2001

Yoga and the Effects on Balance, Hamstring Flexibility, and Blood Pressure

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YOGA AND THE EFFECTS ON BALACE, HAMSTRING FLEXIBILITY, AND BLOOD PRESSURE

by

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Bachelor of Science in Physical Therapy
University of North Dakota, 2000

An Independent Study

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Physical Therapy

Grand Forks, North Dakota
May
2001

This Independent Study, submitted by Kendra Van Valkenburg in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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(Chairperson, Physical Therapy)

PERMISSION

Title	The Effects of Yoga on Balance, Hamstring Flexibility, and Blood Pressure.
Department	Physical Therapy
Degree	Master of Physical Therapy

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Date 5-12-01

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ACKNOWLEDGMENTS

I would like to thank my entire family for all their love, support, and encouragement not only throughout my life, but particularly the last three years while pursing my degree in physical therapy. I would especially like to acknowledge my mother, Bernie, for her own hard work, wise words of wisdom and motivation that she has devoted to me. If it was not for you, I would not be half of the person I am today nor have achieved anywhere near the accomplishments I have made throughout the 23 years of my life. Also, thank you to all my wonderful friends back home who have provided me with all the great advice and support. I love you all.

I would also like to thank the University of North Dakota Physical Therapy faculty, especially Cindy Flom-Meland, Renee Mabey and Beverley Johnson for all of their guidance and hard work in developing and completing this project. Thank you to the Healthsouth® staff, including Cliff Lafreniere for his support and assistance in coordinating this project and the yoga instructors who devoted their voluntary time and efforts to teach the training sessions.

Additionally, thank you to my research partners, Shannon Sorenson and Katie Rood, for all their hard work, dedication and long hours spent on this project.

Lastly, thank you so much to all the amazing friends I have made during this journey. We have shared so many challenging, emotional, and wonderfully memorable experiences together that I will never forget. Thank you all.

ABSTRACT

Yoga is an ancient form of exercise and meditation that has recently gained popularity in the United States. Medical research regarding the benefits of yoga, however, continues to be in demand. The purpose of this study was to determine the effects of yoga on normal, healthy individuals. The focus of this study revolved around balance, hamstring flexibility, and blood pressure changes after six weeks of yoga training.

Eighteen normal, healthy individuals between 20-33 years of age participated in this study. Subjects were assessed using the NeuroCom® Balance Master test for rhythmic weight shift (RWS), the Functional Reach Test (FRT), the measure of blood pressure (BP), the Sit-and-Reach Test (SRT), and the Single Limb Stance Timed Test (SLST). The yoga group performed a random combination of 14 asanas in a six-week yoga-training program that met for 45 minutes, three times per week. The walking group (control group) walked below their target heart rates and performed basic hamstring stretching three times per week for six weeks.

Paired samples t-tests indicated significance for diastolic blood pressure (Sig. .04) and on-axis velocity RWS anterior-posterior (Sig. .048) for the yoga group and for SLST on the left with eyes closed (Sig. .005) for the walking group. Wilcoxen tests indicated significance for the yoga group in the SRT (Sig. .003) and SLST on the right with eyes open (Sig. .003) and eyes closed (Sig. .021). These findings provide evidence that the practice of yoga is beneficial in improving physical well-being.

CHAPTER I

INTRODUCTION

With a history of nearly 5,000 years, yoga is one of the world's most ancient traditions. However, Americans have only become familiar with it in the last century. In a culture focused on body image, it is no surprise that yoga rapidly gained popularity as a method of exercise. Since yoga's emergence in the United States, it has been used by healthy individuals for health maintenance and meditation. More recently, health care professionals have integrated yoga into their treatment plans for various mental and physical dysfunctions. It has also been used by athletes and others to strengthen the body and the mind as well as to prevent injuries.

Problem Statement

Yoga is emerging as a supplemental therapy for patients with diagnoses ranging from carpal tunnel syndrome, arthritis, stroke, and high blood pressure. However, few statistical studies have been conducted to support the efficacy of yoga therapy.

Purpose

The purpose of this study was to determine the effects of yoga on normal, healthy individuals. The main focus revolved around balance, hamstring flexibility, and blood pressure (BP) changes after six weeks of yoga training.

Research Questions

In order to reach the purpose of this study, the researchers attempted to answer the following questions

1. Is there a statistically significant difference between the balance results obtained before and after a six-week yoga-training program for normal, healthy individuals?
2. Is there a statistically significant difference between the hamstring flexibility results obtained before and after a six-week yoga-training program for normal, healthy individuals?
3. Is there a statistically significant difference between the blood pressure results obtained before and after a six-week yoga-training program for normal, healthy individuals?
4. Does a six-week non-strenuous walking program present with the same results for balance, hamstring flexibility, and blood pressure as a six-week yoga-training program?

Hypothesis

It is hypothesized that a six-week yoga program will produce significant results regarding balance and hamstring flexibility in normal, healthy individuals. The researchers expect to see slight changes in blood pressure, because the population consists of individuals without blood pressure abnormalities. Additionally, it is expected that the group receiving yoga training will have more significant changes in balance, hamstring flexibility, and blood pressure when compared to a walking group.

Significance

The results of this study, if significant, will provide physical therapists and other healthcare professionals with a viable alternative in treating patients with various deficits. Studies that prove physical therapy interventions to be effective are essential in the delivery of safe and effective therapy, as well as reimbursement. The data collected along with the literature review will provide beneficial information concerning yoga therapy as a treatment technique.

CHAPTER II

LITERATURE REVIEW

Introduction

According to Micozzi,[1] approximately 80% of the world's population depends on alternative approaches as their primary source of medical care. Alternative medicine's growing popularity has slowly expanded into the western cultures that have been hesitant to accept their beliefs due to the lack of supporting research. The modern form of yoga is among the many different types of alternative medicine that is thought to have first been introduced to the United States at the Parliament of Religions held in Chicago in 1893. Since its introduction over a century ago, yoga has been widely practiced throughout America.

Yoga

Taylor[2] defines yoga as a " 5,000 year old system of technologies and methodologies that provides a complete philosophy of living." It incorporates learning about the nature of life, reality, and the self. Yoga is an open-ended practice that assists in quieting the body, mind, and emotions. First developed in India, yoga is an ancient discipline that increases mental and physical control of the body to achieve a state of well being.[3-5] The word yoga is derived from the Sanskrit root "yug" that means, "to join together."[6]

According to Dr. Murie,[6] there are certain guidelines that should be followed when performing yoga. She believes that the practice of yoga should be done on an

empty stomach to avoid possible nausea or other stomach discomforts. Loose, comfortable clothing should be worn to allow for free movement, and the individual should be barefoot throughout the yoga session. If a woman is menstruating, all inverted poses should not be performed to avoid menstrual backflow into the body. Lastly, Dr Murie focuses on the importance of drinking plenty of water before, during, and after yoga, which is necessary to keep the body systems clean and pure.

Asanas

Yoga involves maintaining sustained poses for prolonged periods of time. The various poses that are performed in yoga are referred to as asanas.[3] According to Taylor,[2] asanas are "positions of dis-equilibrium, deviating the head and trunk from the center of gravity and are maintained purposefully for a length of time." There are approximately 84,000 postures within the spectrum of yoga. There are also three different groups that characterize the objectives that individuals wish to obtain by performing asanas including spiritualists, physical culturists, and patients.[7] The spiritualists simply desire spiritual development, whereas the physical culturists utilize the asanas to maintain their physical and mental health. The patient group includes individuals that are performing yoga as a treatment technique for a disease.

Dynamic and static are the two aspects of asanas.[7] The dynamic aspect requires some movement to occur to allow the individual to attain a specific pose or return to a neutral state at the completion of a pose. However, all movements should be in stages that are slow, smooth, and steady to allow the body to be in a relaxed state. Following the completion of various movements that comprise a single asana, there are usually counter movements that should also be performed. The importance of practicing slow,

controlled diaphragmatic breathing and the avoidance of straining is stressed during this aspect of asanas.

Guidelines for the static aspect of asanas reinforce the belief that the pose should be comfortable, relaxed, and pain-free.[7] The least possible amount of energy expenditure required should be demonstrated to maintain the pose. Once the static state has been reached, many asanas involve performing bandhas, which refers to a locking of the appropriate parts of the body by activating a sustained muscle contraction.[8] By performing bandhas, it enables the yoga practitioner to maintain the pose for a longer period of time.

The various asanas can be classified into the following three broad classifications: meditative, relaxation, or cultural asanas. Meditative asanas require a supportive, comfortable posture to be held for a long period of time. They are considered to be very easy to perform and focus heavily on maintaining an erect spine. This type of asana involves finding a dristi or a gaze point, usually in the direction that the head is facing and keeping the eyes open.[6-8] By finding this point, it assists in increasing the ability to focus during the yoga session.

Relaxation asanas focus on attaining relaxation both mentally and physically throughout the body.[7] They are described as natural and comfortable positions. Although all yoga asanas concentrate heavily on breathing, proper diaphragmatic breathing is viewed as essential in the relaxation asanas. This type of breathing contributes to a very soothing effect on the nervous system and increases abdominal circulation. These asanas have been found to be beneficial for various patients who suffer from hypertension, headaches, and insomnia.

Cultural poses have been found to develop physiological balances in different body systems.[7] These asanas promote stability, help maintain range of motion of the spine, decrease skeletal muscle imbalances, and conserve energy. Cultural asanas provide the nerve roots with an increased circulation of blood flow that assists in maintaining the flexibility of the spine. These poses also produce weight-bearing pressure through the spine that is important for proper growth and development. The passive stretching that is incorporated in cultural asanas assists in decreasing muscular tension. Hypertensive, irritable, short tempered, or stressed individuals, and those with insomnia are among the many people that may benefit from these types of poses.

Asanas can have a positive effect on many joints of the body. When the poses are held for a long duration, the capsule and ligaments are stretched on one side of the joint and compressed on the other side.[7] More blood flow is allowed to enter the joint space, which increases the nutritional supply and moves the waste material out of the space more efficiently. This process improves the arthrokinematics allowing for better joint movement.

Pranayama

According to Behanan,[9] pranayama is "a state of voluntarily regulated breathing while the mind is directed to the feeling of the flow of breath and prana (mind body connection or energy)." Demonstrating proper breathing techniques are of great importance in the art of yoga. In fact, Taylor[2] believes that the only component required to perform yoga is to be able to breath. Pranayama is controlled breathing that includes three phases: inhalation, exhalation, and timed breath holding.[10,11]

With inhalation the abdomen should expand, and, with exhalation, it should contract inward.[8] All breathing should take place through the nose, since Yogis view the purpose of the mouth to be solely for eating and talking. By breathing through the nose, it also allows the air to be warmed, filtered, and purified prior to entering the lungs. One study by Raju, Madhavi, Prasad, et al.[11] looked at the effects that pranayama breathing had on athletes. The researchers found that those who engaged in pranayama could reach greater work rates with less oxygen consumption per unit work than those who did not utilize this method of controlled breathing.

Hatha Yoga

There are many branches of yoga including hatha yoga, which is the most commonly performed yoga in America.[8] The word "ha" means sun and "tha" refers to the moon. Therefore, the word hatha is defined as "a system for creating the balanced well being of the total person." Hatha yoga includes asanas and pranayamas that are viewed as a method of physical culture, an opening to meditation, and a way to become knowledgeable about attaining a sense of homeostasis within the human body.[2]

Benefits From Yoga

Yoga has been found to produce beneficial results for the muscular, cardiovascular, respiratory, and the gastrointestinal systems.[5] This type of training has shown to significantly improve ideal body weight and bone density[12]; increase muscle endurance and delay in the onset of fatigue[13]; and increase VO_2 max.[14] Yoga can also promote equilibrium in the autonomic nervous system (ANS).

The ANS is made up of the parasympathetic and sympathetic nervous systems.[5] The sympathetic nervous system (SNS) is dominant during stressful situations,

accounting for increases in heart rate, respiratory rate, and blood pressure. The parasympathetic nervous system (PNS) controls more of a relaxed state of the body. When an individual is experiencing more dominance from the SNS, the relaxation and reduced blood pressure effects from yoga will allow for a better balance between the two parts of the ANS.

The discipline of yoga has also been proven to be effective for many diagnoses and disabilities. A study conducted by Garfinkel, Singhal, Warren, et al.[15] found that a routine of yoga-based stretching and postural alignment significantly increased grip strength for individuals suffering from carpal tunnel syndrome. The researchers believe that the yoga program helped to promote posture awareness and assist in the prevention of reoccurring symptoms. Respiratory benefits, including improvements with bronchial reactivity, the maximal amount of air an individual can expire in one second (FEV_1), and bronchodilator use, have also been observed with asthma patients.[3] Yoga training has shown to be beneficial in mentally retarded children as well.[4] After a nine-month yoga-training program, a group of children that were mentally retarded demonstrated improvements in psychomotor coordination, intelligent and social behavior, and general mental abilities.

Benefits gained from yoga have been seen expanding out to such diagnoses as multiple sclerosis, arthritis, and cerebrovascular accidents (CVAs).[8] Patients with multiple sclerosis (MS) may benefit from yoga's slow stretching movements that assist with the development of muscle toning, but without the elevation in body temperature that can be debilitating for these patients. For the individual with arthritis, yoga incorporates gentle, relaxing movements that are not harmful to the individual's

susceptible joints, but will still assist in maintaining joint range of motion. Yoga may also be particularly helpful for increasing strength and developing a better sense of balance for individuals who have had a CVA.

Balance

Balance, a critical part of being able to function and perform normally in activities of daily living, is both a static and dynamic activity.[16] When an individual has difficulties in maintaining his/her balance, the person is more susceptible to injury. This is especially true in the elderly population. According to Perrin, Jeandel, Perrin, et al.[17] "Aging is associated with decreased balance abilities, resulting in an increased risk of fall." In fact, falls are contributed to be the accidental cause of deaths in greater than two-thirds of individuals over the age of 75 years.[18] For this very reason it is important for healthcare professionals to recognize possible balance impairments and know how to assist in developing an effective treatment or fall prevention plan.

The goal of maintaining balance is to keep the center of gravity (COG) over the base of support (BOS) by aligning various joint segments.[19-24] During static stance in a normal individual who does not display any balance deficits, the COG continuously oscillates over the BOS.[25-27] The continuous oscillation is known as postural sway. When an individual is unable to respond to a change in stimuli, it causes the postural sway to increase, resulting in more energy required to keep balanced. There must also be continuous communication between the central and peripheral components of the nervous system, which controls the position of the COG over the BOS to maintain balance.[28-29] The three parts of the peripheral nervous system (PNS) that control balance are the visual, somatosensory, and vestibular systems.[16] Depending on which peripheral nervous

system(s) responds, the CNS will then interpret the information and stimulate the appropriate muscles to support the body and maintain an upright position.[30-31]

The visual system is responsible for reporting information to the CNS regarding the position of the head relative to changes in the environment that can be seen.[16,21,32] Many individuals rely upon the visual system, but it is usually not the only system utilized, nor the most preferred, especially during movement of the body.[21,32]

The somatosensory system is made up of elements including the receptors in ligaments, joints, and muscles.[16] This system provides input to the CNS regarding stretch, pain, tension, and the position of joints. When the body is in motion, the somatosensory system is most effective, because this system reports input relative to the movement of the body in space.[21,32] This system works in conjunction with the proprioceptors of the weight bearing structures to provide more accurate feedback than that of the visual system alone.

Lastly, the vestibular system provides feedback relative to the head position and the relationship to gravity, angular velocity, and linear acceleration.[28,29,33,34] The vestibular system does not work independently, although it does come into play when reacting to perturbations to the COG.[21,32] Such perturbations are demonstrated when vision is inhibited or when the standing surface is unstable.

Flexibility

Anderson and Burke[35] define flexibility as "the range of motion available in a joint or a group of joints that is influenced by muscles, tendons, ligaments, and bones." More specifically to a muscle, Zachezeweski[36] defines muscle flexibility as "the ability of a muscle to lengthen, allowing one joint (or more than one joint in series) to move

through a range of motion (ROM)." It is when there is a loss of muscle flexibility that there is a significantly increased potential risk for injury. A muscle strain is exceedingly common as a result of inflexibility due to the inability of the muscle to lengthen, thus causing a decrease in ROM about the joint.

A muscle strain injury is described as a disruption of the muscle–tendon unit.[37] This type of injury is also characterized as a stretch-induced injury because of the excessive stretching of the muscle fibers during a muscle contraction. It is estimated that up to 30% of a typical sports medicine clinic's clientele can be contributed to stretch-induced injuries.[38,39] The most commonly strained muscles in the human body include the hamstrings, adductor longus, rectus femoris, and the gastrocnemius.

Many studies have been conducted that discuss the effects of flexibility on the prevention of injuries.[37,40-43] One study done by Hartig and Henderson[40] examined the correlation between a hamstring stretching program and lower extremity overuse injuries in military basic trainees. The researchers discovered that by increasing hamstring flexibility, they also significantly decreased the number of lower extremity overuse injuries. Another study by Moore[41] looked at the effects of implementing a stretching program in the workplace. Moore showed that a stretching program in the workplace might be beneficial for employees by increasing flexibility and decreasing the risk of injury due to muscle strains. The researcher also found that the stretching program had a positive effect on the employees' perceptions of themselves and increased their sense of general well being. Overall, many researchers support the fact that increasing flexibility through the utilization of a stretching routine will significantly assist in injury prevention.[37,40-43]

There are three stretching techniques that are utilized to gain an increase in flexibility: static stretching, ballistic stretching, and some proprioceptive neuromuscular facilitation (PNF) techniques.[35,36,44,45] To perform a static stretch, the muscle is slowly lengthened to the greatest elongation of comfort and the position is maintained for a certain period of time.[44,45] Ballistic stretching involves bouncing, rapid, jerky movements performed on a muscle to be stretched. PNF involves isometric contractions of contract-relax (CR) and/or hold-relax (HR) followed by a passive or active lengthening of the muscle. Other than the rotational component that is incorporated with contract-relax, the two techniques are similar to one another. PNF techniques often require the assistance of an experienced therapist to perform or teach these activities.

Although all three of the stretching techniques have proven to increase the flexibility of various muscles,[45-47] the static stretch is most commonly utilized.[35,42,45] Researchers also confirm that when demonstrating the static stretch as performed in yoga, maximal flexibility benefits are obtained by holding the position for 30 seconds, once daily.[42,43] No more benefits were gained when performing the stretch more than once nor when holding the stretch for longer then 30 seconds.

Blood Pressure (BP)

Blood pressure defined by Taber's[19] is "the tension exerted by blood against the arterial walls." There are various factors that determine blood pressure including arterial and capillary resistance, ventricular contraction, elasticity of the arterial walls, and blood volume and viscosity. Two components make up a blood pressure recording that are measured in millimeters of mercury (Hg) known as systolic and diastolic. Systole is the ejection phase denoted by ventricular contraction when the aortic and pulmonic valves

open.[48] This is the first sound that is heard when measuring blood pressure. Diastole begins when the ventricles relax. This allows blood to flow into the right and left atrium and down into the tricuspid and mitral valves, filling them with blood. Diastole is recorded as the last sound audible when measuring blood pressure.

A normal blood pressure value for an adult is between 120-129 mm Hg systolic and 80-84 mm Hg diastolic.[49] However, it is normal for BP to vary according to age, gender, muscular development, altitude, and with different states of physical and mental stress.[19] Exercise also has an effect on blood pressure. With exercise the heart begins to pump more rapidly and forcefully to make up for the increase in oxygen demand.[50] In a normal individual, the arteries are capable of supplying the muscles of the heart with a sufficient amount of oxygen to meet the demand. With this response to exercise, it is normal for the systolic blood pressure (SBP) to progressively increase by approximately 8-12 mm Hg.[49] On the other hand, the diastolic blood pressure (DBP) normally does not change or may slightly decrease with exercise.

A systolic reading greater than 140 mm Hg and a diastolic reading greater than 90 mm Hg characterize hypertensive values for blood pressure.[49] This type of individual's systolic and diastolic blood pressure values will be abnormal when compared to the normal response to exercise. Various studies have been conducted to determine what effect exercise has on normotensive and/or hypertensive individuals.[51-53] One study by Cade, Mars, Wagemaker, et al.[54] revealed that approximately 40% of their subjects who were taking antihypertensive medications were able to significantly reduce or discontinue their medications after participating in an exercise program. Fagard, Bielen, Hespel, et al.[55] suggest that in order to decrease blood pressure the following factors must be

considered: 1) the exercise should be performed three or more times per week, 2) the intensity should be at least 60% of the maximal work load, and 3) the duration should be at least 30 minutes long. It is also very important to continue the physical exercise program, because, if the program is discontinued, the lowering blood pressure effect will quickly disappear.[54-56]

Conclusion

Although there are many claims regarding the positive effects that yoga may have on balance and flexibility, few studies have been conducted to support these claims. More studies are available pertaining to yoga and blood pressure, but conclusive research is still lacking. Therefore, by exploring the effects of yoga on balance, blood pressure, and hamstring flexibility, it will increase awareness of the scientific basis for yoga as an alternative form of therapy.

CHAPTER III

METHODOLOGY

Prior to the start of the study, final approval was obtained from the University of North Dakota Institutional Review Board for the use of human subjects. HealthSouth® of Grand Forks, North Dakota also agreed to participate in the study by instructing yoga classes at their facility. Copies of the Institutional Review Board (IRB) form and the HealthSouth® Participation Agreement are located in Appendix A. During the recruitment process, the researchers informed the individuals that participation in the study was strictly voluntary. They were also informed that those individuals who decided to participate in the study were free to drop out at any time before the final data had been collected. Components of the study were explained to the individuals, and they were given the opportunity to address questions and concerns prior to deciding to participate. Those participating in the study signed the Information and Consent Form developed by the researchers (Appendix B).

Subjects

To conduct the study, 22 subjects (8 males, 14 females) between the ages of 20-33 years were recruited from within the University of North Dakota School of Medicine and Health Sciences. Subjects were selected for the study if they were within the age range of 20-39 years and met the health criteria. Pregnant women, as well as those with a history of cardiac problems or abnormalities in blood pressure, were excluded from the

study. Those who performed aerobic exercise more than 40 minutes, three times per week were also excluded. The researchers determined that four applicants did not meet the criteria and were unable to participate in the study.

Eighteen subjects (6 males, 12 females) met the study criteria and were randomly placed in one of two groups. Group 1 (N=11) served as the experimental group and participated in a yoga class three times per week for six weeks. Group 2 (N=7) also served as an experimental group and participated in a mild walking program three times per week for six weeks. More subjects were able to participate in Group 1 due to scheduling conflicts, which accounts for the greater number of participants in this group. It should also be noted that two subjects from Group 2 dropped out during the course of the study due to lack of participation.

The testing process of all subjects took place at the University of North Dakota Physical Therapy Department. Subjects were tested initially at the beginning of the research project and then again six weeks later.

Pilot Study

Following instruction and practice on the Neurocom Balance Master® (NBM®), a pilot study was conducted to determine intrarater (test-retest) reliability for the single investigator that conducted the NBM® test. A population of N=9 ranging in age from 20-60 years old was assessed twice on the on-axis velocity right-left, anterior-posterior, and composite components of the rhythmic weight shift (RWS) test in the same manner as described below in Instrumentation/ Assessment Procedures. The SPSS Version 10.0 was utilized to perform calculations of intrarater reliability.

Intrarater Reliability

A repeated measures analysis of variance (ANOVA) was used to calculate an intraclass correlation coefficient (ICC) to prove test-retest reliability for the single investigator using the NBM®.

The intrarater reliability was statistically determined for the RWS using the ICC. On-axis velocity ICC values are as follows: left-right of .9031, anterior-posterior of .9351, and composite of .9758. According to Munro and Page,[57] a value of .9-1.00 is interpreted as a very high correlation. Therefore, intrarater reliability was established on the NBM® for the preceding components of the RWS test.

Instrumentation/Assessment Procedures

NeuroCom® Balance Master (NBM®)

Founded in 1984 by Lewis M. Nashner,[58] ScD, the NBM® has been used by physical therapists and other medical disciplines as an assessment, training, and analysis tool. Reliability has been established for RWS (.88) according to Liston and Brouwer.[59] In the same study, the test was compared to the Berg Balance Scale and concurrent validity was also established (p=.025).

The NBM® consists of two 9" x 60" forceplates.[60] During testing, the subject stands on forceplates that measure the force under each foot through load sensors. The computerized system interprets the input from the sensors in a quantitative manner. The NBM® provides visual feedback by displaying the subject's center of gravity (COG) on the computer monitor. This allows the subject to modify his/her sway during testing.

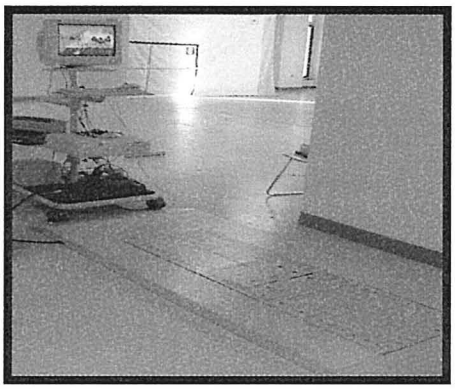

Figure 1: NBM®

The NBM® was used to assess rhythmic weight shift. This assessment was chosen to quantify the subject's ability to move his/her COG from left to right and forward to backward in a rhythmic manner at three degrees per second. The measured parameters are on-axis (intentional) sway velocity and off-axis (extraneous) sway velocity.[58] This test requires the subject to sway reciprocally between two lines. An on-screen cue in the shape of a stick figure person indicates the direction of sway, anterior-posterior or left-right, of the individual being tested.[60] The monitor also shows a square moving at three degrees per second between the two lines denoting the end ranges of movement.

The RWS test was consistently conducted last to ensure the same degree of fatigue for every individual. Subjects were also given at least one practice session before the investigator began scoring. The verbal instructions given to each subject prior to the test are found in Appendix C.

Functional Reach Test (FRT)

The Functional Reach Test was selected to measure the subject's margin of stability during voluntary forward maximal reach. Developed and tested by Duncan,

Shumway-Cook, et al.,[61-63] the FRT is an effective screening tool for balance problems and is often used by physical therapists in the clinic. Duncan and colleagues have established validity and reliability for the FRT. For this reason, the test was chosen as an objective measure of the subject's margin of stability during a routine daily maneuver such as reaching forward.

A 3-inch x 48-inch measurement stick (yardstick) was taped to a wall parallel to the floor to measure the functional reach distance. Each subject stood on a large piece of paper that was taped on the floor next to the wall. The subject's feet were traced to assure that the same base of support (BOS) was used during the re-test period. All subjects performed the test barefoot and with the dominant arm placed nearest the wall. The verbal instructions given to each subject prior to the test are found in Appendix C.

Figure 2: Functional Reach 1

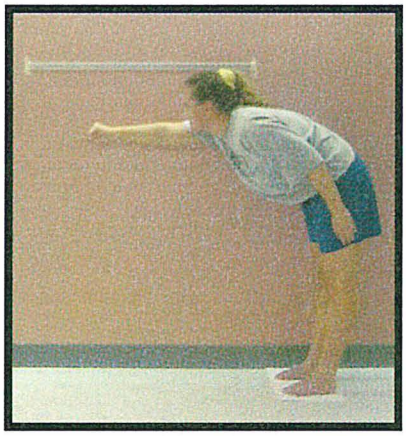

Figure 3: Functional Reach 2

During the re-test period at the end of the six weeks, the subjects were instructed to stand within the foot tracing that was done at the initial test. The subjects were monitored and instructed to avoid protraction, retraction, and elevation of the scapula at the initial position with the shoulder flexed at 90 degrees. One researcher measured the initial position by using a ruler as a straight edge to align the third metacarpalphalangeal joint with the point on the yardstick. A second researcher recorded the position to the

nearest 1/8-inch. The subject was then told to reach forward as far as possible using any strategy but staying within the restrictions mentioned in the instructions. The end reach was then measured and recorded. Each subject was given two practice trials followed by three recorded trials. The dominant hand was recorded for each subject along with the reach measurements. An average of three trials was recorded for each subject.

Blood Pressure (BP)

A standardized blood pressure machine was used to measure each subject's blood pressure. Prior to the study, Altru Biomedical Resources calibrated the machine. Blood pressure was consistently measured at the beginning of testing, prior to all other tests given, to ensure a resting blood pressure. Each subject was questioned to determine the cause of any abnormalities in blood pressure. The main focus of questioning was in regards to the individual's consumption of caffeine intake that day. Protocol for measuring blood pressure is also included in Appendix C.

Sit and Reach Test (SRT)

The sit and reach test is a common procedure used to evaluate the length of the hamstring muscles.[41] Hamstring flexibility is important to prevent muscle strains during activity or exercise. Jackson and colleagues[64,65] compared the standard passive straight leg raise test to the sit and reach test to determine hamstring flexibility. According to their findings, the SRT was found to have moderate criterion-related validity when used to measure hamstring length. Reliability for the sit and reach test has been determined (>.84) by the Texas Governor's Commission on Physical Fitness.[66] With validity and reliability determined, this test is a valuable measure of hamstring flexibility.

The sit and reach device consists of a 19 5/8" x 12 6/8" wood box along with a 26 6/8" ruler that bisects the box. This device was placed against a wall to maintain stability during testing. Each subject was seated on the floor with his/her knees extended, ankles in neutral dorsiflexion, and plantar surfaces of the feet placed against the front of the box. All subjects performed the test with shoes off. The verbal instructions given to each subject prior to the test are found in Appendix C. The researcher visually determined the position of the tip of the third phalanx of the top hand to the nearest 1/8-inch. Each subject did 3 trials of the test, and an average was established.

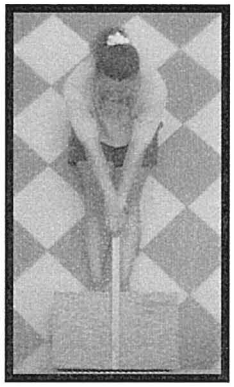

Figure 4: Sit and reach

Single Limb Stance Timed Test (SLST)

The SLST is used commonly to assess static balance.[67] This test can be administered with eyes open (EO) and eyes closed (EC) to elicit different central nervous system (CNS) sensory systems. The visual system is stimulated with the EO portion of this test. During the EC portion of the test, the visual system is inhibited and the subject must rely on the somatosensory and vestibular systems alone.[68] According to Rikli & Busch,[69] reliability for the SLST has been established (.85 -.95).

Subjects performed both the EO and the EC portions of the SLST by balancing on one leg keeping their hands on their hips. For both, the subjects completed three timed

trials using a stopwatch. A mean was established to determine his or her scores. This test was consistently performed prior to the testing on the NBM® to ensure similar fatigue levels between subjects. The verbal instructions given to each subject prior to the test are found in Appendix C.

Training Procedures

Yoga Training

The yoga group participated in a six-week yoga-training program that met for 45 minutes, three times per week. Each 45-minute yoga session consisted of the group performing a random combination of the same 14 asanas. A list of one pranayama and these 14 asanas are as follows: Deep Breathing, Sun Salutation A, Reed Pose, Tree Pose, Dancer Pose, Chair Pose, Warrior Pose, Triangle Pose, Hiker Pose, Staff Pose, Intense West Stretch, Bridge, Childs Pose, Revolved Abdominal Twist, and the Corpse Pose. Pictures along with a description and indications of each of the asanas and pranayama are included in Appendix D.

The yoga sessions were led twice a week by a combination or four yoga instructors at HealthSouth® in Grand Forks, North Dakota. The third session each week was led by one of the three researchers in the laboratory classroom at the physical therapy department at the University of North Dakota School of Medicine. All sessions were held in the evenings.

The Walking Group

The walking group participated in an individual walking and hamstring-stretching program and was instructed to walk three times per week progressing from 30 to 40

minutes in the first week. The written instructions given to each subject for the walking and stretching procedures are found in Appendix C.

Data Analysis

The statistical analysis was performed using SPSS Version 10.0 using an alpha level of .05 for all statistical tests. Descriptive statistics for pre and post testing were run, thereby establishing means, standard deviations, skewness, kurtosis, and ranges. Scores between the pre and post-test assessments were then calculated. Paired Samples t-tests and Wilcoxon tests were run for the two groups to identify any significant improvements between the pre and post-tests. The Paired Samples t-tests were used for all of the tests with a normal distribution. The Wilcoxon Related Sample test was used to report results if any skewness was present among the tests. The independent variables tested were pre-test and post-test times, with the dependent variable being the subjects' scores for each test.

Reporting of Results

Upon completion of this study, a copy of this independent study was given to HealthSouth® and the University of North Dakota Department of Physical Therapy. This study was completed in partial fulfillment of the requirements for the University of North Dakota School of Health Sciences Program of Physical Therapy.

CHAPTER IV

RESULTS

Subject Profile

Eighteen subjects participated in this study. Individuals ranged in age from 20-33 years and were considered to be normal and healthy for all purposes in this study. Two training groups were established consisting of a yoga group (N=11) and a walking group (N=7). However, during the study, two of the individuals from the walking group were dropped from the study due to lack of participation. This resulted in five participants in the walking group (N=5).

Descriptive Statistics

Descriptive statistics including mean and standard deviation were calculated for the data gathered during the pre and post assessments for the two groups. See Table 1 for the yoga results and Table 2 for the walking results.

Analytical Statistics

Analytical statistics were used to answer the research questions and to determine if there is a significant difference between assessments. Paired Samples t-tests were run to analyze data that was determined to have a normal distribution, using an alpha level of .05. These results are shown in Table 2 and Table 3. Table 2 demonstrates significance for diastolic blood pressure (Sig. .04 and M_{diff}=7.45) and on-axis velocity RWS anterior-posterior (A-P) (Sig. .048 and M_{diff} = -.45) for the yoga group. Table 3 identifies significance only in SLST on the left with EC (Sig. .005 and M_{diff} = -9.45) for the

walking group. Wilcoxon tests were run to interpret the data from both groups that did not meet the criteria for a normal distribution, using a significance level of .05. Results of these statistics are shown in Table 4 and Table 5. Table 5 illustrates significance for the yoga group in the sit and reach test (Sig. .003 and M_{diff} = -2.94), SLST with EO on the right (Sig. .043 and M_{diff} = 2.02), and SLST with EC on the right (Sig. .021 and M_{diff} = -2.31). Table 5 proves no significance for any of the tests in the walking group.

In answer to the research questions, there was significance in each of the three variables of balance, hamstring flexibility, and blood pressure after a six-week yoga-training program. A six-week non-strenuous walking program, in comparison to the yoga-training program, did not show the same results in each of the three variables.

Table 1. Descriptive Statistics for the Yoga Group^{Y} and Walking Group^{W}

Variable	N^{Y}	$Mean^{Y}$	SD^{Y}	N^{W}	$Mean^{W}$	SD^{W}
Sit and reach test 1*	11	17.88	2.57	5	13.85	4.46
Sit and reach test 2*	11	20.04	1.82	5	14.92	4.20
Functional reach test 1	11	17.36	3.50	5	15.62	3.29
Functional reach test 2	11	16.58	1.91	5	16.467	3.49
Systolic blood pressure test 1*	11	127.73	6.48	5	122.80	12.56
Systolic blood pressure test 2*	11	122.83	10.18	5	112.20	12.99
Diastolic blood pressure test 1+	11	73.45	10.05	5	68.40	11.26
Diastolic blood pressure test 2+	11	66.00	8.09	5	60.20	7.09
SLST right EO test 1*+	11	85.03	43.33	5	95.76	24.76
SLST right EO test 2*+	11	117.45	8.44	5	107.40	28.17
SLST right EC test 1*+	11	16.60	19.58	5	18.91	10.95
SLST right EC test 2*+	11	36.40	33.28	5	27.02	6.26
SLST left EO test 1*+	11	96.08	36.44	5	96.93	33.15
SLST left EO test 2*+	11	118.23	5.88	5	108.40	25.94
SLST left EC test 1 *	11	21.70	16.95	5	15.91	7.08
SLST left EC test 2*	11	27.40	21.72	5	25.37	7.52
On-axis velocity RWS L-R test 1	11	7.10	.59	5	6.40	.39
On-axis velocity RWS L-R test 2	11	6.96	.78	5	6.20	.51
On-axis velocity RWS A-P test 1	11	3.68	.68	5	4.12	.54
On-axis velocity RWS A-P test 2	11	4.14	.67	5	3.88	.86
On-axis velocity RWS C test 1	11	5.40	.48	5	5.26	.42
On-axis velocity RWS C test 2	11	5.55	.60	5	5.06	.66

* Not a normal distribution yoga + Not a normal distribution walking

Table 2. Paired Samples t-test Results Before and After Training for the Yoga Group

Variable	Mean	SD	t	df	Sig. (two-tail)
Functional reach test 1-2	.7756	3.3060	.778	10	.455
Diastolic blood pressure test 1-2	7.4545	10.4534	2.365	10	.040*
On-axis velocity RWS L-R test 1-2	.1455	.7090	.680	10	.512
On-axis velocity RWS A-P test 1-2	-.4545	.6684	-2.256	10	.048*
On-axis velocity RWS C test 1-2	-.1545	.5574	-.920	10	.379

* Significant at alpha level of .05

Table 3. Paired Samples t-test Results Before and After Training for the Walking Group

Variable	Mean	SD	t	df	Sig. (two-tailed)
Sit and reach test 1-2	-1.0640	2.4739	-.962	4	.391
Functional reach test 1-2	-.8400	1.0546	-1.781	4	.150
Systolic blood pressure 1-2	10.6000	13.8852	1.707	4	.163
SLST left EC test 1-2	-9.4560	3.6844	-5.739	4	.005*
On-axis velocity RWS L-R test 1-2	.2000	.3000	1.491	4	.210
On-axis velocity RWS A-P test 1-2	.2400	.3782	1.419	4	.229
On-axis velocity RWS C test 1-2	.2000	.2550	1.754	4	.154

* Significance at alpha level of .05

Table 4. Wilcoxon Results Before and After Training for the Yoga Group

Variable	z	Asymp. Sig. (two-tailed)
Sit and reach test 1-2	-2.936	.003*
Systolic blood pressure test 1-2	-1.825	.068
SLST right EO test 1-2	-2.023	.043*
SLST right EC test 1-2	-2.312	.021*
SLST left EO test 1-2	-1.826	.068
SLST left EC test 1-2	-1.423	.155

* Significant at alpha level of .05

Table 5. Wilcoxon Results Before and After Training for the Walking Group

Variable	z	Asymp. Sig. (two-tailed)
Systolic blood pressure test 1-2	-1.355	.176
SLST right EO test 1-2	-1.069	.285
SLST right EC test 1-2	-1.214	.255
SLST left EO test 1-2	-.447	.655

CHAPTER V

DISCUSSION

Few studies exist that support the effectiveness yoga may have on balance and flexibility. Although there seems to be more documentation regarding yoga and the effects on blood pressure, both consistent and supportive research are lacking. The results of this study support the researchers hypothesis that a six-week yoga-training program will produce significant results regarding balance and hamstring flexibility in normal, healthy individuals. This study also suggests that a six-week yoga-training program will produce significant results regarding blood pressure. Results show that significance in balance, blood pressure, and hamstring flexibility are more evident in the yoga group than a six-week independent walking group.

When relating the results of this study back to the research questions, the answers varied. The first research question states, "Is there a statistically significant difference between the balance results obtained before and after a six-week yoga-training program for normal, healthy individuals?" The answer to this question varies depending upon which balance test was used. Among the eight different balance tests, three of them are significant for the yoga group. The balance tests with significance are on-axis velocity RWS A-P and SLST on the right with both EC and EO. When comparing the means of each pre and post balance test scores, there are trends toward significance in SLST on the left for both EC and EO. There is no significance for the functional reach balance testing

or the RWS L-R in the yoga group. When looking at one study by Dhume and Dhume,[70] they also agree that yoga is beneficial in increasing concentration and balance.

The second research question states, "Is there a statistically significant difference between the hamstring flexibility result obtained before and after a six-week yoga-training program for normal, healthy individuals?" The answer to this second question is yes. The sit and reach test that was used in the study is significant for the yoga group. According to Bell and Seyfer,[8] yoga involves stretching, which may increase flexibility. However, as stated earlier there is a lack of specific evidence regarding yoga and the direct effects on flexibility.

The third research question states, "Is there a statistically significant difference between the blood pressure results obtained before and after a six-week yoga-training program for normal, healthy individuals?" The answer to this research question varies. Diastolic blood pressure is significant for the yoga group, but there is only a trend toward significance in systolic blood pressure. The majority of the literature regarding yoga and blood pressure supports that yoga can assist in decreasing both systolic and diastolic measurements.[51,52,71]

The fourth research question states, "Does a six-week non-strenuous walking program present with the same results for balance, hamstring flexibility, and blood pressure as a six-week yoga-training program?" The answer to this last question is no. Among the 11 different variables that were pre and post-tested, the walking group is only significant for SLST on the left with EC.

Limitations

There were many limitations that may have had a negative impact on this study as recognized by the researchers. These limitations include the following: 1) The testing environment had auditory distractions and was located in a confined space. 2) There were a limited number of subjects in both the yoga and the walking groups. 3) There is a high learning curve associated with the NBM® that may have contributed to the improvements noted for the yoga group in on-axis velocity RWS A-P. 4) Different instructors taught the yoga sessions. 5) The walking program was independent. 6) The walking group was not instructed on a specific percentage of their maximum heart rate (MHR) to exercise at.

The testing took place at the University of North Dakota Physical Therapy Department in a small and somewhat confined space. With the confined area, it was difficult to avoid audible distractions from the surrounding environment. There were also multiple people conducting each of the tests for the different subjects. With each tester giving verbal instruction to their subjects and limited spacing between other testing locations, it caused for even more distraction. These audible distractions may have played a role in the various subjects' abilities to concentrate and demonstrate their highest level of performance for each test.

Throughout the duration of the study, two people dropped out of the walking program, which left only five people remaining. It is important to note that the yoga group also had a small sample to represent the population with only 11 people. According to Gravetter and Wallnau,[72] a sample size of at least 30 subjects is ideal. The

small sample size in both groups was not an accurate number to represent the population and may have had an impact on the outcome of this study.

There were three different Healthsouth® instructors who volunteered to teach the yoga sessions. One out of the three possible instructors taught the class two times per week. The instructor changed each session based on their schedules and availability. The third weekly session was then taught at the University of North Dakota Physical Therapy Department by one of the researchers. Each of the three researchers taught the class a total of two times. By having a total of six different possible instructors teaching the sessions, it caused for inconsistency. Although the same pranayama and 14 asanas were performed at each session, each instructor had their own ideas and individualized teaching styles, which may have impacted the results of this study.

The last limitations recognized by the researchers was the fact that the subjects in the walking program were independent and were not instructed on a certain percentage of their maximum heart rate to exercise at. At the start of the study, it was anticipated that the walking subjects would all meet together with one of the investigators present, three times a week to perform the walking program. Soon after the start of the study, this expectation became a problem for many members of the group. The majority of the walking subjects could not agree on a mutual time to meet. Therefore, the group was then instructed to perform the walking and stretching routine independently. Also, according to McArdle, Katch, Katch,[73] maximum benefits of exercise are obtained at approximately 70% of ones maximum heart rate. Since the walking group was not educated about a certain percentage of their MHR to exercise within, the investigators were unable to know what intensity the subjects trained at. With this uncontrolled

environment, the researchers had no way of knowing if the walkers were faithful and honest in performing their routines as instructed, or what intensity they were working at. These factors may have affected the results of the walking program.

Recommendations

In order to obtain the best results possible, it is suggested that locations for testing of future studies be in a spacious, isolated, and quiet environment allowing subjects to concentrate and perform at their highest level of functioning. It is also suggested that the number of subjects participating in the study be as large as possible, but ideally at least 30 to increase the ability of the sample to represent the population. A third recommendation is to have only one yoga instructor teaching the sessions to promote consistency in the training and learning of the group. Lastly, it is suggested that future studies designate a certain percentage of ones MHR to train at and require consistent expectations of the walking group by recruiting subjects who will be able to meet at an established time. This will eliminate any questions regarding honesty and increase the reliability and validity of the results. By addressing all these issues, it will decrease the chances of error and produce more efficient results relative to the effectiveness of the training programs.

All subjects that participated in this sample were normal, healthy individuals. It may be beneficial to explore the outcome of yoga training with subjects that are not considered to be normal and healthy. Recruiting subjects such as those with cardiac abnormalities or various balance deficits may produce supportive results that yoga could be an effective alternative or supplement to traditional therapy.

CHAPTER VI

CONCLUSION

Yoga is an ancient form of alternative therapy that has been practiced in the United States since the eighteen hundreds.[70] It is an open-ended discipline that increases mental and physical control of the body to assist in maintaining homeostasis.[71] By performing asanas, many benefits can be obtained for various populations ranging from those with carpal tunnel syndrome, to patients with multiple sclerosis.

Although yoga is thought to have an impact on such factors as balance, blood pressure, and flexibility, there is a lack of supporting evidence to prove yoga's effectiveness. This study has addressed this issue by analyzing the effects of a six-week yoga-training program in 11 subjects that were considered to be normal and healthy. A group of five normal and healthy individuals who performed a six-week walking/hamstring stretching program were also utilized to determine if they would produce the same results as the yoga group.

Significance was found in the yoga group regarding all three factors of balance, blood pressure, and hamstring flexibility. The walking group on the other hand, did not produce the same results as the yoga group. Significance was only shown in a small portion of one balance test. Therefore, results of this study suggest that a six-week yoga-training program does produce an improvement in balance, blood pressure, and hamstring flexibility.

Clinical Implications

Physical therapists and other healthcare professionals see patients with impairments and functional limitations daily. Many of these patients may have blood pressure abnormalities, balance impairments, or possible problems with flexibility. By increasing the knowledge and awareness of these professionals regarding the capabilities of yoga, it offers an alternative to treatment programs. With yoga's gentle, relaxing, and soothing qualities, it is a technique that may benefit many individuals. Yoga routines can be adjusted and monitored to offer great improvements by decreasing an individual's level of disability. Overall, it proves to be an effective therapy within the spectrum of healthcare.

APPENDIX A

X EXPEDITED REVIEW REQUESTED UNDER ITEM 3 (NUMBER[S]) OF HHS REGULATIONS

___ EXEMPT REVIEW REQUESTED UNDER ITEM ___ (NUMBER[S]) OF HHS REGULATIONS

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

Please include ALL information and check ALL blanks that apply.

PRINCIPAL INVESTIGATOR: Cindy Flom-Meland, Shannon Sorenson, Katie Rood, Kendra Van Valkenburg **TELEPHONE:** 777-2831 **DATE:** 2/23/00

ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT: Cindy Flom-Meland, Box 9037 PT

SCHOOL/COLLEGE: Medicine (E.g., A&S, Medicine, EHD, etc.) **DEPARTMENT:** Physical Therapy **PROPOSED PROJECT DATES:** 3/20/00-12/15/00 (Month/Day/Year)

PROJECT TITLE: Yoga and the Effects on Balance, Hamstring Flexibility, and Blood Pressure

FUNDING AGENCIES (IF APPLICABLE):

TYPE OF PROJECT (Check ALL that apply):

X NEW PROJECT ___ CONTINUATION ___ RENEWAL DISSERTATION OR THESIS RESEARCH X STUDENT RESEARCH PROJECT

___ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER: Cindy Flom-Meland

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

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

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

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

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

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

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

Yoga has been found to have a significant reduction in stress levels and may have a positive effect on balance and flexibility. This study will investigate what influences yoga can have on balance, hamstring flexibility, and blood pressure.

A total of 20-30 subjects that are 20-39 years of age are required for this study. All subjects will initially complete a balance test utilizing the Balance Master and the standardized Sit and Reach test for hamstring flexibility. Blood pressures will also be taken. Subjects will randomly be assigned to a yoga exercise group or a walking group. The exercise groups will participate for 45 minutes three times/week for six weeks. At the end of six weeks, the initial testing will be repeated.

The investigators expect to find improvements in balance, hamstring flexibility, and blood pressure. The most significant improvements are anticipated to be among the subjects participating in the yoga group.

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

2. PROTOCOL:(Describe procedures to which humans will be subjected. Use additional pages if necessary. Attach any surveys, tests, questionnaires, interview questions, examples of

interview questions (if qualitative research), etc., the subjects will be asked to complete.)

Recruitment: The investigators will recruit subjects from the population of the University of North Dakota by speaking with various classes on campus. A total of 20-30 subjects are required for this study.

Selection: Subjects will meet the study requirements if they are 20-39 years of age. Subjects will be excluded if they have a history of cardiac problems, abnormalities in their blood pressure, or if they are currently pregnant. Those who perform aerobic exercise more than 40 minutes, three times per week will also be excluded.

Procedures: All subjects will initially complete a balance test utilizing the Balance Master and a standardized sit and reach test for hamstring flexibility. Blood pressures will also be taken. Subjects will be randomly assigned to a yoga exercise group or a walking group. The yoga group will participate 2x/week in a 45-minute yoga exercise class taught by a yoga instructor along with a mandatory practice session 1x/week led by an investigator for a total of six weeks. The walking group will participate in supervised 45-minute sessions 3x/week for six weeks. At the end of six weeks, both groups will repeat the initial testing. Previously established normative data will be use to compare our results. The yoga classes will take place at Healthsouth and UND PT Department. The testing sessions will be conducted at UND PT Department.

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

Risk: Yoga is a form of exercise; consequently, there is a risk of personal injury. The investigators believe the risk to be minimal, since yoga is a very gentle form of exercise. All subjects who are currently pregnant or those with a history of cardiac problems or abnormalities in blood pressure will be excluded from our study. Those who performed aerobic exercise more than 40 minutes, three times a week will also be excluded. The yoga instructor and at least one of the investigators will be present at each yoga session. An investigator will supervise all practice sessions. In addition, all subjects will be informed that they may stop the activity at any time. Should a personal injury occur during a yoga session, the individual will be encouraged to receive prompt medical attention. The subject will be responsible for payment of necessary medical interventions.

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

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

The study is designed to determine the effects that yoga has on balance, hamstring flexibility, and blood pressure. Although the population involved in the study consists of individuals without extreme balance deficits, the investigators feel the results will develop a baseline for future research studying individuals with deficits such as balance problems. Our subjects will have variable hamstring flexibility deficits, which the investigators feel will reflect a normal population.

Minimal research exists relating the effects of yoga on balance, flexibility and blood pressure. The goal of the study is to provide further information and create awareness of yoga as an alternative therapy.

Further benefits for the subjects include relaxation and reduction of stress. Yoga classes are usually of cost to the individuals. However, these classes will be free of charge to our subjects.

4. RISKS:(Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject's dignity and self-respect, as well as psychological, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to protect the confidentiality of data obtained, debriefing procedures, storage of data, how long date will be stored (must be a minimum of three years), final disposition of data, etc.)

Yoga is a form of exercise. Consequently, there is a risk of personal injury. The investigators believe the risk to be minimal, since yoga is a very gentle form of exercise. Subjects will be excluded if they are currently pregnant, have a history of cardiac problems, or have abnormalities in blood pressure. Those who perform aerobic exercise more than 40 minutes, three times per week will also be excluded. The yoga instructor and at least one of the investigators will be present at each yoga session. In addition, all subjects will be informed that they may stop the activity at any time.

Should a personal injury occur during a yoga session, the individual will be encouraged to receive prompt medical attention. The subject will be responsible for any necessary medical intervention.

All materials will be held in a locked office at the UND physical therapy department for three years or longer if further research is to be done. At the end of three years, the materials will be destroyed. At no time will subject names be used during the study or to report the results of the study. Obtained information, in association with the study that can identify the subject, will remain confidential, and will be disclosed only with their permission.

5. **CONSENT FORM:**Attach a copy of the **CONSENT FORM** to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no **CONSENT FORM** is to be used, document the procedures to be used to assure that infringement upon the subject's rights will not occur. Describe where signed consent forms will be kept and for how long (must be a minimum of 3 years), including plans for final disposition or destruction.

All confidential materials from this study are to be retained in Cindy Flom-Meland's office in the UND Physical Therapy Department for three years following completion of this study. After three years, all documents are to be destroyed if they are not needed for a further study. Data collected will be published, but will in no way identify the subjects by name. A copy of the consent forms used will be attached to this form.

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

Office of Research & Program Development
University of North Dakota
Grand Forks, North Dakota 58202-7134

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

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

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

SIGNATURES:

Katie Rood Kendra Van Valkenburg Shannon Sorenson — 3-2-00

Principal Investigators: Katie Rood, Kendra Van Valkenburg, Shannon Sorenson — Date

Cindy Flom-Meland — 3-2-00

Project Director or Student Adviser: Cindy Flom-Meland — Date

Training or Center Grant Director — Date

(Revised 2/2000)

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

STUDENT CONSENT TO RELEASE OF EDUCATIONAL RECORD[1]

Pursuant to the Family Educational Rights and Privacy Act of 1974, I hereby consent to the Institutional Review Board's access to those portions of my educational record which involve research that I wish to conduct under the Board's auspices. I understand that the Board may need to review my study data based on a question from a participant or under a random audit. The study to which this release pertains is The Effects of Yoga on Balance, Hamstring Flexibility, and Blood Pressure

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

3-2-00
Date

Signature of Student Researchers: Katie Rood, Kendra Van Valkenburg, Shannon Sorenson

HEALTHSOUTH®

February 22, 1999

This letter is to confirm that Healthsouth and its instructors will be involved in a study with the UND Physical Therapy School.

The study will be on improvements in balance from participating in yoga.

Sincerely,

Jill Bisson, Healthsouth Fitness Director

Jill Prout

Shannon Ysteboe

Susan Carlson

REPORT OF ACTION: EXEMPT/EXPEDITED REVIEW

University of North Dakota Institutional Review Board

Date: March 21, 2000 **Project Number:** IRB-200003-178

Name: Cindy Flom-Meland, Shannon Sorenson, Katie Rood, Kendra Van Valkenburg **Department/College:** Physical Therapy

Project Title: Yoga and the Effects on Balance, Hamstring Flexibility, and Blood Pressure

The above referenced project was reviewed by a designated member for the University's Institutional Review Board on 3-22-00 and the following action was taken:

☑ Project approved. **EXPEDITED REVIEW** Category No. 7
Next scheduled review is on: 3-22-01

☐ Project approved. **EXEMPT REVIEW** Category No. _____
No periodic review scheduled unless so stated in the Remarks Section.

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

☐ Project approval **deferred. This study may not be started until final IRB approval has been received**. (See Remarks Section for further information.)

☐ Project **denied.** (See Remarks Section for further information.)

REMARKS: Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRB Chairperson or ORPD.

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

Betty A Dahl 3-22-00
Signature of Designated IRB Member Date
UND's Institutional Review Board

cc: Cindy Flom-Meland, Adviser
Chair, Physical Therapy
Dean, School of Medicine

If the proposed project (clinical medical) is to be part of a research activity funded by a Federal Agency, a special assurance statement or a completed 310 Form may be required. Contact ORPD to obtain the required documents.

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APPENDIX B

Information and Consent Form

Title: The Effects of Yoga on Balance, Hamstring Flexibility, and Blood Pressure

You are being invited to participate in a study conducted by Katie Rood, Kendra Van Valkenburg, and Shannon Sorenson, students in the masters of physical therapy program at the University of North Dakota. The purpose of this study is to determine the effects of yoga on balance, hamstring flexibility, and blood pressure. The balance testing will be performed on The Balance Master, a machine objectively measuring changes in balance. The hamstring flexibility will be measured, using a standardized sit and reach test.

Participants will be selected and assigned to one of two groups randomly (yoga or walking). Only subjects 20-39 years of age with no history of cardiac problems or abnormalities in blood pressure and those who are not currently pregnant will be asked to participate in the study. All those who exercise more than 40 minutes, three times per week will also be excluded.

You will be asked to participate in an initial testing period located in the Physical Therapy Department on the campus of UND. We anticipate this testing to take 30 minutes. The testing will consist of a "practice session" on the Balance Master to familiarize you with the machine. Then you will perform the balance tests on the Balance Master. Next, a sit and reach test for hamstring flexibility will be performed and blood pressure will be checked. For the testing we recommend wearing loose fitting clothing.

Your participation in this study will require you to attend Yoga classes at Healthsouth twice a week along with a mandatory practice session that will be held on campus once a week for a total of six weeks. At least one of the evaluators will be present at all sessions. Alternative times are available if you cannot make these sessions. If you are selected for the walking group, you will be participating in a one hour supervised walking session three times a week as opposed to the yoga classes. After the six week period you will be asked to participate in one more testing session at the Physical Therapy Department using the Balance Master and the sit and reach test to evaluate your progress. Blood pressure will also be taken at this time.

We (the evaluators) realize that the time commitment is great. However, we expect to find significant improvement in balance, flexibility, and blood pressure with yoga training and believe the commitment is well worth your time as well as ours.

The results of this study will be confidential, and a number known only by the investigators will identify the data. The results of this study will be published, but will in no way identify you as a subject. The results will be stored for three years after the study has ended, unless they are required for continuing studies. Whether or not you participate in this study will in no way reflect on your relationship with the physical therapy department, the University of North Dakota, or Healthsouth.

The investigators involved will be available to answer any questions or concerns you may have about this study. You may contact the investigators by calling Shannon at 701-777-9867, Katie at 701-746-6933, Kendra at 701-772-0025, and Cindy 701-777-4130. A copy of this consent form is available to all participants in this study.

As with any exercise there are risks of injury. If you decide to participate, you are free to discontinue at any time until the data collection is completed. In the event that this research activity (conducted at UND and Healthsouth) results in physical injury, medical treatment will be available, including the following: first aid, emergency treatment and follow-up care as it is customary to members of the general public in similar circumstances. You and/or your third party payer must provide the cost of treatment.

ALL OF MY QUESTIONS HAVE BEEN ANSWERED AND I AM ENCOURAGED TO ASK ANY QUESTIONS THAT I MAY HAVE OF THIS STUDY IN THE FUTURE. MY SIGNATURE INDICATES THAT I HAVE READ THE ABOVE INFORMATION, AND I HAVE DECIDED TO PARTICIPATE IN THE RESEARCH PROJECT.

Participants signature	Date	Investigators signature	Date

FITNESS CENTER

AGREEMENT AND RELEASE OF LIABILITY

1. In consideration of gaining membership or being allowed to participate in the activities and programs of HealthSouth Fitness Center and to use its facilities, equipment, and machinery in addition to this payment of any fee or charge, I do hereby waive, release and forever discharge HealthSouth Fitness Center and its officers, agents, employees, representatives, executors, and all others from any and all responsibilities or liability for injuries or damages resulting from my participation in any activities or my use of equipment or machinery in the above mentioned facilities or arising out of my participation in any activities at this facility. I do also hereby release all of those mentioned and any others acting upon their behalf from any responsibility or liability for any injury or damage to myself, including those caused by the negligent act or omission of any of those mentioned or others acting on their behalf or in any way arising out of or connected with my participation in any activities of HealthSouth Fitness Center or the use of any equipment at HealthSouth Fitness Center. **(Please initial_____)**

2. I understand and am aware that strength, flexibility, and aerobic exercise, including the use of the equipment, is a potentially hazardous activity. I also understand that fitness activities involve a risk of injury and even death and that I am voluntarily participating in these activities and using equipment and machinery with knowledge of the dangers involved. I hereby agree to expressly assume and accept any and all risks of injury or death. **(Please initial_____)**

3. I do hereby further declare myself to be physically sound and suffering from no condition, impairment, disease, infirmity, or other illness that would prevent my participation in any of the activities and programs of HealthSouth Fitness Center or use of equipment or machinery except as hereinafter stated. I do hereby acknowledge that I have been informed of the need for a physician's approval for my participation in an exercise/fitness activity or in the use of exercise equipment and machinery. I also acknowledge that it has been recommended that I have a yearly or more frequent physical examination and consultation with my physician as to physical activity, exercise, and use of exercise and training equipment so that I might have recommendations concerning these fitness activities and equipment use. I acknowledge that I have either had a physical examination and have been given my physician's permission to participate, or that I have decided to participate in activity and/or use of equipment and machinery without the approval of my physician and do hereby assume all responsibility for my participation and activities, and utilization of equipment and machinery in my activities. **(Please initial_____)**

Name (please print):_____

Address:_____
Street Apt #

_____
City State Zip

Signature: _____ Date: _____

Parent signature if under age 18:_____

2 Forms of ID: _____
Driver License # and other; SS# or ID#
Confirm Address

APPENDIX C

NBM® Verbal Instructions

1. Remove your shoes and socks.
2. Step onto the forceplate, and I will line you up properly.

   *Subjects feet were aligned on the forceplate with the medial malleolus aligned with the wide blue line, and the lateral calcaneous was aligned with the "M" or "T" line according to NBM® guidelines regarding the subject's height.

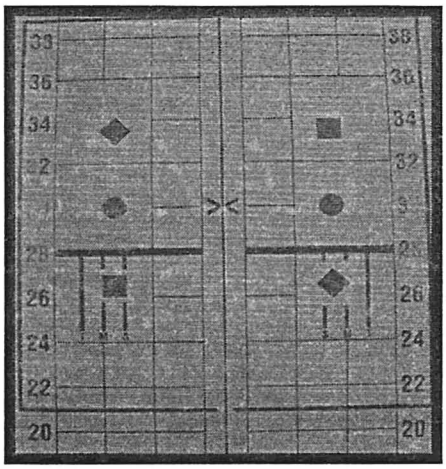

Figure 5: NBM® Forceplate

3. Shift your weight back and forth (side to side) to make your cursor follow the blue square.
4. Try to move the same speed that the square moves.
5. Try to move as straight and as smoothly as you can.
6. Change directions at the lines just like the square does.
7. I can score whenever you are ready. Just say "ready", and I will begin scoring.

Functional Reach Test Verbal Instructions

1. Stand with feet apart in a comfortable stance.

2. Make a fist with your dominant hand and bring your shoulder to 90 degrees of forward flexion.
3. Reach forward as far as you can, keeping your heels on the floor and your knees straight. Do not twist at the waist.

Blood Pressure Procedure

1. Have the subject sit in a chair with their right arm resting on a table at the level of their heart.
2. Place the blood pressure cuff on their right arm with the arrow on the cuff pointing to the brachial artery.
3. Push the start button and wait for the reading.

Sit and Reach Test Verbal Instructions

1. Overlap your hands with your middle fingers aligned evenly.
2. Reach forward as far as you can by sliding your hands on the ruler surface, maintaining knee extension and your feet in contact with the box at all times.
3. You will perform a total of three repetitions. The first two will be practice, and you will hold the third repetition until I tell you to relax.

Single Limb Stance Test Verbal Instructions

1. Remove your shoes and socks.
2. Stand with you hands on your hips at all times.
3. Bend your right/left knee to 90 degrees and hold it there throughout the testing.
4. Keep your knees separated and do no let them come in contact with one another.

5. a. EO: I will start timing when you say "ready".

   b. EC: I will start timing when you close your eyes.

6. I will stop the test if your foot comes in contact with the floor, if you open your eyes, if you take your hands off your hips, or at the end of two minutes, denoting the end of the test.

Written Instructions for the Walking group

- You will be walking three times per week for a total of six weeks.
- The first week, walk 30 minutes the first time, 35 minutes the second time, and then 40 minutes throughout the duration of the remaining five weeks.
- Do not exercise in your walking program above your maximal heart rate (MHR). (MHR = 220 – age)
- You should be able to perform the "talk test" throughout the duration of your walk.
- Perform a standing hamstring stretch five times before and after walking, holding for 20 seconds each.
- Keep a journal of when you walked, including the date, how long, and that you did/did not perform the hamstring stretches before and after walking.
- You must report your recordings to one of the investigators weekly.
- The subjects were all instructed on the proper techniques for conducting the "talk test", monitoring heart rate, and hamstring stretching.

APPENDIX D

Description of Yoga Asanas

Deep Breathing

Deep breathing is a pranayama that helps to increase the circulation of blood flow, increase lung expansion, relax the mind and nervous system, and prepare the muscles for activity.[6] Subjects performed this technique six times at the beginning of each yoga session. This breathing technique is performed by placing the feet together and interlocking the fingers. Place the fingers under the chin while keeping the elbows as close together as possible. With the chin and knuckles in contact with one another throughout the exercise, inhale slowly through the nose while lifting the arms to the side and bringing the head back for a count of six. Then, bring the head back to neutral as the lungs fully expand, and a new cycle is initiated.

Figure 6: Deep Breathing 1

Figure 7: Deep Breathing 2

Sun Salutation A

Sun Salutation A (SSA) is an asana that assists with overall toning of the body.[6] This asana was done three times during each training session. The following steps are followed while performing this pose: 1. Inhale and bring the arms overhead with the palms together. Tighten the quadriceps while looking upward and making sure to avoid

arching the back. 2. Exhale. Slowly, try and place the palms flat on the floor while tucking the chin inward to look toward the navel. 3. Inhale while lifting the head up and keeping the tips of the fingers as close to the floor as possible. 4. Walk or jump both feet back and lower the body to the floor into the "push-up" position. 5. Perform the "upward facing dog pose" by starting in the prone position. Then fully straighten the elbows to extend the trunk. Look upward toward the ceiling, avoiding shoulder elevation and sagging the back. 6. Perform the "downward facing dog" by turning the feet under and walking both hands backward until the body is in an inverted "V" position. The palms should be in direct contact with the floor, with the fingers spread apart. 7. Walk the feet forward individually to the hands and look upward on inhalation. This is the same position as number three. 8. Exhale and tuck the head into the knees, assuming the same position as number two. 9. Slowly bring the body back into the fully erect position and begin a new cycle.

Figure 8: SSA 1

Figure 9: SSA 2

Figure 10: SSA 3

Figure 11: SSA 4

Figure 12: SSA 5

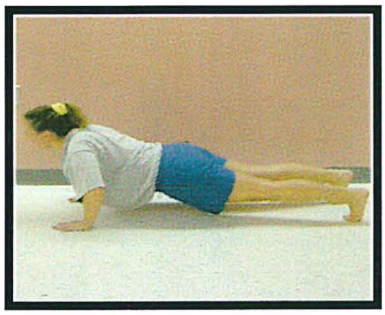

Figure 13: SSA 6

Figure 14: SSA 7

Figure 15: SSA 8

Figure 16: SSA 9

Reed Pose

The Reed is beneficial in stretching the upper body, firming and slimming the waistline, and stimulating blood flow to the abdominal organs.[6] This asana was performed once to each side in every yoga session. To perform the Reed, stand upright with the arms straight overhead and the palms touching one another. Then, exhale keeping the arms straight overhead and bend to the R/L side until resistance is felt, holding for 10 to 20 seconds. Before switching the Reed to the opposite side, slowly return to the starting position.

Figure 17: Reed 1

Figure 18: Reed 2

Tree Pose

The Tree Pose helps to improve concentration, balance, and lower extremity strength.[6] Subjects demonstrated this technique once on each side during the yoga training program. During this pose, it is important to first find a focal point. This will allow for increased concentration and assist in improving balance. Initiate the Tree Pose by standing with both feet together then shifting weight onto one foot. The plantar surface of the non-weight bearing foot is placed on the medial side of the opposite calf making sure to avoid contact with the knee joint. A more challenging alternative is to place the foot on the medial side of the thigh above the knee joint. The elbows are then straightened and raised overhead with the palms in contact with one another. This position is held for 10 to 20 seconds before the leg is lowered to the ground. The individual is now ready to perform this asana on the opposite extremity.

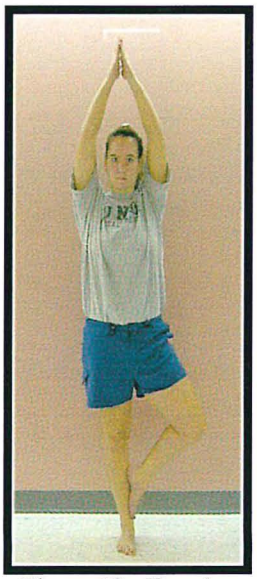

Figure 19: Tree 1

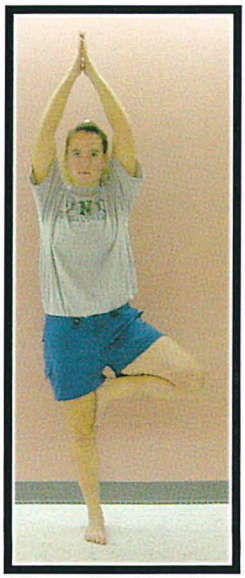

Figure 20: Tree 2

Dancer Pose

The Dancer has been known to be beneficial for increasing balance, flexibility of the quadriceps, and strength of the extremities.[6] This pose was performed at every session once on each side. Again, it is important to find a focal point to assist with concentration and balance. To perform the dancer, shift all the weight onto the right leg and reach back with the left hand to grab the left ankle. Extend the right arm overhead keeping the elbow straight. Next, separate the knees by leaning forward. This position is held for a 10 to 20 seconds before returning to the neutral position and performing the Dancer on the opposite side.

Figure 21: Dancer 1

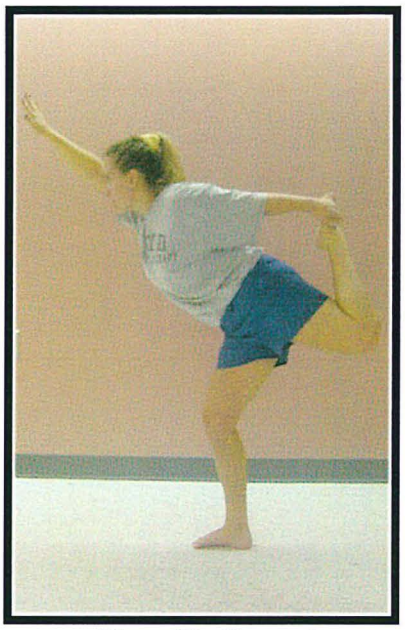

Figure 22: Dancer 2

Chair Pose

The Chair Pose can be used to strengthen the muscles of the leg, increase flexibility of the hip and ankle joints, and improve concentration. [6] Each subject demonstrated this asana once at each session. The Chair Pose is achieved by standing fully erect and flexing both arms out in front to 90 degrees, while bending at the knees and hips as if to sit down in a chair. Make sure to keep the back straight with the weight maintained through the heels. An alternative position is to come up onto the balls of the feet. Hold this pose for 10 to 20 seconds and slowly return to a relaxed standing position.

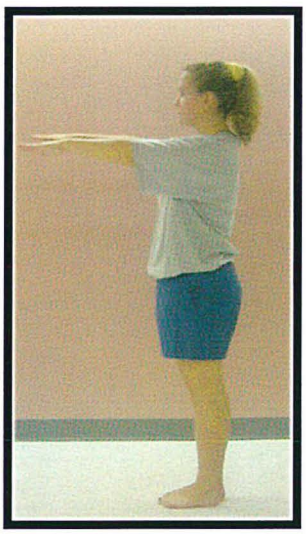

Figure 23: Chair 1

Figure 24: Chair 2

Figure 25: Chair 3

Warrior Pose

The Warrior Pose is an asana that can improve upper and lower extremity strength. [6] The pose was completed once to each side during every yoga session. To begin the Warrior, the individual must start in a standing position and walk the feet three to four feet apart. Turn the left foot inward 30 degrees and the right foot outward approximately 90 degrees. Abduct the shoulders, with elbows fully extended, out to the side 90 degrees. Turn the head to the right and lunge forward by keeping the left knee

straight and bending the right knee. To prevent overstressing the knee joint, it is important to make sure that the knee does not go past the ankle. Slowly return to standing and repeat the asana to the opposite side.

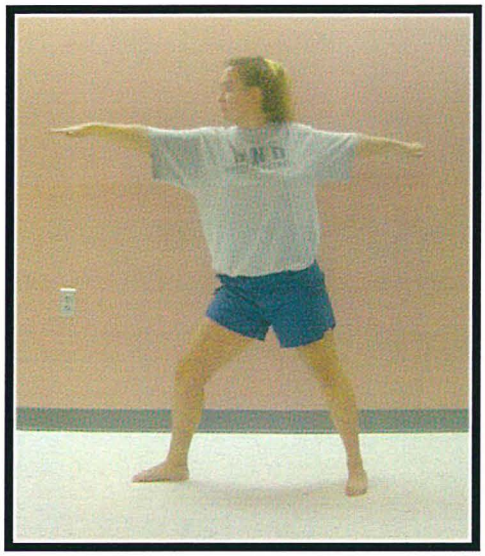

Figure 26: Warrior 1

Figure 27: Warrior 2

Triangle Pose

The Triangle Pose benefits the lower extremities by increasing strength.[6] Other benefits include increasing flexibility of the arms, neck, back, and hips while tightening the abdominal muscles and assisting with an increase in chest expansion. This technique was completed once to each side during each the yoga session. To perform the Triangle Pose, the upper and lower extremities are in the same starting position as in the Warrior, prior to the lunge. For the Triangle Pose, tilt the upper body and arms in a straight line until they are parallel with the bent lower leg. Reach the left arm to the ceiling as the right arm stretches down with the fingertips barely in contact with the floor. Once the parallel position has been reached, the head should turn to look upward to the left thumb.

The pelvis should remain forward to avoid flexion at the waist. Hold for 10 to 20 seconds. Return to standing, and repeat to the other side.

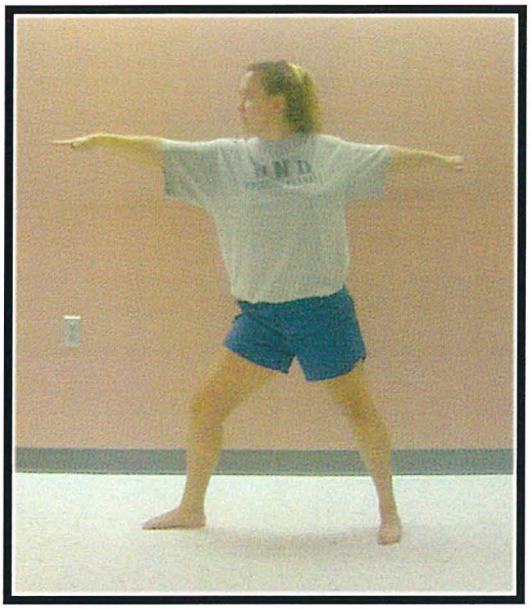

Figure 28: Triangle 1

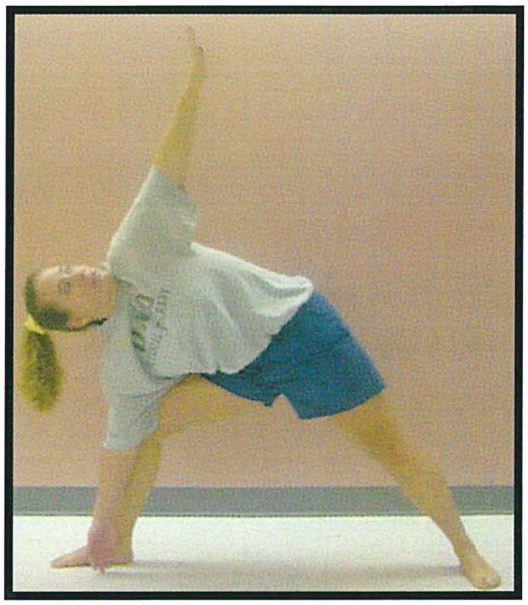

Figure 29: Triangle 2

Hiker Pose

Benefits for the Hiker Pose include upper and lower extremity strengthening, increasing hamstring flexibility, and improving balance.[6] The Hiker was performed once per side during each session. To perform this asana, position the lower extremities slightly greater than shoulder width apart. Place the hands in a prayer position with palms facing one another and elbows flexed. Slowly inhale and fully extend the arms up overhead. While bending at the waist, exhale down with the palms flat on the floor and fingertips facing each other and hold for 5 to 10 seconds. Next, extend one arm toward the ceiling as the head follows to look at the thumb. Hold this position for 10 to 20

seconds. Slowly bring the hand back down to the floor with the fingertips facing each other. Starting from this position, repeat to the other side.

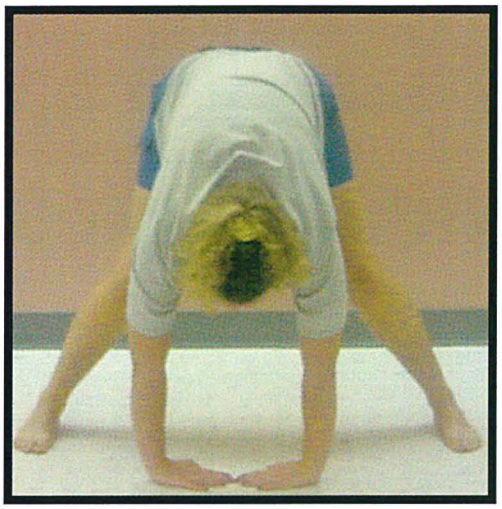

Figure 30: Hiker 1

Figure 31: Hiker 2

Staff Pose

The Staff Pose can be used to increase body awareness and proprioception.[6] During each yoga session, this position was performed once and held for 10 to 20 seconds. Starting in a long sitting position, fully extend the elbows and place the hands on the floor next to the hips. Press the back of the thighs into the floor by contracting the quadriceps.

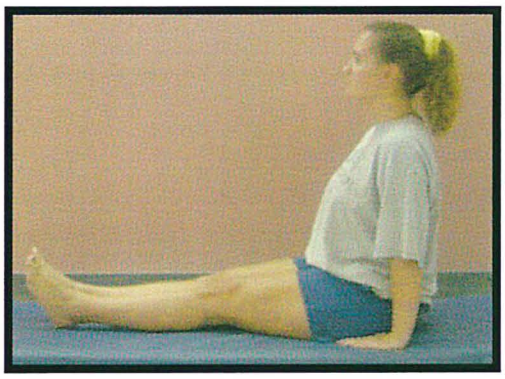

Figure 32: Staff Pose

Intense West Stretch

This posture will increase flexibility of the hamstrings and the back musculature.[6] In the training program the group performed the Intense West Stretch (IWS) one time each session and held it for 20 seconds. In order to perform this pose, attain a long sitting position and tighten the quadriceps, while maintaining a neutral spine. Inhale and sit up tall. Exhale and reach forward to try and grab hold of both feet. While maintaining this position, inhale slowly. As the chest begins to deflate, attempt to increase the stretch by reaching further forward.

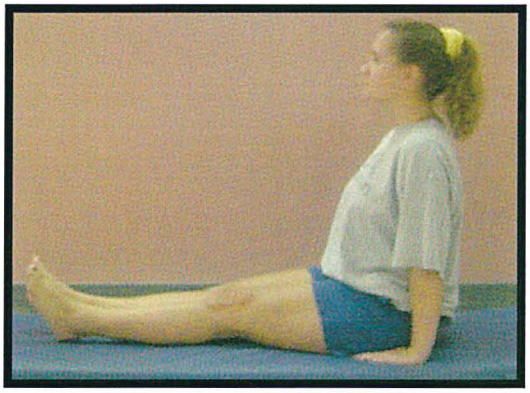

Figure 33: IWS 1

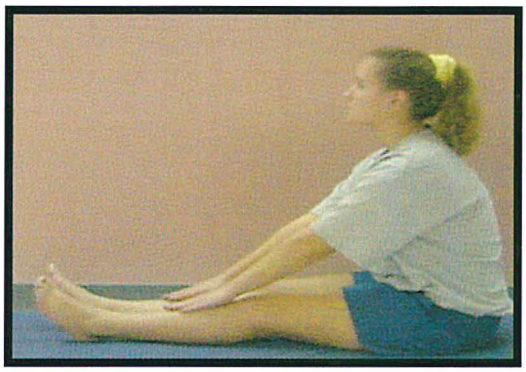

Figure 34: IWS 2

Bridge Pose

The Bridge Pose helps to increase circulation to the head and face along with decreasing back pain and fatigue.[6] This posture was held for 20 seconds and performed once during each yoga session. Begin in the supine position and bend both knees up with feet flat on the floor at approximately hip width apart and parallel to each other. Place the arms on the floor next to the body with the palms facing downward. Exhale and push

the small of the back into the floor by rotating the pelvis backward. Inhale and lift the back off of the floor in a segmental manner, while contracting the gluteal muscles.

Figure 35: Bridge 1

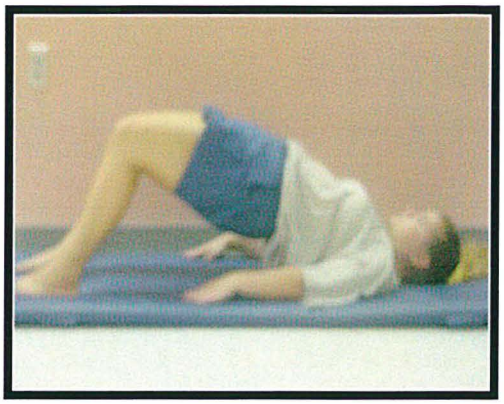

Figure 36: Bridge 2

Child's Pose

Relaxation is the main benefit of the Child's Pose.[6] This pose was performed once during each session and held for 50 to 60 seconds. To perform this pose, kneel down with the heels resting on the buttocks and bend forward until the forehead comes in contact with the floor. The arms should be extended behind the body with the dorsal surface of the hands resting on the floor and palms facing upward next to the feet.

Figure 37: Child's 1

Figure 38: Child's 2

Revolved Abdominal Twist

The Revolved Abdominal Twist (RAT) is a technique that assists with increasing flexibility in the shoulder and trunk regions.[6] During the training, the subjects demonstrated this asana once to each side during each session holding for 20 seconds. This pose is performed in supine with arms abducted to 90 degrees in a "T" position. Slowly bend the lower extremities up to the chest, lower the knees down to the left, and turn the head to the right. Return the bent legs to midline before performing to the other side.

Figure 39: RAT 1

Figure 40: RAT 2

Corpse

The Corpse Pose is the primary asana for relaxation.[6] The goal is to relax all voluntary muscles and clear the mind with concentration on breathing. This posture was held for a minimum of five minutes at the conclusion of every session. Begin in the supine position with the elbows and knees fully extended in a comfortable position, palms facing upward. Eyes should remain closed throughout the exercise. After five

minutes, slowly roll onto one side in the fetal position. End the asana by coming to a sitting position with forearms resting on thighs with palms up.

Figure 41: Corpse 1

Figure 42: Corpse 2

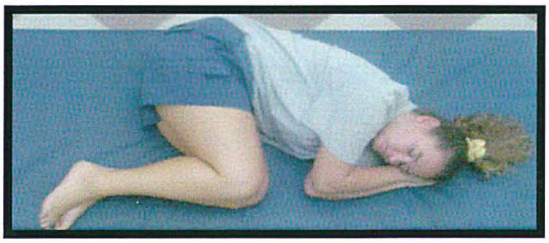

Figure 43: Corpse 3

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