the amount of time that is required by the subjects to complete them.

After obtaining informed consent, blood pressure will be taken for each participant. Each participant will be asked to complete a history questionnaire (see attached). In addition, each participant will complete the Berg Balance Measure, the Timed Get Up and Go, the Functional Reach, and the Short Form 36 Health Survey (see attached for each measure). Each participant will be assigned to one of the two student researchers. Participants will participate in the "Get Off Your Rocker" exercise class three times per week for six consecutive weeks. Each exercise class will last approximately 30 minutes. This class is a low intensity, low impact class that emphasizes balance through single leg stance activities, Swiss ball movements, tandem walking, and various activities that challenge base of support. These are typical exercises that would be incorporated into physical therapy treatment programs. Participants will be asked to continue with their regular activities during the six-week class and to not add any exercise changes to their typical routine. At the end of the six-week time period, each participant will repeat the Berg Balance Measure, the Timed Get Up and Go, the Functional Reach, and the Short Form 36 Health Survey. The Short Form 36 Health Survey will again be repeated three months following the end of the class. This form will be mailed to the participants, and they will be asked to return the completed form via an enclosed self-addressed stamped envelope. Pre and post-testing will be held within the UND Department of Physical Therapy and the exercise classes will be held at HealthSouth in Grand Forks, ND.

e) Describe audio/visual procedures and proper disposal of tapes.

N/A

f) Describe the qualifications of the individuals conducting all procedures used in the study.

The two student researchers are students in the UND physical therapy program and have experience with all the testing instruments used during the pre and post-testing. The two student researches and the student advisor, who is a faculty member in the UND physical therapy program, will be trained by the HealthSouth Fitness Director to lead the "Get Off Your Rocker" exercise classes. All are certified in CPR.

g) Describe compensation procedures (payment or class credit, etc.).

Participants will receive six weeks of the "Get Off Your Rock" exercise class at no charge. This class incorporates balance training activities that would be included in typical physical therapy treatment sessions.

Attachments Necessary: Copies of all instruments (such as survey/interview questions, data collection forms completed by subjects, etc.) must be attached to this proposal.

See attached: Consent form, history questionnaire, and Short Form 36 Health Survey.

3. Risk Identification.

a) Clearly describe the anticipated risks to the subject/others including any physical, emotional, and financial risks that might result from this study.

The "Get Off Your Rocker" exercise class is a form of physical activity that the investigators believe has minimal risk of injury to participants. However, there is always some risk of injury with any form of exercise.

b) Describe precautions you will take to minimize potential risks to the subjects (e.g., sterile conditions, informing subjects that some individuals may have strong emotional reactions to the procedures, debriefing, etc.).

Participants will be excluded if they are found to have uncontrolled blood pressure or abnormally high blood pressure, as noted by a blood pressure screen. During each of the "Get Off Your Rocker" exercise classes, one investigator (or a substitute with equivalent knowledge of exercise and safety precautions) will be present for each participant and serve as a "spotter" to minimize risk of injury. The principal investigators are all certified in CPR.

c) Indicate whether there will be a way to link subject responses and/or data sheets to consent forms, and if so, what the justification is for having that link.

Subject and result information will not be linked to the consent form in order to protect the confidentiality of participants.

4. Subject Protection.

a) Describe procedures you will implement to protect confidentiality (such as coding subject data, removing identifying information, reporting data in aggregate form, etc.).

Subject and result information will not be linked to the consent form in order to protect the confidentiality of participants. Names will not be included on subject research data forms, rather Subject A and Subject B will be used to identify the participants.

b) Indicate that the subject will be provided with a copy of the consent form and how this will be done.

Prior to participation in the study, subjects will be given a copy of an information and consent form (see attached form) to read, and then they will be asked to sign the form. Participants will be able to read and understand the document and will be competent and independent in their decision-making. Participants will be provided with a copy of the information and consent form to keep.

c) Describe the protocol regarding record retention. Please indicate that research data from this study and consent forms will both be retained in separate locked locations for a minimum of three years following the completion of the study.

Describe: a) the storage location of the research data (separate from consent forms and subject personal data)
b) who will have access to the data
c) how the data will be destroyed
d) the storage location of consent forms and personal data (separate from research data)
e) how the consent forms will be destroyed

Results of this study will be secured in the Physical Therapy Department at the University of North Dakota. Participant consent forms will be kept separate from subject research data forms. Records will be destroyed via paper shredder three years after the study has ended. Only the student researchers and student advisor will have access to this information.

d) Describe procedures to deal with adverse reactions (referrals to helping agencies, procedures for dealing with trauma, etc.).

If injury occurs while the study is conducted, medial treatment will be as available as it is to a member of the general public in similar circumstances. The participant and his/her third party payer will provide payment for any such treatment.

d) Include an explanation of medical treatment available if injury or adverse reaction occurs and responsibility for costs involved.

If injury occurs while the study is conducted, medial treatment will be as available as it is to a member of the general public in similar circumstances. The participant and his/her third party payer will provide payment for any such treatment.

III. Benefits of the Study

Clearly describe the benefits to the subject and to society resulting from tng from tas learning experiences, services received, etc.). **Please note:** payment is not a benefit and should be listed in the Protocol Description section under Methodology.

The purpose of this study is to determine the effects of the "Get Off Your Rocker" exercise class on balance for patients following a CVA. Results of previous research have indicated that participation in regular exercise has been shown to improve balance. Improved balance can have an impact on a person's gait, postural control, and functional activities. We expect that participants in the "Get Off Your Rocker" exercise class will have improved balance scores. The goal of our study is to demonstrate that participation in this class will enhance balance and quality of life

Additional benefits of this study for participants include increased social interaction, improved confidence in performing activities of daily living and enhanced general health and well-being.

IV. Consent Form

A copy of the consent form must be attached to this proposal. If no consent form is to be used, document the procedures to be used to protect human subjects. Refer to the ORPD website for further information regarding consent form regulations.

Please note: Regulations require that all consent forms, and all pages of the consent forms, be kept for a minimum of 3 years after the completion of the study, even if subject does not continue participation. The consent form must be written in language that can easily be read by the subject population and any use of jargon or technical language should be avoided. It is recommended that the consent form be written in the third person (please see the examples on the ORPD website). A two inch by two inch blank space must be left on the bottom of each page of the consent form for the IRB approval stamp. The consent form must include the following elements:

a) An introduction of the principal investigator

b) An explanation of the purposes of the research

c) The expected duration of subject participation

d) A brief summary of the project procedures

e) A description of the benefits to the subject/others anticipated from this study

f) A paragraph describing any reasonably foreseeable risks or discomforts to the subject
g) Disclosure of any alternative procedures/treatments that are advantageous to the subject

h) An explanation of compensation/medical treatment available if injury occurs.

i) A description of how confidentiality of subjects and data will be maintained. Indicate that the data and consent forms will be stored separately for at least three years following the completion of the study. Indicate where, in general, the data and consent documents will be stored and who has access. Indicate how the data will be disposed of. Be sure to list any mandatory reporting requirements that may require breaking confidentiality.

j) The names, telephone numbers and addresses of two individuals to contact for information (generally the student and student adviser). This information should be included in the following statement: "If you have questions about the research, please call (insert Principal Investigator's name) at (insert phone number of Principal Investigator) or (insert Adviser's name) at (insert Adviser's phone number). If you have any other questions or concerns, please call the Office of Research and Program Development at 777-4279."

k) If applicable: an explanation of who to contact in the event of a research-related injury to the subject.

l) If applicable: an explanation of financial interest must be included.

m) Regarding Participation in the study:

1) An indication that participation is voluntary and that no penalties or loss of benefits will result from refusal to participate.

2) An indication that the subject may discontinue participation at any time without penalty, with an explanation of how they can discontinue participation.

3) An explanation of circumstances which may result in the termination of a subject's participation in the study.

4) A description of any ation of any ans to the subject.

5) A statement indicating whether the subject will be informed of the findings of the study.

6) A statement indicating that the subject will receive a copy of the consent form.

By signing below, you are verifying that the information provided in the Human Subjects Review Form and attached information is accurate and that the project will be completed as indicated.

Signatures:

Cindy Flom-Meland → Kim Lindemann 3-27-03

(Principal Investigator) Date:

Cindy Flom-Meland 3-27-03

(Student Adviser) Date:

Requirements for submitting proposals:

Additional information can be found at the Office of Research and Program Development website at **www.und.nodak.edu/dept/orpd**

Original Proposals and all attachments should be submitted to: Office of Research and Program Development (ORPD), P.O. Box 7134, Grand Forks, ND 58202-7134, or drop off at Room 105, Twamley Hall.

The criteria for determining what category your proposal will be reviewed under is listed on page 3 of the IRB Checklist. Your reviewer will assign a review category to your proposal. Should your protocol require Full Board review, you will need to provide additional copies. Further information can be found on the ORPD website regarding required copies and IRB review categories, or you may call the ORPD office.

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.

Please Note: Student Researchers must complete the attached "Student Consent to Release of Educational Record".

Revised 7/15/2002

TUDENT RESEARCHERS: As of June 4, 1997 (based on the recommendation of UND Legal Counsel) e University of North Dakota IRB is unable to approve your project unless the following "Student Consent Release of Educational Record" is signed and included with your "Human Subjects Review Form."

STUDENT CONSENT TO RELEASE OF EDUCATIONAL RECORD[1]

ursuant to the Family Educational Rights and Privacy Act of 1974, I hereby consent to the Institutional eview Board's access to those portions of my educational record which involve research that I wish to onduct under the Board's auspices. I understand that the Board may need to review my study data ased on a question from a participant or under a random audit.

he study to which this release pertains is

THE EFFECTS OF THE 'GET OFF YOUR ROCKER' EXERCISE CLASS ON BALANCE FOR PATIENTS FOLLOWING A CVA: A CASE STUDY APPROACH

nderstand that such information concerning my educational record will not be released except on the ondition that the Institutional Review Board will not permit any other party to have access to such formation without my written consent. I also understand that this policy will be explained to those ersons requesting any educational information and that this release will be kept with the study ocumentation.

/27/03 — Date

Kim Lindemann — Signature of Student Researcher

onsent required by 20 U.S.C. 1232g.

HEALTHSOUTH
Sports Medicine & Rehabilitation Center

March 2003

HealthSouth Sports Medicine will be assisting UND physical therapy regarding a balance study beginning April 2003.

The students have full permission to use the HealthSouth facility and equipment to complete their study.

Please contact me if you have questions.

Sincerely,
Jill Bisson
Fitness Director
746-1323

2617 S. Columbia Road • Grand Forks, ND 58208-4858 • 701 746-8374 • Fax 701 780-0885
404 N. Broadway • Crookston, MN 56716 • 218 281-7188 • Fax 218 281-7371
404 Fourth Street • Devils Lake, ND 58301 • 701 662-3544 • Fax 701 662-9493

INFORMATION AND CONSENT FORM

The Effects of the "Get Off Your Rocker" Exercise Class on Balance For Patients Following a CVA: A Case Study Approach

You are invited to participate in a study conducted by Michele Jackson and Kim Lindemann, students in the Master's of Physical Therapy Program at the University of North Dakota. The purpose of this study is to determine the effects on balance of the HealthSouth sponsored "Get Off Your Rocker" exercise class for persons who have had a stroke.

Requirements of the study include being over 20 years of age, living in the community, and having a medical history of a stroke. In addition, you must be able to walk independently and provide your own transportation to the exercise classes. You will be excluded if you have abnormal or uncontrolled blood pressure.

If eligible, you will participate in an initial testing session. This will include completing a blood pressure screen, a history questionnaire, the Berg Balance Measure, the Timed Get Up and Go, the Functional Reach and the Short Form 36 Health Survey. Each of the balance measures are standardized and provide an objective measure to evaluate balance. This initial testing will take approximately 45 minutes. You will attend the 30-minute "Get Off Your Rocker" classes three times per week for six weeks. Following the six-week exercise class, you will repeat the three balance tests and the Short Form 36 Health Survey. The Short Form 36 Health Survey will also be repeated three months following the completion of the exercise classes. This form will be mailed to you, and you will be asked to return the completed form in the enclosed self-addressed stamped envelope. The two testing sessions will be conducted at the UND Department of Physical Therapy and the exercise classes will be held at HealthSouth.

This form of exercise is considered a low risk activity, but as with any type of physical exercise there is some risk of injury. A researcher, or trained equivalent, will attend each exercise class to minimize the risk of injury. If injury occurs while the study is being conducted, medical treatment will be as available as it is to a member of the general public in similar circumstances. Payment for any treatment will be provided by you and your third party payer. By signing this document, you are not giving up any legal rights you may have in case of negligence or other legal fault of anyone that is involved in the study.

The information obtained through this study will be kept confidential. Your name and identifying information will not be revealed at any time. The results of this study will be secured in the Physical Therapy Department at the University of North Dakota. They will be destroyed three years after the study has ended. Neither you nor the researchers will receive any financial compensation associated with involvement in this study.

Participation in this study is entirely voluntary. Your decision whether or not to participate will not change your future relations with the University of North Dakota or HealthSouth. If you decide to participate, you are free to discontinue participation at any time without it being held against you.

We realize that your time is valuable and that the time commitment of participating in this study is considerable. However, we believe that the result will be worth your time. We expect to find an improvement in your balance scores. We hope this improved balance will translate to improved walking and ability to perform daily activities for you. We greatly appreciate your time and participation in this study.

The investigators involved are available to answer any questions you have concerning this study. In addition, you are encouraged to ask any questions concerning this study that you may have in the future. Questions may be asked by calling Michele Jackson or Kim Lindemann at 777-2831 or our student adviser Cindy Flom-Meland at 777-2831 or 775-2476. If you have any other questions or concerns, please call the Office of Research and Program Development at 777-4279.

I HAVE READ AND UNDERSTAND THE ABOVE INFORMATION AND WILLINGLY AGREE TO PARTICIPATE IN THIS STUDY. 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. A COPY OF THIS CONSENT FORM HAS BEEN GIVEN TO ME.

______________________________ ____________________

Participant's Signature Date

APPENDIX B

Subject History

Subject A

Subject A was a 51-year-old male who experienced a right-sided CVA with left-sided involvement in September 2000. His past medical history is unremarkable, and he has no history of smoking or drinking alcohol. At the time of the study, the subject was taking Agronoz daily.

Following his CVA, the subject spent one week in an acute hospital, one month in a rehabilitation facility, and two months in outpatient physical therapy. He also received some occupational therapy services. His rehabilitation consisted of resistive theraband strengthening, balance activities, walking activities, weight lifting with machines, and electrical stimulation. He utilized an everter brace on his left foot for two months following his outpatient physical therapy. Currently, the subject participates in an exercise program at a local fitness center. He works out on a variety of weight machines and a treadmill three times a week for two hours each session.

Subject A stated that his greatest difficulty is not being able to return to work. Previously, he worked in construction and stated that problems with balance prevent him from walking along elevated beams, which would be a requirement to return to employment. The subject has previously participated in studies by the University of North Dakota Physical Therapy Department including a LiteGait study.

Subject History

Subject B

Subject B is a 71-year-old male who experienced a left-sided CVA with right-sided involvement on November 8, 2001. His past medical history included double coronary artery bypass graft in 1998 and high blood pressure that is controlled with weight loss and diet. He has no history of smoking. He drinks one beer per week. Current medications include pyridostigmine bromide, baclofen, trazodone HCL, multivitamin with iron, and aspirin.

Following his CVA, the subject spent three weeks in an acute hospital, two months in a rehabilitation facility, and three months in outpatient physical therapy. Rehabilitation consisted of resistive theraband strengthening, gait training, and balance training. He utilized an ankle-foot orthosis during the time he was in the rehabilitation facility. The subject resumed outpatient physical therapy services two weeks prior to the start of this study and continued throughout the course of the study. His physical therapy consisted primarily of strengthening and stretching exercises, improving the use of his right upper extremity, and enhancing independent mobility. He has a home exercise program that involves strengthening and stretching.

The subject reported that he is having the most functional difficulty with walking and stair climbing (at present he is unable to descend the stairs to the basement in his home). He uses a cane while walking. The subject has previously participated in studies by the University of North Dakota Physical Therapy Department including a LiteGait study.

APPENDIX C

Timed Up and Go

Set-up:

1. Place standard chair in hallway.
2. Measure 3 meters from the chair and place a line on the floor with tape.
3. Person wears regular footwear.
4. Person uses usual assistive device.
5. Person starts with back against chair and assistive device in hand.
6. For safety, use a gait belt and a spotter will be available.

Instructions:

1. "When I say go, I want you to stand up, walk to just beyond the line, turn around, walk back to the chair, and sit down."
2. "Walk at a safe pace."
3. "Before we do a timed trial, I'll have you practice once to become familiar with the task."
4. "Ready?" "Go"
5. "Ready?" "Go"

Measure:

1. Record in seconds the time it takes person to complete.

Pre-test **Post-test**

_______________ (time in seconds) _______________ (time in seconds)

APPENDIX D

Functional Reach

Set-up:

1. Person is to remove shoes and stand with shoulder close to wall on tracing paper in a normal, relaxed stance.
2. Secure yardstick to the wall at person's shoulder height.
3. Trace foot position on paper.
4. Person is instructed to make a fist and raise arm to 90° of shoulder flexion.
5. For safety, use a gait belt and a spotter will be available.

Instructions:

1. "When I say go, please make a fist and raise your arm level with the yardstick, and we will measure the position on the yardstick."
2. "Next, we will ask you are to lean forward as far as you can without losing your balance or taking a step, and we will again measure the position on the yardstick."
3. "You will have one practice trial and then 3 trials which are measured."
4. "Ready?" "Ok, go, make a fist and raise your arm level with the yardstick."
5. Complete one practice trial and three measured trials.

Measure:

1. In normal stance position, record position of distal third metacarpal along the yardstick.
2. In forward position, record position of distal third metacarpal along the yardstick.
3. Use a ruler to intersect the yardstick at the most advanced position in order to obtain an accurate reading.
4. Record the mean difference between the two positions over three trials.
5. If person touches the wall or takes a step, the trial is repeated.

Pre-test (measured in inches) **Post-test** (measured in inches)

	Starting Position	Ending Position	Difference	Starting Position	Ending Position	Differ
Trial 1	______	______	______	______	______	______
Trial 2	______	______	______	______	______	______
Trial 3	______	______	______	______	______	______
			Mean Difference			Mean Difference
			______			______

APPENDIX E

1. SITTING TO STANDING
INSTRUCTIONS: Please stand up. Try not to use your hands for support.
( ) 4 able to stand without using hands and stabilize independently
( ) 3 able to stand independently using hands
( ) 2 able to stand using hands after several tries
( ) 1 needs minimal aid to stand or to stabilize
( ) 0 needs moderate or maximal assist to stand

2. STANDING UNSUPPORTED
INSTRUCTIONS: Please stand for two minutes without holding.
( ) 4 able to stand safely 2 minutes
( ) 3 able to stand 2 minutes with supervision
( ) 2 able to stand 30 seconds unsupported
( ) 1 needs several tries to stand 30 seconds unsupported
( ) 0 unable to stand 30 seconds unassisted

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

3. SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL
INSTRUCTIONS: Please sit with arms folded for 2 minutes.
( ) 4 able to sit safely and securely 2 minutes
( ) 3 able to sit 2 minutes under supervision
( ) 2 able to sit 30 seconds
( ) 1 able to sit 10 seconds
( ) 0 unable to sit without support 10 seconds

4. STANDING TO SITTING
INSTRUCTIONS: Please sit down.
( ) 4 sits safely with minimal use of hands
( ) 3 controls descent by using hands
( ) 2 uses back of legs against chair to control descent
( ) 1 sits independently but has uncontrolled descent
( ) 0 needs assistance to sit

5. TRANSFERS
INSTRUCTIONS: Arrange chairs(s) for a pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.
( ) 4 able to transfer safely with minor use of hands
( ) 3 able to transfer safely definite need of hands
( ) 2 able to transfer with verbal cuing and/or supervision
( ) 1 needs one person to assist
( ) 0 needs two people to assist or supervise to be safe

6. STANDING UNSUPPORTED WITH EYES CLOSED
INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.
( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays safely
( ) 0 needs help to keep from falling

7. STANDING UNSUPPORTED WITH FEET TOGETHER
INSTRUCTIONS: Place your feet together and stand without holding.
( ) 4 able to place feet together independently and stand 1 minute safely
( ) 3 able to place feet together independently and stand for 1 minute with supervision
( ) 2 able to place feet together independently but unable to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds

8. REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING
INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the finger reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)
( ) 4 can reach forward confidently 25 cm (10 inches)
( ) 3 can reach forward 12 cm safely (5 inches)
( ) 2 can reach forward 5 cm safely (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/requires external support

9. PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION

INSTRUCTIONS: Pick up the shoe/slipper which is placed in front of your feet.

( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5 cm (1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

10. TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING

INSTRUCTIONS: Turn to look directly behind you over toward left shoulder. Repeat to the right. Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.

( ) 4 looks behind from both sides and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

11. TURN 360 DEGREES

INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cuing
( ) 0 needs assistance while turning

12. PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED

INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.

( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps > 20 seconds
( ) 2 able to complete 4 steps without aid with supervision
( ) 1 able to complete > 2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try

13. STANDING UNSUPPORTED ONE FOOT IN FRONT

INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width

( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead of other independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds
( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

14. STANDING ON ONE LEG

INSTRUCTIONS: Stand on one leg as long as you can without holding.

( ) 4 able to lift leg independently and hold > 10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independently and hold = or > 3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but r remains standing independently
( ) 0 unable to try or needs assist to prevent fall

( ) TOTAL SCORE (Maximum = 56)

APPENDIX F

The SF-36v2™ Health Survey

Instructions for Completing the Questionnaire

Please answer every question. Some questions may look like others, but each one is different. Please take the time to read and answer each question carefully by filling in the bubble that best represents your response.

EXAMPLE

This is for your review. Do not answer this question. The questionnaire begins with the section ***Your Health in General*** below.

For each question you will be asked to fill in a bubble in each line:

1. **How strongly do you agree or disagree with each of the following statements?**

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
a) I enjoy listening to music.	○	●	○	○	○
b) I enjoy reading magazines.	●	○	○	○	○

Please begin answering the questions now.

Your Health in General

1. **In general, would you say your health is:**

Excellent	Very good	Good	Fair	Poor	
○1	○2	○3	○4	○5	GH01

2. **Compared to one year ago, how would you rate your health in general now?**

Much better now than one year ago	Somewhat better now than one year ago	About the same as one year ago	Somewhat worse now than one year ago	Much worse now than one year ago	
○1	○2	○3	○4	○5	HT

Please turn the page and continue.

3. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

	Yes, limited a lot	Yes, limited a little	No, not limited at all	
a) **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	O1	O2	O3	PF01
b) **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	O1	O2	O3	PF02
c) Lifting or carrying groceries	O1	O2	O3	PF03
d) Climbing **several** flights of stairs	O1	O2	O3	PF04
e) Climbing **one** flight of stairs	O1	O2	O3	PF05
f) Bending, kneeling, or stooping	O1	O2	O3	PF06
g) Walking **more than a mile**	O1	O2	O3	PF07
h) Walking **several hundred yards**	O1	O2	O3	PF08
i) Walking **one hundred yards**	O1	O2	O3	PF09
j) Bathing or dressing yourself	O1	O2	O3	PF10

4. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
a) Cut down on the **amount of time** you spent on work or other activities	O1	O2	O3	O4	O5	RP01
b) **Accomplished less** than you would like	O1	O2	O3	O4	O5	RP02
c) Were limited in the **kind** of work or other activities	O1	O2	O3	O4	O5	RP03
d) Had **difficulty** performing the work or other activities (for example, it took extra effort)	O1	O2	O3	O4	O5	RP04

5. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
a) Cut down on the **amount of time** you spent on work or other activities	O1	O2	O3	O4	O5	RE01
b) **Accomplished less** than you would like	O1	O2	O3	O4	O5	RE02
c) Did work or other activities **less carefully than usual**	O1	O2	O3	O4	O5	RE03

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

Not at all	Slightly	Moderately	Quite a bit	Extremely	
O1	O2	O3	O4	O5	SF01

7. How much bodily pain have you had during the past 4 weeks?

None	Very mild	Mild	Moderate	Severe	Very severe	
O1	O2	O3	O4	O5	O6	BP01

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

Not at all	A little bit	Moderately	Quite a bit	Extremely	
O1	O2	O3	O4	O5	BP02

9. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
a) did you feel full of life?	O1	O2	O3	O4	O5	VT01
b) have you been very nervous?	O1	O2	O3	O4	O5	MH01
c) have you felt so down in the dumps that nothing could cheer you up?	O1	O2	O3	O4	O5	MH02
d) have you felt calm and peaceful?	O1	O2	O3	O4	O5	MH03
e) did you have a lot of energy?	O1	O2	O3	O4	O5	VT02
f) have you felt downhearted and depressed?	O1	O2	O3	O4	O5	MH04
g) did you feel worn out?	O1	O2	O3	O4	O5	VT03
h) have you been happy?	O1	O2	O3	O4	O5	MH05
i) did you feel tired?	O1	O2	O3	O4	O5	VT04

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?

All of the time	Most of the time	Some of the time	A little of the time	None of the time	
O1	O2	O3	O4	O5	SF02

11. How TRUE or FALSE is each of the following statements for you?

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false	
a) I seem to get sick a little easier than other people	O1	O2	O3	O4	O5	GH02
b) I am as healthy as anybody I know	O1	O2	O3	O4	O5	GH03
c) I expect my health to get worse	O1	O2	O3	O4	O5	GH04
d) My health is excellent	O1	O2	O3	O4	O5	GH05

APPENDIX G

History Questionnaire

Age: ______

Date of stroke:_______________

Type of involvement: Right-sided _______ Left-sided _______

Describe the type and duration of treatment you received after your stroke:

____

____

____

____

Check all treatments received for rehabilitation:

____ Free weights

____ Machines

____ Theraband exercises

____ Parallel bar activities

____ Walking activities

____ Balance activities

____ Home exercise program

____ Assistive devices:

  ____ Ankle foot orthosis

  ____ Walker

  ____ Cane

How long have you been out of rehabilitation services? _________

Which activities or daily responsibilities do you currently have difficulty with (grooming, social or family engagements, dressing, vacuuming, cooking, etc):

____

____

____

____

List the activities you are or have been involved in (i.e. studies, other therapies (chiropractor, naturopath, acupuncture), working out (days/week)):

____

____

____

____

List all prescription, over the counter medications, and herbal supplements you are taking (aspirin, laxatives, antacids, vitamins, etc):

____

____

____

____

Place an (X) before any illness you have had or currently have:

___	Heart disease	___	Emphysema	___	Arthritis
___	High blood pressure	___	Allergies/asthma	___	Diabetes
___	Vision/hearing problems	___	Epilepsy	___	Phlebitis
___	Numbness/tingling	___	Dizziness/fainting	___	Cancer
___	Shortness of breath	___	Nervous disorder	___	Osteoporosis
___	Ulcer (peptic, gastric)	___	Kidney/bladder		

Please list past surgeries and other illnesses:

____

____

____

____

Do you smoke? Yes No

Estimate amount: __________

Do you use alcohol? Yes No

Estimate amount: __________________

APPENDIX H

Figure 1. Hang Time. Subjects perform hip abduction, alternating hip flexion/extension, and holding single leg stance, while maintaining unilateral stance on the opposite foot. Theraband is held for support.

Figure 2. Floor Ladder Walk. Subjects advance along the floor ladder forward, backward and side-stepping.

Figure 3. Zoom Ball. Subjects receive and return zoom ball to each other by moving their arms in horizontal abduction and adduction.

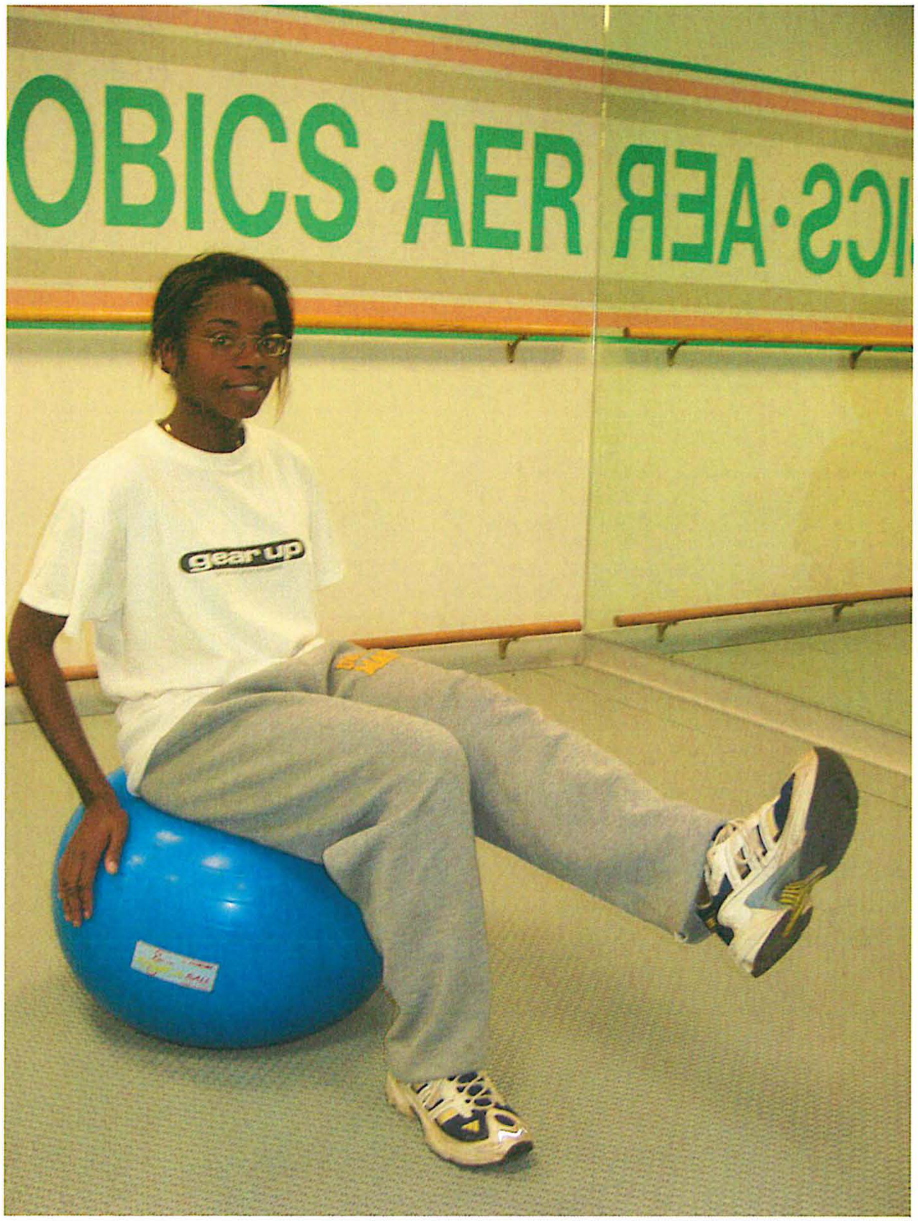

Figure 4. Swiss Ball Activities. Subjects perform a variety of activities (i.e. knee extension, side steps, marching and tossing a ball back and forth), while maintaining seated balance on the Swiss ball.

Figure 5. Partner Ball Toss. Subjects throw a ball back and forth to each other.

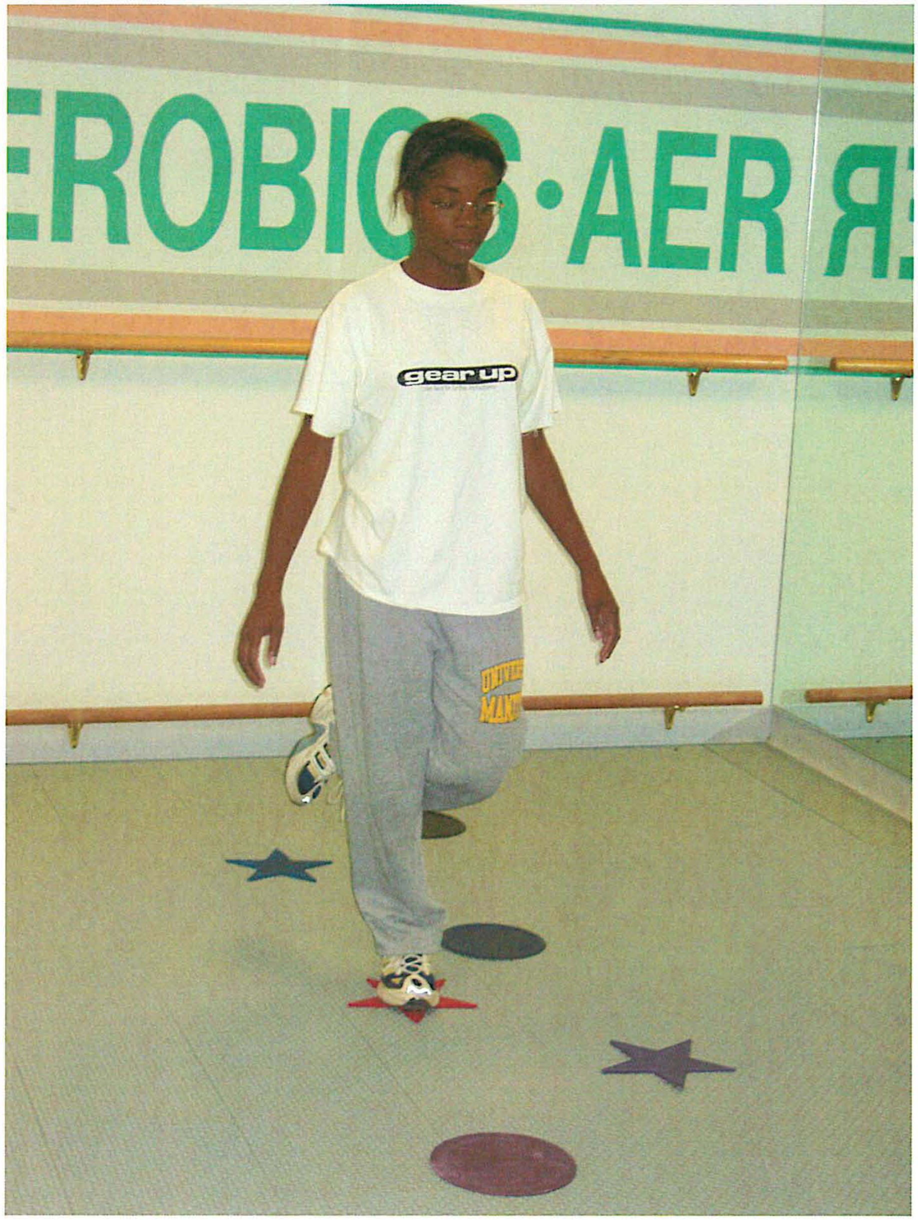

Figure 6. Star Balance Walk. Subjects proceed along a pathway of stars and circles, placing one foot on each shape. They maintain a unilateral stance for up to five seconds on each star.

Figure 7. Block Walk. Subjects move a block across the room by using one foot to tip the block end over end, while maintaining unilateral stance on the opposite foot. This block can be moved backward and to each side.

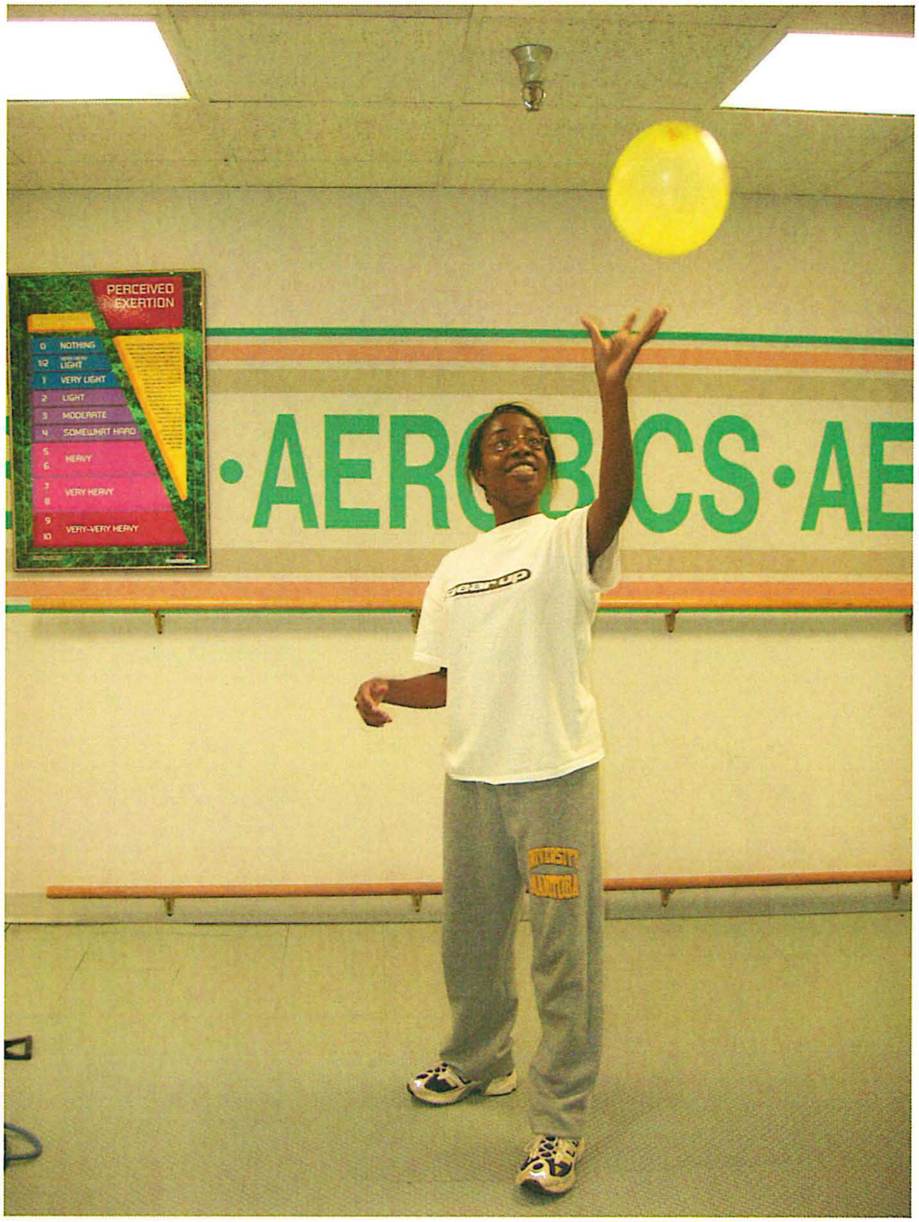

Figure 8. Balloon Walk. Subjects walk four lengths of the exercise room, while tapping the balloon in the air.

Figure 9. Tight Rope. Subjects walk forward along the rope in tandem or using scissor steps. They can also walk backward along the rope.

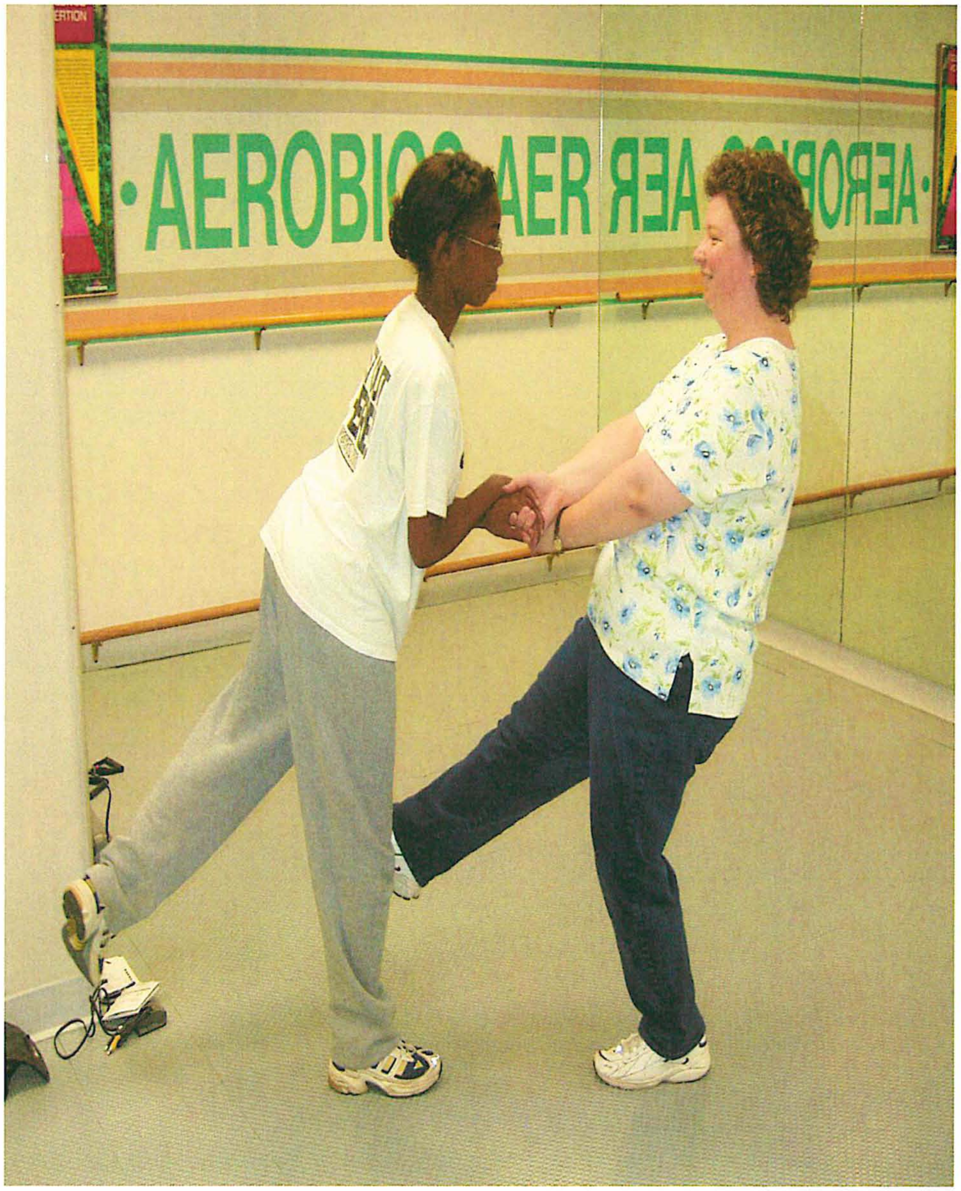

Figure 10. Partner Dance. Subjects stand facing each other with hands held for support and maintain stance on a single leg. An alternate activity entails subjects maintaining balance on one leg, while one partner leans forward with hip extended and the other leans backward with hip flexed. Partners hold hands for support and alternate between swaying forward and backward. For both activities, partners alternate between balancing on right and left.

Figure 11. Obstacle Course. Subjects progress through an obstacle course of steps, uneven surfaces, and hurdles.

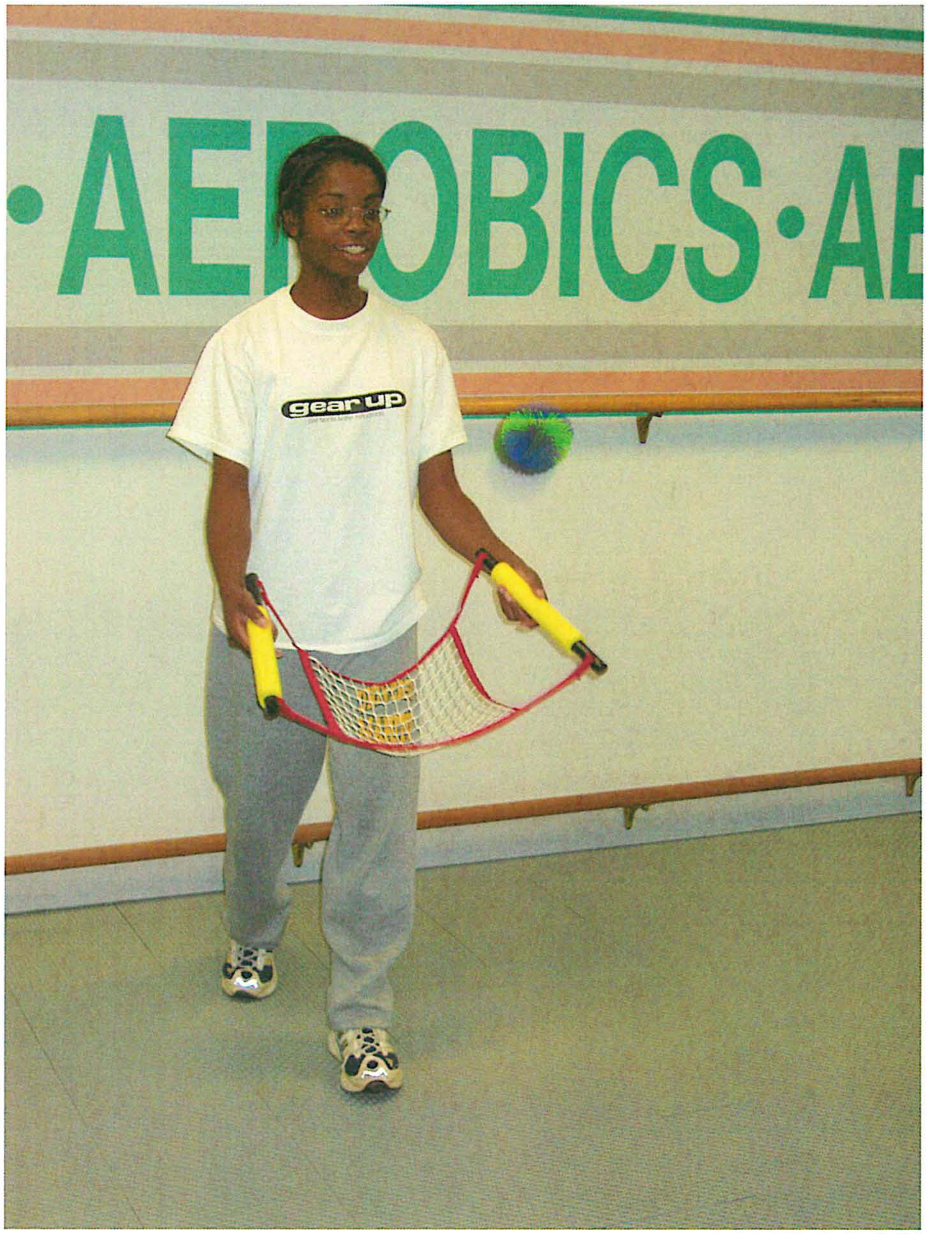

Figure 12. Net Toss. Subjects catch and return a ball between partners by closing and opening the net.

Figure 13. Ball Throw Against Wall. Subjects throw a ball against the wall and catch it as it rebounds back. The ball is thrown with and without a bounce at the wall.

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