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THE EFFECT OF AN 8-WEEK YOGA EXERCISE PROGRAM AND A 4-WEEK RELAPSE PREVENTION PROGRAM ON PAIN, PHYSICAL FUNCTION, BALANCE, FLEXIBILITY, PHYSICAL ACTIVITY LEVEL AND PREDICTORS OF EXERCISE IN ADULTS WITH OSTEOARTHRITIS

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THE EFFECT OF AN 8-WEEK YOGA EXERCISE PROGRAM AND A 4-WEEK RELAPSE PREVENTION PROGRAM ON PAIN, PHYSICAL FUNCTION, BALANCE, FLEXIBILITY, PHYSICAL ACTIVITY LEVEL AND PREDICTORS OF EXERCISE IN ADULTS WITH OSTEOARTHRITIS

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF HEALTH AND EXERCISE SCIENCE

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ABSTRACT

The purposes of this study were to determine (1) the effectiveness of a 4 week relapse prevention intervention on exercise adherence rate, exercise self-efficacy, social support for exercise, and exercise intention and (2) the effectiveness of an 8-week Hatha yoga exercise program on joint pain, joint stiffness, physical functional performance, balance, flexibility and physical activity level in adults aged 40-64 years with lower limb osteoarthritis. Physical functional performance was measured using the CS-PFP 10, flexibility was measured with a goniometer, and balance was measured using NeuroCom Balance Master®. Pain, stiffness, and predictors of exercise were measured using questionnaires. Twenty participants were recruited and were randomly assigned to one of two groups, an intervention group (10) and a comparison group (10). The yoga intervention was provided to all the participants in classes that were conducted for 1 hour twice a week for 8 weeks. After the completion of the yoga program, the intervention group participated in a 4-week relapse prevention intervention in which participants received encouragement and guidance to continue practicing yoga through emails and phone calls. The comparison group received no contact or information during this period, however, they were asked to continue practicing yoga.

A two-way repeated measures ANOVA for time (pre-test, post-test, and follow-up) and group (intervention and comparison) were conducted to evaluate the time and group main effects and time*group interaction for all the outcome variables in order to assess change related to participation in the yoga intervention (pre- to post-test) and the relapse prevention intervention (post-test to follow-up). The results from the study indicated that participation in the yoga intervention significantly improved the pain, stiffness, physical functional performance, and physical activity levels of the participants. There was no statistically significant improvement in laboratory measures of balance and flexibility from pretest to posttest or from posttest to follow-up. Participation in the relapse prevention intervention was not associated with improvements in predictors of exercise (exercise self-efficacy, exercise intention, and social support for exercise) and yoga exercise adherence rate when the intervention group was compared to the comparison group. Future research is advised to further explore the most beneficial modes of yoga, particularly for the middle-aged adults with arthritis. Likewise, the most beneficial methods of relapse prevention should also be further explored.

CHAPTER ONE

INTRODUCTION

Background

Arthritis is a joint disorder that results in the inflammation of one or more joints.[1] Osteoarthritis (OA) is the most common type of arthritis. OA is a joint disease with pain, tenderness and stiffness as major clinical symptoms. These symptoms in older adults usually lead to muscle atrophy, decline in strength, flexibility, mobility, balance, and physical functional performance.[1-2] OA is a degenerative disease that results from overuse of joints, especially weight bearing joints like the knee, hip, spine, or feet. OA of the knee and hip are more associated with physical and functional disability than OA of other joints.[2] The disease frequently leads to physical disability, especially in elderly patients. During the past 10 years the incidence and prevalence of the disease has increased dramatically among middle-aged and older adults.[3]

Currently, an estimated 26.9 million adults are affected with OA in the United States.[4] A report published by the CDC stated that overall OA affects 13.9% of adults aged 25 and older and 33.6% of adults aged 65 and older. Of those aged 65 and older, about 80% have some degree of physical limitation. As noted previously, the number of diagnosed cases of OA increased over the last 10 years and accounts for nearly 500 deaths per year, which is approximately 6% of all arthritis-related deaths.[4] Symptomatic OA occurs in 10% men and 15% in women aged 60 years or older.[5] One in two American adults, including middle-aged and older adults aged 60 years and older, may develop symptomatic OA in their lifetime.

Aging is a major non-modifiable risk factor of OA, but overall risk for OA is multifactorial.[6] Other risk factors of OA include genetics, obesity/overweight, previous joint injuries, repetitive use of joints, muscle weakness, or nerve injury.[6] The most common modifiable risk factor of OA is obesity because excess body weight increases the forces exerted upon joints, especially the hips and knees, and can lead to OA.[7] Therefore, overweight people have a higher risk of developing knee or other joint OA than normal weight individuals. Moreover, men have 45% lower risk of developing knee OA and 36% lower risk of hip OA than women, especially after age 50.[4] There also are certain occupations that have an increase in risk of developing OA due to repetitive use of joints involved in work-related activities. These include occupations such as competitive athletics, farming, operating high impact equipment such as a jackhammer, and working in mills.

There are many negative consequences associated with the development of OA, which most often affects the neck, spine, hips, hands, knees, and ankles. The most common consequences of OA include pain, stiffness, decreased range of motion, and swelling in and around the joints that can lead to decreased movement and impaired performance of activities of daily living. If OA worsens overtime, bones may break or bone spurs may develop due to chronic joint inflammation. It also may cause bits of bone and/or cartilage to break and float around in the joint capsule leading to reduced quantity and quality of synovial fluid.[8] This could cause erosion of cartilage and inflammation in the lining of the joints, causing more pain, swelling, and damage. As a result, older adults with lower limb OA also are at higher risk of falls because of lower limb weakness, slower gait, and decreased mobility.[8]

Physicians and other health care professionals recommend targeting three areas of arthritis management: weight counseling for overweight and obese patients, physical activity counseling, and pain-management education.[8] Exercise has proved to be the most effective non-drug treatment for reducing pain and improving function, movement, mood, and quality of life in adults with osteoarthritis.[9] Because of these benefits, therapeutic exercise is one of the most recommended options for the treatment and prevention of OA. Simple activities such as walking can result in improvement in OA symptoms.[9] Current research focus is on determining the most appropriate exercise intensity and frequency recommendation for middle-aged and older adults with OA.

Recent research has suggested that exercises that are associated with complementary and alternative medicine (CAM) may improve OA symptoms.[10] Yoga, Tai Chi Chuan, and Qigong are a few types of exercise that are good for older adults with OA because they are low impact strength training exercises. These exercises are also associated with improvement in function, balance, strength, psychological well-being, and quality of life.[10] Based on the growing consensus that low impact exercise can reduce the symptoms associated with osteoarthritis, it follows that yoga may have a positive effect on OA symptoms, particularly given the potential additional benefits associated with the relaxation/meditation aspects of yoga practice. Yoga can have physiologic benefits similar to those of a regular aerobic program.[11] A number of randomized controlled studies exist on the efficacy of yoga in healthy middle aged and older adults. Moreover, yoga has shown to decrease pain and stiffness associated with OA and symptoms associated with carpal tunnel syndrome.[11-12] When used as an adjunct in the management of rheumatoid arthritis and OA of the knees, participation in yoga has been associated with both a significant reduction in pain, stiffness, and functional disability and improvement in strength, flexibility, balance, and gait.[13-14]

Most interventions have targeted older adults (60 or older) with arthritis[12-13] to determine the effectiveness of yoga therapy; only a few studies have focused on a younger population. For this study middle aged adults between 40 and 64 years with osteoarthritis were recruited to determine if yoga exercise has beneficial effects in younger group with arthritis. In addition, if adults with arthritis have already started to decline at the time they practice yoga, then it may require longer and more intense yoga practice to produce improvement. However, if adults enter the period of old age with greater fitness, better balance, and a high level of physical functional performance after practicing yoga, then the time to frailty should be extended significantly.

Purpose of the Study

The primary purpose of this study was to determine the effectiveness of a relapse prevention intervention on continued participation in yoga after the end of an 8-week Hatha yoga program. The secondary purpose was to determine the effectiveness of the yoga exercise program on components of physical health among adults with osteoarthritis. Based on the purposes, the study was divided into two phases. The objective of the first phase of this study was to determine the effectiveness of an 8-week Hatha yoga exercise program on joint pain, joint stiffness, physical functional performance, balance, flexibility and physical activity level in adults aged 40-64 years with lower limb osteoarthritis (OA). It was predicted that pain, stiffness, physical functional performance, balance, flexibility, physical activity level, and predictors of exercise would improve at the end of the 8-week yoga. The objective of the second phase of the study was to determine the impact of a 4 week relapse prevention intervention on exercise adherence rate, exercise self-efficacy, social support for exercise, and exercise intention and maintenance of beneficial effects of yoga exercise on physical health (pain, stiffness, physical function, balance, flexibility and physical activity level) at 1-month follow-up. This study would help to identify the health advantages associated with continued participation in yoga exercise in middle-aged adults with OA. The results obtained from this study may assist practitioners to develop programs for middle aged and older adults that can slow the progression of this disease, provide symptomatic relief, and extend the period of independent living.

Research Questions

This study has tried to answer the following research questions:

RQ1: Will participation in 8 weeks of Hatha yoga be associated with improved physical functional performance from pre to post yoga intervention in middle-aged adults with lower limb OA?

RQ2: Will participation in 8 weeks of Hatha yoga be associated with reduced pain and stiffness from pre to post yoga intervention in middle-aged adults with lower limb OA?

RQ3: Will participation in 8 week Hatha yoga be associated with in improved balance (decreased postural sway) from pre to post yoga intervention in middle-aged adults with lower limb OA?

RQ4: Will participation in 8 week Hatha yoga be associated with improvement in flexibility from pre to post yoga intervention in middle-aged adults with lower limb OA?

RQ5: Will participation in 8 week Hatha yoga be associated with an increase in physical activity level from pre to post yoga intervention in middle-aged adults with lower limb OA?

RQ6: Will participation in a relapse prevention intervention be associated with improvement in exercise self-efficacy, exercise intention and social support for exercise when compared to control group?

RQ7: Will participation in a relapse prevention intervention be associated with an increase in the rate of continued participation in yoga exercise adherence when compared to control group?

RQ8: Will the beneficial outcomes associated with participation in yoga be maintained at 1-month follow-up testing?

Hypotheses

H_R1: Participation in Hatha yoga will be associated with improvement (increase) in physical functional performance from pre to post intervention in middle-aged adults with lower limb OA.

H_01: There will be no change in physical functional performance from pre to post intervention in middle-aged adults with lower limb OA.

H_R2: Participation in Hatha yoga will be associated with improvement (decrease) in pain & stiffness from pre to post intervention in middle-aged adults with lower limb OA.

H_02: There will be no change in pain & stiffness from pre to post intervention in middle-aged adults with lower limb OA.

H_R3: Participation in Hatha yoga will be associated with improvement (decrease) in postural sway from pre to post intervention in middle-aged adults with lower limb OA.

H_03: There will be no change in postural sway from pre to post intervention in middle-aged adults with lower limb OA.

H_R4: Participation in Hatha yoga will be associated with improvement (increase) in flexibility from pre to post intervention in middle-aged adults with lower limb OA.

H_04: There will be no change in flexibility from pre to post intervention in middle-aged adults with lower limb OA.

H_R5: Participation in Hatha yoga will be associated with improvement (increase) in physical activity level from pre to post intervention in middle-aged adults with lower limb OA.

H_05: There will be no change in physical activity level in middle-aged adults with lower limb OA from pre to post intervention.

H_R6: Participation in a relapse prevention intervention will be associated with improvement (increase) in exercise self-efficacy, exercise intention, and social support for exercise when compared control group.

H_06: There will be no difference in exercise self-efficacy, exercise intention, and social support for exercise between relapse prevention group and control group.

H_R7: Participation in a relapse prevention intervention will be associated with a higher yoga exercise adherence rate when compared to control group.

H_07: There will be no difference in yoga exercise adherence rate between the relapse prevention group and control group.

H_R8: The beneficial outcomes associated with yoga intervention will be maintained at 1-month follow-up.

$H_0 8$: The beneficial outcomes associated with yoga intervention will not be maintained at 1-month follow-up.

Significance of the Study to Health Promotion and Education

The results from this research study provide useful information related to functional benefits and improvements in range of motion and mobility of joints affected by OA and balance associated with regular participation in yoga exercise. Yoga is generally a low-impact, safe, and effective form of physical activity for people with arthritis that can be a beneficial and enjoyable alternative to traditional forms of exercise such as aerobics or aquatic exercise.[13] Overall, the risk of serious injury from yoga is quite low.[13] This study assessed the effectiveness of yoga exercise in improving measures of physical functional performance, flexibility, and balance in middle aged adults with OA. With the growing size of the elderly population and the associated increase in the health care costs, it is important to have the ability to effectively perform necessary activities of daily living and maintain postural stability in order to live independently. Unfortunately, many health promotion programs offer exercise programs without providing support to participants to assist them to continue exercising after the completion of the program. However in this study, one group was provided with an additional relapse prevention intervention in order to determine whether this better facilitated continuation of yoga practice after completion of the yoga intervention among intervention group participants when compared to control group participants that received no additional support. The continuation of yoga practice immediately after completion of a program is critical to long-term adoption of yoga as an ongoing exercise modality. Long-term exercise maintenance is uncommon even for healthy individuals. For people with arthritis, adherence to yoga exercise is important so that benefits can be maintained. The information gained from this research will be beneficial to practitioners since development of programs that integrate yoga exercise and long-term adoption of yoga may be beneficial as a means to gain symptomatic relief from the disease and facilitate independent living.

Delimitations of the Study

Delimitations for this study include:

- This study was delimited to male and female middle-aged adults with OA in the Oklahoma City metropolitan area
- Participants were between the ages of 40 and 64 years.
- In total 20 participants were recruited who were insufficiently physically active (did not meet the recommended moderate physical activity level of 30 minutes per day most days of the week).
- The 1 hour yoga exercise classes were conducted in the OU Student Union, Norman, OK every Monday and Wednesday at 5:00pm for 8 weeks.
- The physical functional performance, flexibility, balance testing, and all questionnaires (pain, stiffness, physical activity level, exercise self-

efficacy, exercise intention, and social support for exercise) were administered in the Functional Performance Lab in the Collums Building of University of Oklahoma, Norman.

Limitations of the Study

Limitations for this study include:

- The participants were tested before program participation. This may have influence on participant's effort to perform better during the intervention and on post-test measures. This may have result in both internal (testing) and external (interaction effect of testing) threats to validity.

- A convenient sampling method was used. Volunteers were recruited by flyers and email contacts. Volunteers tend to be better educated, which could have resulted in both internal (selection biases) and external (interaction effects of selection bias and experimental treatment) threats to validity.

- Self-reporting of pain, stiffness, physical activity, predictors of exercise, and exercise adherence measures. Self-report measures may yield over- or under-reporting, which can result in measurement error.

Assumptions

The following assumptions were made when conducting the research:

- Participants responded to all questions honestly and accurately, and completed all performance-based testing with maximal effort.

- The members of the control group participated in none of the structured motivational activities that were provided to the intervention group during the 4 week follow-up period (period between post-testing and follow-up testing).

- The weather (or season) in which data was collected and the intervention was delivered did not impact results.

Operational Definitions

Operational definitions for this study include:

- *Activities of Daily Living (ADL):* ADLs are defined as the basic tasks done on a daily basis that are necessary to maintain independent living.[15] These tasks include activities such as walking, eating, dressing, getting into or out of a bed or chair, transferring, continence, taking a bath or shower, and using the toilet.[15]

- *Base of Support (BOS):* BOS is the point of contact between the feet and the standing surface. For example, if the feet are placed apart, BOS is larger than if feet are together.[16]

- *Continuous - Scale Physical Functional Performance (CS-PFP) testing battery:* This is a group of performance based measurement protocols designed to provide a comprehensive measure of physical functional performance that reflects functional abilities in several separate physical domains and integrates physiological, physical, and psycho-social factors.[17] The CS-PFP testing protocols were used in this study to assess physical functional ability by simulating "real life" activities such as carrying groceries, doing laundry, and sweeping the floor.

- *Dynamic balance:* Balance during a state of movement such as walking.[16]

- *Forceplate:* Platform base that includes four pressure transducers placed in specific points to measure the vertical force exerted by the participant's feet during standing or movement.[16]

- *Functional Status/Functional ability:* Functional status is usually conceptualized as the "ability to perform self-care, self- maintenance and physical activities."[18] It is the ability to perform both activities of daily life (ADL) and instrumental activities of daily life (IADL).[18]

- *Functional Tests:* A battery of assessment tests that can be completed using the NeuroCom Balance Master® and are categorized as providing dynamic measures of postural sway.[16]

- *Gait:* Term referring to the way an individual walks or runs, which can include width of step, speed, sway, etc.[16]

- *Instrumental Activities of Daily Life (IADL):* IADLs are defined as the secondary level of activities important to daily living, or a series of life functions necessary for maintaining a person's immediate environment.[19] IADLs are functional activities that involve use of a tool or instrument (e.g., making a telephone call, driving, cooking, shopping, managing finances, laundering, housekeeping, managing money, taking medication etc.) and require more steps for completion than basic activities.[19]

- *Insufficiently physically active:* People who do not meet the health-related physical activity recommendations are considered to be insufficiently physically active. The health-related physical activity recommendation (American College of Sports Medicine and American Heart Association) is to participate in moderate intensity physical activity 30 minutes a day, five days a week (at least 150 minutes a week).[20]

- *NeuroCom Balance Master®:* A testing system used in the laboratory or clinical settings to measure balance, sway, and gait based on measurement obtained using a forceplate mechanism.[16]

- *Osteoarthritis:* OA is a progressive degenerative condition of the joint, characterized by focal degeneration of the articular cartilage.[5]

- *Pain*: Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage.[5]

- *Physical functional performance (Physical function):* Physical functional performance is used to assess the physiological capacity of older adults and to predict their living status.[18] It is used in rehabilitation facilities, research laboratories, and retirement communities to assess function in older adults, people with chronic diseases, and those recovering from acute conditions. It also has been used effectively as an evaluation tool for program efficacy.[18]

- *Postural stability/balance:* the ability of an individual to maintain his/her center of mass over his/her base of support.[16]

- *Postural sway:* the amount of movement an individual experience during static or dynamic activity such as during standing or rising up or turning around.[7]

CHAPTER TWO

REVIEW OF LITERATURE

One purpose of this research was to determine the effectiveness of an 8-week Hatha yoga exercise program in improving the pain and stiffness, physical functional performance, balance, strength, and flexibility in individuals with OA. A second purpose was to assess the effectiveness of a relapse prevention program on exercise self-efficacy, intention to exercise, social support, and adherence to yoga exercise after completion of this structured yoga program in adults aged 40-64 years with lower limb OA. The review of relevant literature in this chapter is organized around several areas. With respect to the purpose of yoga interventions, four different approaches are apparent. First, there are studies that focus on the effect of participating in yoga exercise on pain, stiffness, and physical functional performance in adults with OA. A second group of studies relates the effect of participation in yoga on flexibility, and balance in adults with OA. A third group of studies relates to the effect of participation in yoga exercise on physical activity level. The fourth group of studies relates to the effect of participation in a behavioral intervention on exercise self-efficacy, intention to exercise, social support, and yoga exercise adherence rate.

Yoga has been regarded as an exercise for the body, mind, and spirit for centuries. The theory behind yoga practice is that the union of mind and spirit in exercise brings balance to the body and promotes healing.[11] The objectives of yoga include: (1) harmony of the mind, (2) improved vitality, (3) reduced anxiety, depression, and fatigue, and (4) attainment of rejuvenation and longevity.[11] There is a large body of anecdotal evidence of the benefits of yoga and many studies have shown that yoga practice has a beneficial effect in elderly participants. However, to date, only a few scientific studies have been conducted to determine the effectiveness of yoga in patients with osteoarthritis. More research is needed to determine the effect of yoga on pain, stiffness, physical performance, flexibility, strength, and balance in middle aged and older adults with OA.

Impact of Osteoarthritis on Function

Osteoarthritis is a debilitating condition characterized by pain, joint inflammation, and joint stiffness, which results in physical disability.[5] It is caused primarily by the degeneration of the collagen and protein in cartilage, leading to erosion and cracking in the cartilage layer. The main function of cartilage is to reduce friction in the joints and act as a "shock absorber".[6] The main cause of OA is an imbalance in the natural breakdown and repair process that occurs with cartilage.[22] In healthy cartilage, there is a continual process of natural breaking down and repair of the cartilage in joints. In patients with OA, this normal process of break down and repair is disrupted causing degeneration of cartilage and an abnormal repair response where damaged cartilage cannot repair itself in the normal way.[22] Overtime deterioration occurs when the cartilage that covers and cushions the ends of bones in your joints cannot repair itself. Eventually, the cartilage may wear away in some areas, greatly decreasing its ability to absorb shock.[7] As the cartilage deteriorates, tendons and ligaments stretch, causing pain. Repetitive use of worn joints over the years can cause constant irritation, joint pain, and inflammation of surrounding tissues.[7] When cartilage wears down completely, bone is exposed, resulting in bone-on-bone contact, friction, and debilitating. Also, frequent bob-on-bone contact can cause the bone to change in shape.[22] As pieces of cartilage break off, bones thicken and broaden, causing inflammation. This inflammation may stimulate new bone outgrowths called spurs or osteophytes to form around the joints. As the bones thicken and broaden, joints become stiff, painful, and may be difficult to move. Fluid may also build up in joints causing joint swelling.[22] Over time this process spreads to the deeper layers of cartilage, and eventually large, clinically observable erosions are formed.[22] The main health consequences resulting from OA are joint pain and stiffness, impaired range of motion (ROM), decreased ability to carry out activities of daily living (ADL), and overall impairment in physical functional performance.[22] People with OA have less time available for leisure activities and are more dependent on the assistance of family and friends.[3] Osteoarthritis of the knee and hip accounts for more of the decline in ability to carry out activities of daily living such as walking, stair climbing, and performance of other lower-extremity tasks than any other disease.[22] Physical disability caused by OA also has been found to affect social and psychological life. During the last century, the increase in obesity rates and the aging of our population have resulted in an increase in joint damage, which in turn has resulted in an increase in the physical and financial burden of OA worldwide.[3] Osteoarthritis also has been shown to cause muscular weakness and imbalance.[3] Muscular weakness and subsequent muscular atrophy are key risks for loss of balance and falls in older adults.[3]

Many health care groups have recommended targeting three areas of arthritis management: (1) weight counseling of overweight and obese patients that encourages weight loss, (2) physical activity counseling to encourage an increase in physical activity levels, and (3) pain-management education.[8] Prevention/treatment of arthritis could be categorized into three levels - primary, secondary, and tertiary. Primary prevention methods include focus on strategies to reduce risk factors for OA so that fewer people develop this condition. Secondary prevention deals with screening and early treatment to slow the progression of the disease, while tertiary prevention includes treatment of consequences of the condition and rehabilitation to improve overall function.[23] Treatment should be tailored to the needs of an individual patient. Due to constant pain and disability from large joint OA (i.e., knee or hip), people often opt for treatments that promise instant relief, like joint replacement surgery. Unfortunately, this potentially increases the overall healthcare cost of OA treatment.[7] Currently, therapeutic interventions focus on preventing the onset of OA, slowing the progression of this disease, or providing symptomatic relief.[7] Traditional treatments emphasized the use of medication and encouraged rest, as it was believed that physical activity actually worsened the symptoms that are commonly linked with OA.[24] This was a widespread assumption among adults with all forms of arthritis. As a result of their physical disability combined with the assumption that physical activity would magnify this limitation, many patients avoid unnecessary physical activity. With OA, it is very common to have pain after activity, which may discourage people from regular exercise. Moreover, many worry that exercising with OA can harm their joints and cause more pain. There is a high prevalence of inactivity among OA patients, even though joint pain may be exacerbated by both exercise and rest.[24] Because they feared exacerbation of symptoms, many individuals with OA prefer use of medication for pain relief instead of participation in physical activity.

Pain and functional limitations can result in challenges to participation in physical activity among patients with OA. However, regular exercise is beneficial in managing this condition. In order to prevent muscle atrophy, exercise has to be performed on a regular basis, since health benefits do not persist if exercise programs are discontinued.[25] Therefore, people with degenerative joint disease should participate in a continuous exercise program. A proper exercise program is designed to strengthen muscle and improve body alignment. Stronger muscles help joints function more efficiently, which slows the wear and tear of joint cartilage.[23] The knees and hips are particularly susceptible to development of OA. A proper arthritis exercise program can increase mobility and reduce pain in these joints. For those with advanced joint discomfort, an aquatic program designed for individuals with OA may be effective. The buoyancy effect of water reduces the load on the joints and makes exercise easier and safer for those suffering from degenerative joint disorders.[7] Also, weight loss and low intensity physical activity have been found to reduce the development of large joint OA.[7]

Yoga as an Exercise Modality

The word "yoga" is derived from the Sanskrit word meaning "union". It is an ancient method of exercise that originated from Indian philosophy an estimated 5,000 years ago.[13] It is considered as an integrated approach to health that uses relaxation and healing, and promotes improvements in flexibility, strength, and stamina, and also nurtures self-confidence, self-awareness, and feelings of well-being. Yoga can be performed anywhere, requires no special equipment, is gentle on the joints, and can be modified for each person. It uses only gravity and the body itself as resistance, so it is a low-impact activity. However, it is not just an exercise. It is a mind-body intervention that is well suited for OA since it combines stress management and gentle physical activity.[13] Overall, those who practice yoga have lower risk of serious injury. As with any physical activity, there may be side effects that make a technique (such as postures or breathing) inadvisable for specific individuals.[12] In recent years, yoga has been considered an effective treatment for OA.[24, 26] Iyengar Yoga, a form of Hatha Yoga that was created by BKS Iyengar, is commonly practiced in the United States. It stresses strength, balance, breathing, and alignment of the body. It allows for the use of various assistive devices such as chairs or blocks to aid balance and straps to facilitate stretching. It can be performed by anyone at any age and level of fitness. Because the body can be supported and balanced through the use of assistive techniques/devices, beginners can achieve many postures that would otherwise be difficult.[11]

Clinical and Psychosocial Benefits of Yoga

<u>Impact on Pain, Stiffness, and Physical Functional Performance</u>: As specified earlier, few studies have assessed the effects of yoga as an exercise activity that can improve physical fitness, reduce functional limitation, and decrease pain and stiffness among adults with OA. Most of these studies were conducted to determine the impact of participation in Yoga on pain, stiffness, and physical functional performance. A pilot study was conducted to assess the effectiveness of using Hatha yoga to treat the symptoms of osteoarthritis of the knee.[21] Eleven participants between 50 and 68 years of age who were diagnosed with knee OA participated. They were instructed in modified Iyengar yoga postures during 90-minute classes once weekly for 8 weeks. The outcome variables were pain, stiffness, physical functional performance, and impact on social and psychological function. Pain was measured using Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Patient Global Assessment (GA) by a 100-mm visual analog scale (VAS), and the Physician Global Assessment by a 100-mm visual analog scale. Stiffness and physical functional performance also were measured using WOMAC. The impact of arthritis impact on social and psychological function was measured using the Arthritis Impact Measurement Scale 2 (AIMS2).[21] All the variables were measured before and after the intervention. The study reported that pain (p=0.04), physical functional performance (p=0.04), and psychological function (p=0.002) improved significantly after participation in yoga. These study results suggest that yoga may provide a feasible treatment option for reducing pain and disability caused by knee OA in previously yoga-naive, obese patients who were greater than 50 years of age.[21]

Another study was conducted to assess the feasibility and potential efficacy of a Hatha yoga exercise program in managing OA-related symptoms in older women (n=36, mean age=72 years) with knee OA.[13] Participants were randomly assigned to an 8-week yoga program involving group and home-based sessions or to a wait-list control group. Outcome variables were pain, stiffness, physical functional performance, body mass index (BMI), quality of sleep (QOS), and quality of life (QOL). The knee OA pain, stiffness, and physical functional performance were measured using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) total score. BMI was measured using height and weight. Quality of sleep (QOS) was measured using the Pittsburgh Sleep Quality Index (PSQI), and quality of life (QOL) was measured using the short physical performance battery (SPPB), the Cantril Self-Anchoring Ladder, and the Medical Outcome Study SF-12v2 Health Survey.[13] Data were collected at baseline, 4 weeks, 8 weeks, and 20 weeks. The results indicated significantly greater improvement in physical functional performance and pain in the group that participated in a weekly yoga program with home practice when compared to the scores of the control group ($p<0.05$).[13]

Another group of researchers assessed the effect of Hatha yoga therapy versus therapeutic exercises on symptoms of individuals with osteoarthritis (OA) of the knee joints.[26] Two hundred and fifty (250) participants who had OA of the knees and who were between 35 and 80 years of age were randomly assigned to receive hatha yoga therapy or therapeutic exercises. Each group received physiotherapy with transcutaneous electrical stimulation and ultrasound treatment (20 minutes/day) for 2 weeks. Both of the groups practiced supervised interventions (40 minutes per day) for 2 weeks and were asked to practice their assigned exercise modality at home for 10 weeks after the 2 week supervised period. The outcome variables were pain while walking, knee disability, knee flexibility, joint tenderness, swelling, crepitus, and walking time.[26] Pain while walking was measured using a walking numerical rating scale. Knee disability was assessed using the WOMAC scale that measures three domains: pain, stiffness, and physical functional performance. Flexibility was measured using a goniometer. Joint tenderness, swelling, and crepitus were assessed by a clinician, while walking time was assessed by measuring the time required to walk 50 meters using a stopwatch. Data were collected at baseline, the15th day, and the 90th day. The results indicated that participation in hatha yoga therapy was associated with significantly greater improvement in walking pain, range of knee flexion, and walking time. Participation in yoga also was associated with greater decreases in tenderness, swelling, crepitus, and knee disability in patients with arthritic knees on day 15 and 90 (p <0.001) when compare to the therapeutic exercise group.[26]

Another pilot study was conducted to determine compare the effects of chair yoga, Reiki, and an educational program on pain, depressive mood, and physical functional performance compared to for older adults with osteoarthritis.[27] A quasi-experimental research design with pretest/posttest was used. Twenty-nine participants aged 55 and older were assigned to one of three groups: chair yoga, Reiki, and an educational group. The yoga group received a yoga class twice a week for 45 minutes for 8 weeks. Reiki is a complementary energy therapy used to create subtle changes in life-energy. It is a form of healing that uses energy from the hand of the Reiki practitioner to channel bodily energy to the Reiki recipient. The Reiki group received a 30-minute Reiki session weekly for 8 weeks. The educational group met for 1.5 hours every other week for 8 weeks. The 4 sessions were divided into 4 presentations that included discussions of OA, benefits and drawbacks of medications for OA, exercise for OA, and alternative and complementary treatments for OA. The outcome variables were pain, stiffness, and physical functional performance, and depression. Pain, stiffness, and physical functional performance were measured using Western Ontario and McMaster Universities Osteoarthritis Index.[27] Depression was measured using the Center for Epidemiologic Studies Depression Scale.[27] A 1 hour focus group also was conducted to collect information about the participants' experience of the intervention and how it had affected them physically, emotionally, and socially during the 8-week period. Findings showed significant improvement only in physical functional performance in the chair yoga group (p=0.02) when compared to the Reiki and educational group.[27]The interactions between each of the 3 interventions and pain, stiffness, and depressive symptoms were not statistically significant. In focus group interviews, participants expressed feelings of improved health and well-being after the yoga intervention. After the Reiki intervention participants expressed increased relaxation and soothing emotionally. Educational group expressed interest in sessions but they agreed that the sessions did little to actually relieve chronic pain from OA.[27]

Similarly, another pilot study aimed at examining whether an 8-week chair yoga program was effective in reducing pain level and improving physical functional performance and emotional well-being in a sample of community-dwelling older adults with osteoarthritis. [12] Ten participants aged 65 and above were asked to participate in 45 minute chair yoga sessions twice a week for 8 weeks. Outcome variables were pain, stiffness, physical functional performance, and depressive symptoms. All the variables were measured using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Center for Epidemiologic Studies Depression scale (CES-D).[12] The variables were measured at baseline, midpoint (4 weeks), and end of the intervention (8 weeks). Results indicated that chair yoga was effective in improving physical functional performance (p=0.03) and reducing stiffness (p=0.05) in older adults with osteoarthritis, however, there was no significant reduction in pain level or improvement in depressive symptoms.[12]

From the previous studies, it can be concluded that physical functional performance, pain, and stiffness can be improved by yoga in adults with OA. In order to better understand the effect of yoga exercise on physical functional performance, pain, and stiffness in people with OA, it was suggested that additional research be performed. Most of the studies that were reviewed reported positive impact on OA symptoms including decreases in pain and stiffness and improvement in physical functional performance. However, all the studies did not examine adherence to yoga practice, which is essential for obtaining long-term effects.

Impact on Flexibility (ROM) and Balance: Many studies have been conducted focusing on the effect of yoga on flexibility and balance in healthy sedentary adults. The results from these studies indicate that yoga therapy has resulted in significant improvement in flexibility, strength, balance, stamina, and gait in healthy sedentary adults.[9, 10] However, because of a lack of evidence, it cannot be concluded that participation in yoga improves flexibility and balance in patients with OA. A group of researchers conducted a case series study that describes the impact of various forms of exercise on symptoms associated with osteoarthritis of the knee.[28] They studied the effect of yoga therapy on flexibility, strength, and quality of life in individuals with osteoarthritis (OA) of the knee joints. A group of 15 women and men aged 55 and older performed one of the following for 6 weeks: traditional stretching and strengthening exercises, Iyengar yoga, or no structured group exercise. The outcome variables were flexibility, strength, and quality of life. The sit and reach test was used to measure low back and hamstring flexibility, and quadriceps strength was measured using dynamometry. A global assessment questionnaire was used to measure quality of life. They also measured pain, stiffness, and physical function using WOMAC questionnaire. [28] All measures were collected pre- and post- intervention. The result of this study indicated improvement in physical function and improvement in quality of life in the traditional exercise and the yoga groups, which suggests that participation in yoga may improve flexibility, strength, and QOL in individuals with OA of the knee.[28]

Another study was conducted to evaluate whether participation in a yoga program is feasible, safe, and effective for improving physical health in people with arthritis.[29]They randomized 75 participants with OA or rheumatoid arthritis to an 8-week standard yoga program that had been modified for use by persons with arthritis or to a wait-list control condition. Participants had a mean age of 52 years. Yoga classes were held twice a week (lasting 60 minutes each), and participants were asked to practice the exercises for an additional 60 minutes at home each week.[29] The outcome variables were: (1) physical health (measured using the Physical Health Summary Scales of the MOS Short Form-36), (2) physical fitness that included balance, strength, flexibility, and mobility, (3) perceived stress, (4) self-efficacy to manage disease, and (5) depressive symptoms. Balance was measured using the one leg stand, strength was measured using the hand grip test, flexibility was measured using the sit and reach test, mobility with a 6-minute walk, perceived stress with the Perceived Stress Scale, self-efficacy with the Arthritis Self-efficacy Scale, and depressive symptoms with the Center for Epidemiologic Studies Depression scale (CES-D). They also measured pain (MOS SF-36 pain subscale). The results of this study revealed significant improvements in physical health (physical function), flexibility, balance, pain, and depressive symptomatology in the yoga group ($p<0.05$) suggesting that participation in a yoga program tailored to the needs of people with arthritis was safe and feasible.[29]

A group of researchers assess the impact of Hatha yoga therapy on management of OA.[30] They randomized 25 participants with OA to a yoga therapy group and no therapy group. Yoga classes were held twice a week (lasting 60 minutes each) for 8 weeks supervised by a certified yoga instructor. Variables assessed were pain, strength, range of motion, joint circumference, tenderness, and hand function using the Stanford Hand Assessment questionnaire.[30] Results indicated that the yoga therapy group had significantly decreased finger pain during activity *(p=0.02)*, less tenderness of the joints *(*$p<0.05$*)*, and greater finger range of motion *($p<0.05$)*. Conversely, there was no difference between groups in grip strength or joint circumference.[30] However, there was improvement in grip strength and joint circumference after practicing yoga, though not statistically significant, suggesting that the yoga derived program was effective in providing relief in OA.

Similarly, another study tried to measure the effects of the Sit 'N' Fit Chair Yoga program on pain, physical function, and psychological functioning.[31] This study used a quasi-experimental research design that included a yoga intervention group and an attention control group HEP (Health Education Program). This program was designed for older adults with OA who were not able to participate in standing yoga or other exercise programs due to weakness and fatigue. A total of 38 participants aged 65 and older were recruited from senior centers. The intervention group was asked to participate in a 45 minute yoga class twice a week for 8 weeks, which was taught by 2 certified yoga instructors.[31] The control group was asked to participate in a 45 minute health education class twice a week for 8 weeks. They received general health education information and specific facts related to the effects of OA. The outcome variables were pain, physical functional performance, gait, balance, depression, and life satisfaction. Pain was measured using the short form of the McGill Pain Questionnaire, physical functional performance was measured using a 6-minute walk, balance was measured using the Berg Balance Scale, and gait was measured using the Gait Speed Test. Depression level (Geriatric Depression Scale-SF) and life satisfaction level (Life Satisfaction Index-SF) were measured using questionnaires.[31] All the outcome variables were measured at baseline, after 4 weeks, after 8 weeks, and at 1 month follow up. The results indicated a trend of improvement in balance, physical functional performance, gait, and pain in both yoga and HEP group; however, there were no significant differences between groups. There was greater improvement in depression (p=0.007) and life satisfaction (p=0.012) in the yoga group than in the control (HEP) group.[31]

Based on the results of previous literature, it can be concluded that yoga has a positive impact on flexibility and balance, in adults with OA. However, only a few studies have been conducted at this time. In order to better understand the relationship between participation in yoga and flexibility and balance, additional research should be conducted that addresses these particular outcomes.

Impact on Physical Activity Level: A few studies have investigated the impact of yoga as an exercise activity that can improve fitness. One study investigated the effects of participation in 8 weeks of *Hatha* yoga exercises on women with knee osteoarthritis. [32] The volunteer sample included 30 women with osteoarthritis of the knee. The women were divided into a control group (n=15) and a yoga group (n=15).[32] The yoga group received 60 minutes sessions of *Hatha* yoga, 3 times a week for 8 weeks. Pain, symptoms, participation in daily activities, sports and spare-time activities and quality of life were measured respectively using the Visual Analog Scale (VAS) and the Knee Injury and Osteoarthritis Outcome Scale (KOOS). Findings showed that pain and symptoms were significantly decreased and scores of participation in daily activities, sports, spare-time activities, and quality of life were significantly increased in the yoga group ($p<0.05$), while the difference in control group was not significant.[32] However, there was no significant difference between the control group and the yoga group for all the outcome variables. In this study physical activity level was not measured, but the score of participation in daily activities, sports, and spare-time activities could be used as a surrogate for PA level.

Another study investigated the feasibility of an Iyengar yoga (IY) program for eight young adults with arthritis.[33] The IY program lasted six weeks with two sessions of yoga per week. Each session was for 1.5 hours, resulting in a total dose of 18 hours of IY. After the IY program, participants were also interviewed in person regarding their experiences in the program. Semi-structured interview items asked about potential post intervention changes in physical and psychological functioning, including pain and Rheumatoid Arthritis symptoms. In addition, a weekly monitoring form was administered by either telephone or email two weeks before the intervention by a trained researcher, then weekly during the intervention, and at a two-month follow-up.[33] The weekly monitoring form assessed patients' weekly pain, anxiety, depression, and energy ratings using a 0-10 numeric rating scale. For example, patients were asked to rate their average pain over the past week from 0 (no pain) to 10 (worst pain imaginable). Participants were also asked to report any adverse events during the classes, any changes in medication, home practice of yoga, and level of physical activity. During the follow-up period, participants were not given specific instructions regarding yoga. When requested, they were provided with referral information regarding IY teachers in their area. Participants completed a battery of questionnaires pre- and post-intervention. Pain and functioning was measured using the Pain Disability Index, the Health Assessment Questionnaire, and the Medical Outcome Study Short Form-36 form. Psycho-spiritual functioning was measured using the Brief Symptom Inventory, the Arthritis Self-Efficacy Scale, the Chronic Pain Acceptance Questionnaire, and the Mindfulness Attention Awareness Scale.[33] As secondary outcome variables, participants were asked to report change in medication, home practice of yoga, and level of physical activity. The results indicated significant improvements in pain, pain disability, depression, mental health, vitality, and self-efficacy ($p<0.05$). The level of physical activity showed improvement from pre- to post- intervention, though not statistically significant. Baseline physical activity scores began high at an average of 103.5 minutes per week (SD=111.4), dropped during the first week of classes to 56.5 minutes per week (SD=62.3), and then increased each week to reach 116.5 minutes per week (SD=116.0) by the last week of classes; however, at the two-month follow-up, physical activity level had dropped to 82.5 (SD=70.4) minutes per week.[33]

One study was specifically designed to examine the effects of a Social Cognitive Theory-based Kundalini Yoga intervention on arthritis patients. [34] A total of 24 participants enrolled in the study with 15 completing the course. It was a single group pre-test, post-test design. The participants attended 75 minutes yoga class once a week for 6 weeks. Outcome variables were self-reported pain, joint swelling, joint stiffness, functional independence, self-efficacy for performing yoga, and recollection of the frequency of yoga behaviors performed in the past week.[34] All the variables were measured using self-report questionnaires. The only statistically significant change from pre- to post-intervention was an increase in frequency of performing yoga ($p<0.001$). Other outcome variables did not improve after performing in yoga for only 6 weeks. Therefore, this study offered limited support regarding the effectiveness of Yoga for arthritis patients and suggested a need for a larger trial.[34]

Because there are few research studies that have been conducted to determine the impact of yoga exercise on overall physical activity levels, it cannot be concluded that yoga has a positive impact on increasing physical activity level. Therefore, to determine the accurate relationship between yoga and physical activity, more research is needed.

Impact on Self-efficacy, Exercise Intention, and Social Support for Exercise: Only a handful of studies have been conducted to assess the effectiveness of yoga exercise on self-efficacy. To date, no studies have been conducted using adults with OA to evaluate the effectiveness of yoga exercise on exercise intention and social support for exercise. As specified earlier, a few studies measured arthritis self-efficacy, which is important for successful disease management, using a questionnaire.[29, 33] These studies evaluated whether a yoga program is feasible, safe, and effective method for improving physical health in people with arthritis. To measure self-efficacy, the Arthritis Self-efficacy Scale was used. This instrument is a valid measure of arthritis management self-efficacy. In both of these studies, self-efficacy was a secondary outcome variable with pain, stiffness, physical functional performance, balance, and other physical and psychological functioning measures as primary outcome variables. The result from these studies revealed significant improvements in physical health ($p<0.05$) suggesting that yoga program tailored to the needs of people with arthritis was safe and feasible.[29, 33] The effect on arthritis self-efficacy also showed improvement from pre to post intervention; however the results were not statistically significant.

Another study was specifically designed to examine the effects of a Social Cognitive Theory-based Kundalini Yoga intervention in arthritis patients, also measured self-efficacy for performing yoga among 15 participants.[34] Results indicated that there was no improvement in self-efficacy for performing yoga after participating in the yoga program for 6 weeks.

Another group of researchers tried to evaluate the effect of Integral-based hatha yoga in sedentary people with arthritis.[14] Integral-based hatha yoga combines traditional postures and breathing exercises along with self-less service, meditation, chanting, and prayers. There were 75 sedentary adults aged 18+ years with rheumatoid arthritis (RA) or knee osteoarthritis. They were randomly assigned to 8 weeks of yoga class (twice a week, 60-min classes and 1 home practice/week) or waitlist. The primary outcome variables were physical fitness, mood, stress, self-efficacy, which were measured using Medical Outcomes Study Short Form-36 (SF-36) physical component summary, SF-36 health-related quality of life (HRQOL), Arthritis Self-efficacy scale and Center for Epidemiological Studies Depression Scale (CES-D).[14] The result showed significant improvements ($p < 0.05$) in SF-36 role physical, pain, self-efficacy, general health, vitality, and mental health scales in yoga group compared to the waitlist group. Balance, strength, and flexibility were also measured but it showed no significant improvement between groups. It was suggested that yoga might help sedentary individuals with arthritis safely increase physical activity and improve physical and psychological health.[14]

Only a few studies have focused on determining the relationship between yoga therapy and self-efficacy in patients with OA. Due to the limited resources available, it cannot be concluded that participation in yoga increases exercise self-efficacy or other predictors of exercise. In order to better understand the relationship between participation in yoga exercise and changes in predictors of exercise, additional research is needed.

Literature on Methods Used to Measure Outcome Variables

Physical Functional Performance: Different methods have been developed to assess the physical functional performance of an individual, including both self-report questionnaires and performance based testing. Self-report questionnaires are easy and inexpensive, but they may not provide adequate information about functional impairment. Therefore, to get accurate and reliable information, it is always recommended to use performance based testing even though it is more expensive and time consuming than questionnaires. To date, there is no widely accepted “gold” standard for measurement of functional performance because there are many factors that must be taken into consideration.[35] One comprehensive performance based testing protocol, the Continuous Scale Physical Functional Performance (CS-PFP) test battery assesses 10-16 tasks that are associated with activities of daily living.[35] The CS-PFP was developed to quantify whole-body physical performance and includes a series of tasks simulating activities of daily living arranged from low effort to hard effort. The CS-PFP test battery has two versions – the CS-PFP 10 and CS-PFP 16, where the numbers 10 and 16 indicate the total number of activities performed during the test. This test battery provides information about physical functional impairment and is more responsive to change than a self-report instrument. It was designed to integrate measurement of physiological capacity across a wide range of performance based physical tasks and psychosocial factors. [35] The physiological component is related to function of the cardiovascular, musculoskeletal, and neuromuscular systems.[36]

The CS-PFP is a valid and reliable performance based measure of physical functional performance and is applicable to a wide range of functional levels. [37] The total score and subscale scores can be used to evaluate, discriminate, and predict physical functional performance. In a validation study with a sample of 148 older adults, test-retest reliability and internal consistency (Cronbach's alpha) for the CS-PFP total and five domains was established.[37, 17] Both the total and individual domains of the CS-PFP increased with higher levels of independence, which supports construct validity.

Pain and Stiffness: To measure pain & stiffness in adults with OA, the most commonly used tool is the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). It consists of 7 items that are divided into 2 subscales, pain and stiffness. There are 5 items that measure the pain felt while doing different daily tasks and 2 items for stiffness that focus on stiffness level after waking up and at a time later in the day.[38] The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is one of the best methods to assess pain and stiffness in patients with hip and/or knee OA. The pain and stiffness measures have shown good validity and test-retest reliability, and have been used in a wide range of research studies.[38, 39] This multidimensional questionnaire showed well-defined reliability, test–retest reliability, content and construct validity.[38]

Balance: Many clinical and functional tests have been developed to assess postural balance. Some clinical and laboratory tests are conducted using forceplates and posturography, such as the NeuroCom Balance Master®. Posturography is a technique used to quantify postural control in upright stance either in static or dynamic condition and forceplates are the platform base that includes several force sensors placed in specific points to measure the vertical force exerted by the participant's feet during movement.[16] Different studies have recommended using posturography for preliminary assessment or risk evaluation of falls. A study in 1994 used posturography to confirm increase in postural sway with age and to identify factors that had the greatest effect on balance changes with age.[40] Tests were performed on subjects whose age ranged from 20 to over 70 years old. These tests were conducted using a forceplate and included standing on a firm and foam surface with eyes open and closed. Results of the study indicated that the loss of vision (eyes closed condition) increases sway significantly in all age groups tested, but with increase in age the sway for both conditions increased. With age, sway increased linearly with no significant differences found between genders at any age.[40]

The NeuroCom Balance Master® System is a sensitive instrument on which a series of tests are performed that measure postural stability and postural sway in order to provide an objective assessment of the sensory and voluntary motor control of balance.[41] This system uses multi-dimensional measurements to quantify an individual's steadiness and balance during both dynamic (moving) and static (standing) activities.[16] The use of a forceplate system to measure the aspects of balance is referred to as posturography. One study tested the validity of the NeuroCom Balance Master® measures by comparing them to scores from the Berg Balance Scale and gait velocity. [41] Twenty volunteers that were ambulatory hemiparetic patients with no history of lower extremity orthopedic problems and no neurological deficits apart from stroke were the subjects. They completed the Berg Balance Scale, a ten meter timed gait test, and the NeuroCom Balance

Master® protocols. The testing periods were one week apart and performed at the same time of day and on the same day of the week for each session. Almost all the variables measured reflecting the dynamic balance abilities were significantly associated with the Berg Balance Scale and gait velocity. Correlations and test-retest comparisons showed the NeuroCom Balance Master® was both valid and reliable when compared to the field tests, and the dynamic measures were valid indicators of functional balance performance.[40] The NeuroCom Balance Master® estimates both postural stability and the function of the vestibular system, and reproduces the physiological conditions of daily life.[42] This system also can be used for rehabilitation training with the biofeedback in individuals with impaired balance.[42]

Joint Flexibility: Range of motion (ROM) is a primary measure for assessing the knee or elbow's integrity. ROM also can be used as an investigative tool to verify disease progression or treatment effectiveness.[43] Healthcare professionals commonly use a goniometer to measure joint ROM.[43] The universal goniometer (UG) is a simple, easy-to-use instrument, which is commonly used in physical therapy for assessing the limitation of a patient's joint motion.[44] The usefulness of goniometric measurements for providing objective assessments of a patient's initial status and progress depends on the reliability and validity of the measurements. A study conducted in 1949 was the first to report on the reliability of goniometric measurements.[44] The researchers tested patients with a variety of disabilities and investigated inter-tester reliability of ROM measurements of the shoulder, elbow, radioulnar, and wrist joints. They found that well-trained physical therapists could measure the range of motion of specified joints with a high degree of reliability. Good test–retest reliabilities were reported in the study.[44] Another study assessed the inter-tester reliability of goniometric measurements at the knee and the validity of the clinical measurements by comparing them to measurements taken from radiographs of the knee. [45] Thirty healthy subjects between the ages of 20 and 60 years were studied. Two physical therapists independently used a standard plastic goniometer to measure the knee joint angle in the sagittal plane using the greater trochanter, the lateral condyle of the femur, the head of the fibula, and the lateral malleolus as bony landmarks. [45] A radiograph was taken of the extremity before the subject was moved. Pearson product-moment correlation coefficients (r's) and intra-class correlation coefficients (ICCs) were used to analyze the data. The data revealed that the inter-tester reliability and validity were high. [45] The results of this study indicate that goniometric measurements of the knee joint are both reliable and valid.

Physical activity: Physical activity (PA) is considered a global health concern, and there is a need for more precise understanding about the amount and the pattern of PA required for health benefits.[46] However, accurately assessing total PA and PA of different intensity levels daily and over extended periods of time is difficult. The International Physical Activity Questionnaire (IPAQ) is a self-report measure of physical activity level in young and middle aged adults.[44] It is a valid and reliable method for the assessment of PA among adults aged 18–65 yr. in diverse settings.[47] The long version IPAQ was designed to collect detailed information within the domains of household and yard work activities, occupational activity, self-powered transportation, leisure-time physical activity, and sedentary activity.[47] A cross-sectional study was conducted to assess concurrent validity by comparing measures of PA by the long, self-administered, last 7 day version of the IPAQ with those obtained by a log book and an activity monitor. Construct validity was assessed by comparing PA levels measured by the IPAQ with aerobic fitness, body composition (BMI), and percentage body fat.[46] A weak correlation was observed between IPAQ data for total PA and both aerobic fitness and BMI. No significant correlation was observed between percentage body fat and IPAQ variables. Strong positive relationships were observed between the activity monitor data and the IPAQ data for total PA and vigorous PA, but a weaker relationship was found for moderate PA. Calculated MET-h day^{-1} from the PA log book was significantly correlated with MET-h day^{-1} from the IPAQ. It was concluded that the long, self-administered IPAQ questionnaire has acceptable validity when assessing levels and patterns of PA in adults. [46] The results of the IPAQ reliability and validity study show that IPAQ exhibited measurement properties that are at least as good as other established self-report physical activity measures.[46, 47]

Exercise Self-efficacy, Exercise Intention and Social Support for Exercise: In order to help explain why certain people engage in healthier behavior than others, behavioral theories commonly incorporate self-efficacy or other closely related constructs. Self-efficacy is a person's confidence to perform a specific task or exhibit a specific behavior.[48] Due to its importance in influencing health behaviors and health outcomes, many chronic disease self-management and other behavioral intervention studies, including those for people with arthritis, target self-efficacy and measure it as a study outcome. Exercise self-efficacy is defined as participants' confidence in their ability to exercise regularly.[48] Exercise Self-efficacy is most commonly measured using an 18-item exercise self-efficacy (ESE) scale developed by Bandura.[48] A validation study was conducted with 110 participants who completed a six-minute walk test (6MWT) and Bandura's exercise self-efficacy scale at enrollment and on completion of a 6-week Cardiac Rehabilitation program.[49] Participants attended an initial 2-h pre-program assessment of exercise capacity, psychological status, health-related quality of life, and discussion of risk factor modification. This was followed by a 6-week individually tailored, high-intensity exercise program, which was combined with individual and group education sessions. The intervention was followed by a post-program assessment.[49] The researchers measured exercise self-efficacy using the ESE scale and distance walked using a 6 minute walk. Bandura's ESE scale had a single factor structure with high internal consistency and demonstrated no floor or ceiling effects. A positive and significant correlation between the change in scores on the ESE scale and the change in the 6MWT distance was also seen.[49] It was determined that the ESE scale is a robust measure of exercise self-efficacy, and is a valid and reliable measure appropriate for patients attending outpatient cardiac rehabilitation program.

Behavioral intentions are seen as the immediate predecessor of actions, and reflect the person's commitment and determination to enact the behavior in question.[50] According to the Theory of Planned Behavior, behavioral intentions are shaped by one's attitudes, normative beliefs, and perceived behavioral control. To measure intention to exercise, the most commonly used tool is 3-item Exercise Intention Survey (EIS). In order to establish the validity and reliability of the Exercise Intention Survey, a study was conducted with 674 Greek adolescents aged 10-17 years.[51] The psychometric testing of EIS involved a translation and back-translation procedure and a test-retest study. The three EIS items loaded on one single factor, demonstrated acceptable factor loadings and acceptable Cronbach's alpha values in both the test and retest assessment. EIS scores correlated positively with a measure of attitudes toward physical activity and a measure of participants' intentions to be physically active next month, supporting both construct validity and criterion-related validity of the EIS-Questionnaire.[51] Acceptable reliability and validity of EIS was found, which supports the use of this instrument in future research.

Social support is an important mediator of success in changing health habits. There is evidence to suggest that exercisers with a supportive family are more likely to continue their exercise programs than others.[52] Moreover, close friends represent a significant resource for emotional support. Therefore, exercise social support needs to be considered as an essential behavioral antecedent in interventions.[52] The Social Support for Exercise scale is designed to assess social support related to exercise participation. A cross-sectional study was conducted to examine the reliability and validity of the Persian version of Sallis' Social Support for Exercise.[53] It also aimed to measure the predictive power of this scale among diabetic women. A total of 348 women who were referred to a diabetes institute in

Iran filled in the questionnaire. This study evaluated the Social Support Scale for Exercise in terms of face, and construct validity, and internal consistency reliability. Confirmatory factor analysis was used to identify potential differences between English and Persian versions and construct validity of the scale. Confirmatory factor analysis supported the friend factor of the scale completely; however, it modified the family factor and reduced the English items into 13 items. Cronbach's α coefficients for the family support and friend support, and the content validity of 13 questions was acceptable.[53] Therefore, this scale consisting of 13 items can be used to assess the social support (friend and family) related to exercise behavior. It was determined that the e Social Support for Exercise scale is a valid and reliable measure that can assist in the process of identifying friend and family support related to physical activity.[53]

Summary

A review of available research literature indicated that participation in yoga exercise is associated with reductions in pain and stiffness, and improvements in physical functional performance, strength, flexibility, balance, physical activity level and predictors of exercise in adults with OA.[21, 13, 29, 30, 33, 34] There also is indication that the instruments used in this study have acceptable validity and good test-retest reliability and these tests have been used in a wide range of research studies. However, only a few studies have been conducted to determine the positive impact of yoga on flexibility, balance, physical activity level, and predictors of exercise measures. Therefore, there is a need for addition research investigating the impact of yoga on the above said outcome variables among people with OA.

CHAPTER THREE

METHODS

The first objective of this study was to determine the effectiveness of an 8-week Hatha yoga exercise program on joint pain, joint stiffness, physical functional performance, balance, flexibility, and physical activity level in adults aged 40-64 years with lower limb osteoarthritis (OA). The second objective is on determining the effectiveness of an 8-week relapse prevention intervention on exercise adherence, self-efficacy, social support, and intention to exercise. This chapter describes the study sample including subject recruitment methods, sample size, and sampling techniques. The data collection procedures and instrumentation are presented next, which includes the measurement protocols and equipment used. This will be followed by data analysis procedures. Appendix A includes all the supplemental research documents (i.e., consent form, recruitment script). This study was conducted in March 2015 and continued until the first week of June 2015. The ethical issues associated with this study were also being identified in this chapter. Approval was obtained from the Institutional Review Board of the University of Oklahoma, Norman campus. In the present study, the reliability and validity for all instruments were reported high or acceptable and these tests have been used in a wide range of research studies.

Sample

Once approval was obtained from the University of Oklahoma Institutional Review Board, participants were recruited through: (1) promotion of the program using printed material like flyers in community displays in the Norman area and (2) advertising via the internet using social media outlets such as Facebook/Twitter. Those who agreed to participate were given specific place, times, and dates in order to be screened for participation in the intervention. Upon arrival at the research site, participants were asked to respond to a questionnaire regarding medical history in order to screen them for inclusion in the study.

The study targeted 20 sedentary or insufficiently physically active middle-aged adults with lower limb OA living in the Norman, OK area. The participants constituted a convenient sample. The inclusion criteria were:

- Adult men or women aged between 40 and 64 years who have lower limb OA (hip, knee, ankle or feet),
- Community dwelling (those who are not in assisted living or nursing homes),
- Insufficiently physically active,
- Not currently participating in an exercise program, and
- Not practiced yoga in last 12 months.

The exclusion criteria were:

- Duration of OA symptoms < 6 months,
- Inability to walk across a room unaided, and

- History of acute hip or knee damage in recent 6 months.

An a priori sample size calculation of 20 was obtained on G Power software using the parameters of $\alpha = 0.05$, power value of 0.80, effect size of 0.3, and two intervention groups with repeated measures ANOVA considering the mean effect sizes for physical functional performance and pain from earlier studies.[26, 44]

Research Design

For this study, two different interventions were tested. The first part was a yoga intervention. Participants attended yoga class for 1 hour twice a week for 8 weeks. The second part, which took place after the yoga intervention, was a randomized control relapse prevention intervention. After participating in the yoga intervention, participants were randomly assigned to one of two groups: relapse prevention group and control group. The relapse prevention group received a 4-week program to encourage them to continue participating in yoga after the completion of the yoga intervention. The control group received no intervention during this period. As noted previously, a convenience sample was used in the form of volunteers, which could result in threats to internal (selection bias) and external validity (interaction effects of selection bias and experimental treatment). The participants were tested before and after different phases of participation. Therefore, these multiple tests may result in threats to both internal (testing) and external (interaction effect of testing) validity. In order to minimize this testing threat, the results of the pre-testing were not given to the subjects.

Intervention

This study included two major components: an 8-week yoga intervention (Phase-1) and a 4-week relapse prevention intervention (Phase-2). In the beginning, all participants were provided with an information brochure that included details about yoga exercise and its benefits for people with arthritis.

Phase 1: 8 week Hatha Yoga Intervention

Phase 1 of the study included the yoga intervention with pre-post assessment of all outcome variables. All participants were pre-tested at week 0 followed by initiation of the yoga intervention. During the yoga intervention, all participants were asked to attend yoga classes for 1 hour, twice a week for 8 weeks. A certified yoga instructor taught 1-class per week. The yoga intervention consisted of 14 postures (Appendix-D). Classes began with gentle warm-up and breathing exercises or a meditation and continued with practice of specific movements, ending with a directed cool-down. Participants were tested after the completion of the yoga intervention at week 9. Initially, a restorative pose was used to gently stretch the back, neck, and torso and to relieve stress and muscle tension. Restorative poses are designed to restore and revitalize mind and body. The class started with sitting in a comfortable cross-legged position (Siddhasana), which is a restorative pose. Poses then were introduced that lengthened muscles attaching to the spine and pelvis in positions with the spine fully supported. Next standing poses were introduced to open the hips and groin and to teach participants how to use their legs and arms to lengthen pelvic and spinal tissues. In between practicing different poses, a restorative pose called Balasana (child's pose) was introduced to rest and recharge the body and mind. Twists were taught to access the deeper layer of back muscles to help realign the vertebra, increase intervertebral disc space and decrease possible impingement of nerve roots. Participants were gradually progressed from simple poses to progressively more challenging poses. No back bending poses were introduced to avoid the risk of injury. Throughout the intervention, the instructor focused on correcting imbalances in muscles affecting spinal alignment and posture while performing the poses. The practice session ended with a 10 minute relaxation using restorative poses such as Savasana (corpse pose) or Viparita karani (leg-up-the-wall pose). At the end of the program, yoga participants were encouraged to continue yoga therapy at home and/or through community classes. They were provided with a yoga home practice sheet (Appendix-D) that included most of the poses they practiced during the 8-week program. For this phase, the targeted outcome variables were pain, stiffness, physical function, balance, flexibility, and physical activity level.

Phase 2: 4 week Relapse Prevention Intervention

Phase 2 of the study included a relapse prevention intervention that was conducted after the yoga intervention. As part of this randomized control trial, all the participants were randomly assigned to one of two groups, a relapse prevention group and a control group. Participants in both groups were encouraged to continue to practice yoga at home since the continuation of yoga practice immediately after completion of the program is critical to long-term adoption of yoga as an ongoing exercise modality. They were told to practice their yoga for at least 120 minutes per week during the follow-up period using the poses that were practiced during the yoga intervention. Participants in the control group received no additional information or contact from the researcher until the end of the follow-up period. Participants in the relapse prevention group were given guidance on how to continue practicing yoga at home that reinforced use of the poses taught and information given during the structured yoga class. They received an email and a phone call every week for 4 weeks that was designed to provide encouragement and to give them guidance about how to do their yoga practice at home (Appendix-D). Messages were designed to encourage development of exercise self-efficacy through social support and encouragement. For this phase, the targeted outcome variables were exercise self-efficacy, exercise intention, social support for exercise, yoga exercise adherence, and the maintenance of the yoga program benefits.

Exercise intention of the participants in the intervention group was targeted by sending them messages with weekly tips on how to set an effective yoga routine and how to meet the weekly yoga practice goal of 120 minutes/week with addition of an increase of 10% more practice time every week. Participants were asked to keep a yoga practice log to document the frequency and duration of yoga home practice during the designated 4 weeks as a method of encouraging participants to self-monitor. Self-monitoring of yoga practice may be associated with fewer barriers to exercise.[48] For targeting exercise self-efficacy, the participants received messages that encouraged them to evaluate their personal success with yoga practice up to that point in time and also to reward themselves when they reached their yoga practice goal each week. For targeting social support, participants were encouraged to invite a family member or a friend to practice yoga with them. The messages also included a supplemental information component each week. In this part they were provided with information that included names of yoga apps for smart phones, YouTube videos on practicing yoga at home, yoga classes currently conducted in the area, and long-term osteoarthritis self-care tips. The frequency and duration of yoga home practice documented by yoga practice log every week was also used to determine exercise adherence rate. Members of the control group received no contact or information during this period; however, they were asked to document the frequency and duration of home practice in the log to record exercise adherence rate. The outcome variables for both groups were measured at week 14, which is 4 weeks after the post-testing.

Instrumentation

For this study the outcome measures for evaluating the effectiveness of participation in the yoga program were physical functional performance, pain & stiffness, balance, flexibility, and physical activity level. The outcome measures for evaluating the effectiveness of behavioral intervention were exercise self-efficacy, exercise intention, social support for exercise, and yoga exercise adherence post intervention. Different testing devices and self-reported questionnaires were used to measure these outcome variables (Appendix B & C). Several performance-based measures were utilized to measure outcome variables. The primary measure of physical functional performance was the Continuous

Scale-Physical Functional Performance 10 (CS-PFP 10) test battery. Postural sway was measured using the NeuroCom Balance Master® and flexibility was measured using a goniometer. Exercise self-efficacy, exercise intention, social support for exercise, yoga exercise adherence, physical activity level, pain & stiffness, and a secondary measure of physical functional performance were assessed using self-reported measures. All testing for this study was controlled and conducted by a trained research assistant in the certified Functional Performance Laboratory of University of Oklahoma. The reliability and validity reported for all instruments have been high (see Chapter II). These tests have been used in a wide range of research studies and have good validity and test-retest reliability. A description of the testing procedures and instruments used in this study are described below.

Continuous Scale-Physical Functional Performance (CS-PFP 10) Test battery: Physical functional performance level of the participants was measured using the CS-PFP 10 test battery, which is a valid, reliable, and sensitive measure of physical functional performance.[17] Tasks of the domains of the CS-PFP have test-retest reliability coefficients that ranged from 0.85 to 0.97 and internal consistency coefficients that ranged from 0.74 to 0.97 for the CS-PFP total and five domains.[17] The CS-PFP consists of 10 household tasks that are performed in serially increasing work.[17] In order to carry out the CS-PFP 10 testing protocol, a specific laboratory configuration was established that conforms to the guidelines of the test developer. Likewise, all testing was completed using a standardized verbal script that was developed by the test developer. The tasks are categorized into three levels: (1) low difficulty tasks including the pan carry, jacket on and off, and reach tasks, (2) moderate difficulty tasks include scarf pick up, laundry, and floor sweep tasks, and (3) high difficulty tasks include floor up/down, grocery carry, stair climb, and 6 minute walk tasks. Performance of tasks was quantified by time, weight, and distance.[17] Per recommendation of the developer of the test battery, participants were not required to perform a practice trial to familiarize themselves with all the 10 tasks before the pre-test.[37] Raw data was recorded on an excel datasheet by hand. Scoring was accomplished by entering the raw data into the Physical Functional Performance Data Management software program.[17] Calculation of composite scores was based on a combination of performance data of tasks that were defined by the test developer. Composite scores included a total physical functional performance score and summary scores for 5 domains: upper body strength (UBS), upper body flexibility (UBF), lower body strength (LBS), balance and coordination (BALC), and endurance (END).[17] Scores are scaled from 0 to 100 utilizing the following formula, which is based on lower and upper extremes of performance from previously tested older adults[17]:

- CS-PFP score = (observed score - lower limit) / (upper limit - lower limit) x 100

Higher scores reflect higher levels of fitness and physical function. Depending on the ability of the older adults being tested, the CS-PFP requires approximately 1 hour to complete.[17]

NeuroCom Balance Master®: Postural sway was measured using the NeuroCom Balance Master®, which provides objective assessment of the sensory and voluntary motor control of balance. Previous research using the NeuroCom Balance Master has established the reliability and validity of the testing procedure.[41] The Balance Master system utilizes a fixed 18" x 60" dual forceplate to measure the vertical forces exerted by the participant's feet.[16] It lies on the floor and measures changes in the surface pressure and force caused by body movement of the individual standing on the forceplate surface. The forceplate is connected to a computer that provides standardized testing instructions during testing and collects and calculates all sway measures based on input from the forceplate. Written instructions were provided on the computer screen during each testing protocol. Testing using the NeuroCom Balance Master® required approximately 20-30 minutes to complete all the protocols. Results for each testing protocol are provided both in graphic and numeric (i.e., percentage, ratios, etc) versions.[16] The testing protocols are broken into two categories, Impairment and Functional tests, based on the aspect of balance being assessed. Impairment tests assess static measures of postural sway and functional tests assess dynamic measures of postural sway.[16] For this study, the following functional testing protocols were used: Sit to Stand, Tandem Walk, Step/Quick Turn. All these functional limitation assessments quantify the patient’s ability to safely and efficiently perform mobility tasks common in daily life. Each test was repeated three times with each trial lasting for 10 seconds. The first 2 trials were considered as practice trial to familiarize the participants with the testing maneuver. The third trial was recorded for data analysis.

Goniometry: A goniometer is a device used to measure joint angles or range of motion (ROM) of joints for either active or passive joint range.[45] Range of motion is a measure of joint flexibility and was assessed using a traditional goniometer was used. A traditional goniometer is a protractor with extending arms. To use a goniometer, there are steps that must be followed.[45] The fulcrum of the device is aligned with the joint to be measured and then the stationary arm of the device is aligned with the limb being measured. Holding the arms of goniometer in place, the joint is moved through its range of motion (ROM). Finally, ROM is determined by calculating the number of degrees between the endpoints.

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): To measure pain and stiffness, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was used. It consists of 24 items with 3 subscales: pain, stiffness and physical functional performance.[38] There are 5 items that measure pain while doing different daily tasks. The pain scale was measured on 4-point Likert scale that ranged from 0 (none) to 4 (extremely). The possible range of scores for pain was 0-20, with higher scores reflecting worse pain. Two items measure stiffness and focus on stiffness level after waking up and later in the day. The scale measured on 4-point Likert scale that ranged from 0 (none) to 4 (extremely). The possible range of scores for stiffness was 0-8, with higher scores reflecting worse stiffness. There are 17 questions that measure physical function that assess the capacity for doing activities of daily living.[38] The physical function scale was measured on 4-point Likert scale that ranged from 0 (none) to 4 (extremely). The possible range of scores for physical function was 0-68, with higher scores indicating higher functional limitations.

International Physical Activity Questionnaire (IPAQ): The International Physical Activity Questionnaire (IPAQ) was used to measure the physical activity level of participants over a 1-week recall period. The IPAQ consists of 27 items that measure the average number of hours/day spent participating in household/yard work activities, occupational activity, self-powered transportation, leisure-time physical activity, and sedentary time. Each activity is weighted by the metabolic cost value to derive an overall estimate of the energy consumed during physical activity. [46] There are different metabolic costs associated with different types of activity. The range of scores that would capture the activity range of most people was 0-18000 MET/minutes/week, with the upper limit representing the MET/minutes/week of someone who participated in 10 hours of VIPA on 5 days of the week. Higher scores indicate more intense activity.

Exercise Self-efficacy Scale (ESE): Bandura's Exercise Self-efficacy Scale was used to measure exercise self-efficacy. The ESE Scale is an 18-item questionnaire. The original statement asked participants to rate how certain they were that they could get themselves to perform their exercise routine regularly (three or more times per week), for a range of conditions. The scale ranged from 0 (I cannot do this activity at all) to 10 (I am certain that I can do this activity successfully).[48] Examples of the types of exercise conditions that were rated include *'when you are feeling tired', 'when you are feeling under pressure from* *work', 'during bad weather', 'after recovering from an illness or injury', 'when feeling depressed', etc.….* The ratings for all conditions were summed to form a total score. The possible range of scores was 0-180. Higher scores indicate greater levels of exercise self-efficacy.

Exercise Intention Survey (EIS): The Exercise Intention Survey was used to measure exercise intentions of the participants. Intention to engage in physical activity was measured as the total of the scores of the three items that were scored on a seven-point Likert scale (e.g., 1 = strongly disagree, 7 = strongly agree). The possible range of scores was 3-21 with higher scores reflecting stronger behavioral intentions. These items include *'I intend to engage in physical activity in the next month,' 'I will try to engage in physical activity in the next month,' and 'I am determined to engage in physical activity in the next month'*.[50]

Social Support for Exercise Survey (SSE): The Social Support for Exercise Survey was used to assess social support of participants. It is a 13-item survey that includes a statement that asks respondents to rate how often family/friends has done exercise for a range of conditions. Examples of the types of exercise conditions that were rated include 'exercised with me', 'gave helpful reminder to exercise', 'gave me encouragement to stick with my exercise program', 'discussed exercise with me', 'helped plan activities around my exercise', etc. The social support items were scored on a five-point Likert scale (e.g., 1 = none, 5 = very often). The possible range of scores was 10-50 with higher scores reflecting stronger social support.[53]

Exercise Adherence: Exercise adherence was measured as the number of weeks in which participants carried out the home yoga exercises recommended by their yoga instructor, which was to practice yoga for at least 120 minutes per week. It was measured using yoga practice log. Participants self-reported their adherence to recommendations for yoga exercises by providing the number of minutes they practice yoga every week for 4 weeks. Adherence is reported as the total number of weeks they reached 120 minutes/week (0-4) during the 4-week follow-up period. Also, the average minutes of yoga practice/week were calculated.

Data Collection Procedures

Once approval was obtained from the University of Oklahoma Institutional Review Board, the participants were recruited from the Norman area through promotion of the program using flyers in community displays, web listings, mass e-mail, advertisement, and personal referral via personal contacts (i.e., friends, relatives, co-workers). Those who agreed to participate were screened using an information and medical history questionnaire (Appendix-A) that screened them for all inclusion and exclusion criteria. After reviewing their medical histories, twenty volunteers qualified to participate. They were asked to read and sign an informed consent form and complete a demographic information form before beginning the testing and intervention period (Appendix-A).

During pre-, post-, and follow-up testing, participants completed the CS-PFP test battery (physical functional performance), NeuroCom Balance Master testing protocols (balance), goniometer testing (flexibility), and completed a series of questionnaires that included WOMAC Questionnaire (pain and stiffness), IPAQ (physical activity level), Exercise Self-efficacy Scale, Exercise Intention, and Social Support for Exercise. The sequenced list of pre-, post-, and follow-up testing activities was as follows:

- Questionnaires (WOMAC, IPAQ, ESE, EIS, SSE)
- Goniometer (measure flexibility)
- Continuous Scale Physical Functional Performance 10 (physical function measures)
- NeuroCom Balance Master® (balance measures)

See Appendix B for all questionnaires and Appendix C for all performance based and laboratory based testing protocols. Pre-test and post-test measures were used to establish change in outcome variables associated with participation in the yoga intervention during phase 1of the study. Likewise, post-test to follow-up measures were used to quantify the stability of outcomes one-month post completion of the intervention. Adherence was measured only during the 4-week follow-up period (post-test to follow-up test) and was used to determine the efficacy of the behavioral intervention implemented during phase 2 of the study. The risk involved in this study primarily involves the possibility that a participant could lose balance or strain muscles/ aggravate inflamed joints while completing the performance-based tests. By using the medical history of participants during the screening phase before the study, those with medical conditions that made them more susceptible to injury were excluded from participation. Above all, safety precautions (i.e., use of spotters) were used to minimize the possibility of fall during exercise and while performing tasks required during testing.

Continuous Scale Physical Functional Performance test Battery: During the CS-PFP testing, participants performed 10 household tasks in sequence from low effort to high effort. The test battery included functional measures of tasks typically required for independent living such as sweeping the floor, doing laundry, carrying groceries, climbing stairs, and walking briskly. A specific dialog was read to each person during testing. Most tasks were quantified by time taken to complete the task, the weight carried during the task, and distance moved during the task. The time taken to complete this test battery was approximately 45 minutes -1 hour.

A description of the 10 tasks and their order of completion are described below. The parameters that were measured for each task are indicated in parentheses.

Low difficulty tasks:

- Weight carry: Participants were asked to carry a pan with a self-selected amount of weight from one counter surface to another (time and weight)
- Jacket on and off: Participants were asked to pick up a jacket, put it on, close the front, and then remove the jacket (time)
- Stand and Reach: Participants were asked to reach as high as possible and place a sponge on the highest shelf without losing balance (distance)

Medium difficulty tasks:

- Floor sweep: Participants were asked to sweep ½ cup of kitty litter from the floor, collect the litter in a dust pan, and place the pan on a counter (time)
- Laundry 1: Participants were asked to open a washer and transfer clothes and 9 lbs of sand bags from washer and then close the dryer door.
- Laundry 2: Participants were asked to open a dryer door to remove clothes from dryer and place them in a laundry basket (time)
- Scarves: From standing location, participants were asked to pick up 4 scarves from the floor (time)

High difficulty tasks:

- Floor up/down: From a standing position, participants were asked to sit down on floor, stretch out her/his legs in front, and then stand up while placing hands at the side (time)
- Grocery Carry: Participants were asked to carry bags that are weighted (self-selected) to a simulated bus stop, walk up and back down the steps, walk back to the starting position, and place the bags on a counter (time, weight)
- Stair climb: Participants were asked to walk up one flight (7) of stairs without pulling the body up the stairs using the railing (time)
- Endurance walk: Participants were asked to walk as far as possible in 6 minutes (distance)

During the testing process, there was one researcher that started, stopped, and timed the tasks and also responsible for recording the scores on a standardized data sheet. Another individual assisted with station set up, measuring weight, and timing of tasks.

Postural Sway: For the balance testing, participants completed five assessment protocols while either standing or walking on the forceplate. The time taken to complete this test was approximately 15-30 minutes. The NeuroCom Balance Master functional tests used in this study included:

- *Sit to Stand (STS):* The Sit to Stand assesses the sway produced when a participant rises from a seated to a standing position. A wooden box was placed on the force-plate, the subject was asked to sit on the box, and then s/he was asked to stand while his/her end sway velocity was measured.[42]
- *Tandem Walk (TW):* The Tandem Walk quantifies characteristics of gait as the participant walked heel to toe from one end of the forceplate to the other.[42] The outcome measure used in this study was endpoint sway velocity.
- *Step Quick Turn (SQT):* The Step Quick Turn quantifies turn performance characteristics as the participant takes two forward steps, then quickly turns 180º and returns to the starting point.[42] The outcome variable used in this study was turn sway velocity.

Joint Range of Motion: The joint flexibility (ROM) was measured bilaterally for the hip, knee and ankle using a goniometer. The measurement was taken for extension and flexion of the hip, knee and ankle using the following procedure:

- Knee Flexion - participants were asked to lay supine on a firm flat surface with hip and knee in neutral rotation. Then they were asked to flex their hip and knee by moving the heel toward the buttock and the knee flexion measurement was taken

- Knee Extension - participants were asked to lay supine on a firm flat surface with hip and knee in neutral rotation and then the knee extension was measured
- Hip Flexion - participants were asked to lie in supine position with hips and knees in neutral rotation. Then hip flexion with knee flexion was allowed and the measurement was taken
- Hip Extension - participants were asked to lie prone on a firm flat surface with hips & knees in neutral and feet extending off end of the table. Then hip extension with knee extension was allowed and the measurement was taken
- Ankle Plantarflexion - participants were asked to sit at the edge of table and the ankles were actively plantarflexed and measured
- Ankle Dorsiflexion - participants were asked to sit at the edge of table and the ankles were actively dorsiflexed and measured

Pain: The participants were asked to complete WOMAC questionnaire to evaluate their current pain and stiffness. This tool helps to evaluate the intensity of participant's pain and difficulty level in performing different activities.

Physical Activity: IPAQ questionnaire was used to measure participants' physical activity levels by recording the average number of hours/day spent participating in leisure, household, and occupational activities over the previous 7-day period.[47]

Process evaluation focused on measuring the degree to which the intervention phases were implemented as planned. Process evaluation helps to document a program's early development and implementation. As a part of process evaluation, a checklist was used that listed the components of the intervention that were to be implemented and the sequence in which these components were to be implemented. For example, at each yoga session, it was determined whether the specific sequence of activities (i.e., such as first take attendance, 10 minute breathing/meditation, 40 minutes yoga poses & stretching and 10 minute cool-down) was included. Likewise, it was determined whether program strategies were implemented as designed. Participants also were given a satisfaction survey at the end of the intervention to get an overall feedback about the intervention (see Appendix B). Participants gave feedback about the actual program including what they liked and what could be improved.

Data Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) V20.0. Descriptive statistics was reported as means and standard deviations for all outcome variables. For testing the equality of groups, an omnibus MANOVA was performed on all the pre-test dependent variables of the intervention and control groups to determine the between group difference during the pre-testing. A two-way repeated measures ANOVA (pre-test, post-test, and follow-up) was used to evaluate the time, group, and time*group interaction for all the outcome variables in order to assess change related to participation in the yoga intervention immediately after program completion and change related to participation in relapse prevention intervention at one month follow-up. To assess adherence to yoga exercise recommendations during the follow-up period (post-test to follow-up), independent t-tests were performed on (1) the mean minutes/week of yoga participation and (2) the total number weeks in which participants met to yoga recommendations (120 minutes/week) to determine whether there was a difference in yoga participation between the two groups after completion of the behavioral intervention. The following assumptions for the single group univariate repeated measures analysis were evaluated using (a) normality using the Shapiro-Wilk test, histograms and Q-Q plots, (b) homogeneity of variance using the Levene's Test, and (c) sphericity using the Mauchly's Sphericity test before proceeding with the analysis.

CHAPTER FOUR

RESULTS AND DISCUSSION

The purposes of this study were to investigate the effectiveness of (1) an 8-week Yoga exercise program on improving the pain, stiffness, physical functional performance, balance, flexibility, physical activity level, and predictors of exercise and (2) a 4-week relapse prevention program on adherence to yoga exercise in women, aged 40-64 years. The variables of interest were measured using the NeuroCom Balance Master®, the Continuous-Scale Physical Functional Performance (CS-PFP 10) test battery, a goniometer, and questionnaires. Study results are presented in the following order:

- Demographic characteristics of participants
- Description of outcome variables used in the study
- Descriptive statistics for all outcome variables
- Data analysis procedures
- Evaluation of equality of study groups
- Assumptions testing on outcome variables
- Results for research questions
- Discussion of results

Participant characteristics are reported as means, standard deviations, and frequencies for the two groups. In the following tables, the relapse prevention intervention group is represented as INT and the control group is represented as CON. Means and standard deviations of all the variables measured at pre-test, post-test, and follow up are reported for all the participants of the intervention and control groups.

Demographic Characteristics of Participants

Demographic information about study participants is reported in Table 4.1. Twenty participants were recruited for the study, with ten participants each in the intervention group and control group. The average age of participants was 57 years. Almost all the participants were White/Non-Hispanic (85%) with 60% married. Most worked full-time (65%). This was a well-educated sample, with 55% having a graduate degree and an additional 35% having a college degree. The majority of participants reported their health status as good or excellent (85%) and that they used no medication to treat osteoarthritis pain (75%). The remaining 25% of the participants reported using over the counter pain medication. All subjects reported themselves as independent and healthy prior to participation in the 8-week yoga class. During the yoga training, 2 participants reported having their joint pain aggravated after doing some of the yoga poses. During the post-testing, 5 participants reported having either knee or ankle pain.

Description of All Outcome Variables

All outcome variables measured using the NeuroCom Balance Master® assessment tests, the Continuous-Scale Physical Functional Performance (CS-PFP 10) tasks, goniometer measurements, and questionnaires are listed in Table 4.1 (CS-PFP 10 Variables), Table 4.2 (Pain and Stiffness Variables), Table 4.3 (NeuroCom Balance Master® Variables), Table 4.4 (Goniometry Variables), Table

4.5 (Physical Activity Variable) and Table 4.6 (Predictors of Exercise Variables). Tables 4.1 and 4.2 include variable name, abbreviation for each variable used in subsequent tables, and the range of scores for physical functional performance and pain variables, respectively. Table 4.3, 4.4, 4.5 and 4.6 includes all information of the variables measured for balance, flexibility, physical activity, and predictors of exercise, respectively.

Table 4: Demographic characteristics (N=20)

Characteristics and Category	N	%
Gender		
Female	17	85%
Male	3	15%
Race		
Caucasian	17	85%
Native American	1	5%
Hispanic	1	5%
Asian	1	5%
Marital Status		
Married	12	60%
Never Married	4	20%
Divorced/Separated	4	20%
Education		
Graduate	11	55%
College	7	35%
High School	2	10%
Occupation		
Employed Full-time	13	65%
Unemployed	3	15%
Full-time Student	2	10%
Part-time Student	1	5%
Retired	1	5%
Income		
Over $80,000	9	45%
$60,000-$40,000	2	10%
$40,000-$60,000	4	20%
$20,000-$40,000	5	25%
Physical Health Status		
Good	17	85%
Excellent	3	15%

Table 4.1: Description of physical functional performance variables - CS-PFP 10 and WOMAC

Variable Measured	Abbreviations	Range of Scores
Total Functional Performance	TFP	0-100
Lower Body Strength	LBS	0-100
Balance &Coordination	BAC	0-100
Physical Function- WOMAC	PFWOMAC	0-68

Table 4.2: Description of pain and stiffness variables - WOMAC

Pain & Stiffness Measurements	Abbreviations	Range of Scores
Pain-WOMAC	PWOMAC	0-20
Stiffness-WOMAC	SWOMAC	0-8

Abbreviations: WOMAC (The Western Ontario and McMaster Universities Osteoarthritis Index)

Table 4.3: Description of balance variables - NeuroCom Balance Master® Protocols

Test Name & Abbreviation	Variable Measured	Range of Scores
Sit-to-Stand (STS)	Mean Sway Velocity (degrees/sec)	0-20
Tandem Walk (TW)	Mean Sway Velocity (degrees/sec)	0-10
Step/Quick Turn(SQT)	Mean Turn Sway (degrees/sec)	0-60

Table 4.4: Description of flexibility variables - Goniometry

Joints Measured	Abbreviations	Normal Range of Motion
Ankle Plantarflexion	APLANFLEX	0˚-50˚
Ankle Dorsiflexion	ADORSIFLEX	0˚-20˚
Knee Extension	KEXT	0˚-15˚
Knee Flexion	KFLEX	120˚-150˚
Hip Extension	HEXT	0˚-30˚
Hip Flexion	HFLEX	110˚-130˚

Table 4.5: Description of physical activity variable

Variable Measured	Abbreviations	Range of Scores
Physical Activity Total	PATOT	0 – 18000 MET/min/week

Table 4.6: Description of predictors of exercise variables

Measurements	Abbreviations	Range of Scores
Exercise Self-efficacy	ESE	0-180
Exercise Intention Scale	EIS	3-21
Social Support Family	SSFAM	10-50
Social Support Friends	SSFRI	10-50

Descriptive Statistics for All Outcome Variables

Tables 4.7-4.12 below present the descriptive statistics for pre-test, post-test, and follow up-test scores for outcome variables related to participation in the yoga and behavioral interventions (pre-test to follow-up) by sample and by groups - the intervention group (INT) and control group (CON). Descriptive statistics are reported as means and standard deviations. An increase in scores across time for CS-PFP 10 subscales and a decrease in scores across time for the physical function WOMAC subscale reflect an improvement in physical functional performance. Decreases in measures for postural sway over time indicate improvement in balance/postural stability. In the case of flexibility measurements, an increase in the number of degrees of flexion and extension over time reflects improvement in joint flexibility. Decreased pain and stiffness subscale scores (WOMAC) over time also indicate improvement. An increased in total physical activity level over time as measured by the IPAQ reflects an improvement in physical activity level. Similarly, an increase in scores over time for exercise self-efficacy, exercise intention, social support for exercise from family and friends reflect an improvement in the above said predictors of exercise

Table 4.7: Descriptive statistics for physical functional performance variables by total sample

Variables	n	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
TFP	20	56.9±12.4	68.7±9.5	70.9±11.8
LBS	20	47.8 ±14.8	62.0 ±11.9	66.2 ±14.3
BAC	20	56.3 ±12.4	70.1±9.1	71.7±12.3
PFWOMAC	20	16.1±8.1	3.8±3.3	5.6±4.6

Table 4.7a: Descriptive statistics for physical functional performance variables by groups

Variables	Group	N	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
TFP	INT	10	51.5 ±9.6	65.6 ±10.5	67.8 ±13.4
	CON	10	52.3 ±12.9	71.9 ±7.7	74.1 ±9.7
LBS	INT	10	41.3 ±11.3	58.2 ±13.3	62.9 ±15.6
	CON	10	44.3 ±15.5	65.8 ±9.6	69.4 ±12.7
BAC	INT	10	51.7 ±10.8	67.6 ±11.1	68.5 ±14.1
	CON	10	60.8 ±12.6	72.5 ±6.1	74.9 ±9.8
PFWOMAC	INT	10	17.8 ±8.4	3.7 ±3.9	6.5 ±5.3
	CON	10	14.3 ±7.8	3.9 ±2.8	4.6 ±3.8

Abbreviation: INT- Intervention group; CON- Control group

Table 4.8: Descriptive statistics for pain variables by total sample

Variables	N	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
PWOMAC	20	6.8 ±3.9	2.1 ±1.3	2.8 ±2.0
SWOMAC	20	4.2 ±2.1	1.7± 1.3	2.6±1.6

Table 4.8a: Descriptive statistics for pain variables by group

Variables	Group	n	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
PWOMAC	INT	10	6.4 ±4.0	2.1 ±1.6	3.2 ±2.4
	CON	10	5.1 ±3.2	2.1 ±1.1	2.4 ±1.5
SWOMAC	INT	10	4.7 ±2.5	1.8 ±1.6	2.8 ±1.9
	CON	10	3.6 ±1.6	1.5 ±0.8	1.7 ±0.8

Abbreviation: INT- Intervention group; CON- Control group

Table 4.9: Descriptive statistics for balance variables by total sample

Variables	N	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
STS	20	3.4 ±1.5	3.5 ±1.6	4.4 ±1.9
TW	20	3.3 ±2.1	3.8± 1.8	4.5±3.6
SQT	20	22.4±8.4	21.6±9.7	22.0±9.1

Table 4.9a: Descriptive statistics for balance variables by group

Variables	Group	n	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
STS	INT	10	3.2 ±1.7	3.4 ±1.8	4.4 ±1.8
	CON	10	3.7 ± 1.5	3.6 ±1.6	4.3 ±2.1
TW	INT	10	3.7 ±2.3	3.8 ±1.6	5.3 ±3.6
	CON	10	3.0 ±1.8	3.6 ±2.0	3.7 ±3.6
SQT	INT	10	26.1 ±9.2	25.7 ±6.5	24.1 ±7.2
	CON	10	18.6 ±8.2	18.9 ±11.0	19.3 ±10.5

Abbreviation: INT- Intervention group; CON- Control group

Table 4.10: Descriptive statistics for flexibility variables by total sample

Variables	n	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
APLANFLEX	20	48.6 ±7.0	51.2 ±4.7	51.7 ±4.7
ADORSIFLEX	20	16.1 ±4.5	18.6±2.2	20.3±5.1
KEXT	20	8.6±2.7	7.9±1.6	7.7±2.5
KFLEX	20	131.6 ±11.4	137.6±7.3	135.4±11.4
HEXT	20	9.2±3.0	7.8±1.7	8.0±2.1
HFLEX	20	119.9±14.2	112.8±9.1	112.6±8.4

Table 4.10a: Descriptive statistics for flexibility variables by group

Variables	Group	N	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
APLANFLEX	INT	10	47.9 ±6.8	51.9 ±4.5	52.2 ±6.6
	CON	10	49.4 ±7.6	50.5 ±5.1	51.3 ±4.6
ADORSIFLEX	INT	10	16.1 ±5.6	19.0 ±2.5	21.2 ±6.2
	CON	10	16.0 ±3.3	18.1 ±1.9	19.4 ±3.8
KEXT	INT	10	9.3 ±2.5	8.0 ±1.5	7.5 ±2.4
	CON	10	7.8 ±2.8	7.9 ±1.8	7.8 ±2.6
KFLEX	INT	10	133.0 ±13.2	138.3 ±8.1	135.2 ±13.3
	CON	10	130.2 ±9.8	136.9 ±6.9	135.6 ±9.8
HEXT	INT	10	9.0 ±3.6	7.9 ±1.7	7.8 ±1.9
	CON	10	9.4 ±2.4	7.7 ±1.8	8.2 ±2.3
HFLEX	INT	10	119.7 ±11.8	109.2 ±6.4	113.0 ±6.2
	CON	10	120.0 ±16.9	116.3 ±10.2	112.1 ±10.4

Abbreviation: INT- Intervention group; CON- Control group

Table 4.11: Descriptive statistics for physical activity variable by total sample

Variable	N	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
PATOT	20	3295.1 ±1829.3	5883.6 ±3505.9	5738.6 ±3183.3

Table 4.11a: Descriptive statistics for physical activity variable by group

Variable	Group	N	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
PATOT	INT	10	3094.3 ±1696.9	6530.4 ±4323.5	6038.9 ±2942.1
	CON	10	3495.9 ±2023.7	5236.8 ±2515.1	5438.3 ±3540.6

Abbreviation: INT- Intervention group; CON- Control group

Table 4.12: Descriptive statistics for predictors of exercise by total sample

Variables	N	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
ESE	20	116.0 ±45.7	129.6 ±36.2	102.3 ±44.5
EIS	20	18.1 ±1.7	18.1±1.8	16.9±3.1
SSFAM	20	20.6±8.7	20.4±8.3	20.7±8.2
SSFRI	20	17.8 ±5.8	21.8±6.7	22.2±9.4

Table 4.12a: Descriptive statistics for predictors of exercise by group

Variables	Group	N	Pre-Test Mean ± SD	Post-Test Mean ± SD	Follow-Up Mean ± SD
ESE	INT	10	113.1 ±41.9	129.3 ±37.2	106.4 ±36.9
	CON	10	108.9 ±59.7	129.9 ±37.2	98.2 ±54.7
EIS	INT	10	18.1 ±1.9	17.6 ±1.8	17.9 ±2.5
	CON	10	18.0 ±1.6	18.5 ±1.9	15.9 ±3.4
SSFAM	INT	10	20.3 ±8.7	20.8 ±8.5	19.9 ±5.9
	CON	10	21.2 ±9.2	20.0 ±8.6	21.5 ±10.2
SSFRI	INT	10	15.9 ±5.4	21.3 ±7.0	24.7 ±10.5
	CON	10	19.6 ±5.9	22.2 ±6.7	19.7 ±7.9

Abbreviation: INT- Intervention group; CON- Control group

Plots of the overall time effect for all variables for the total sample and by group are found in Appendix E – Figure 1-20a. Likewise, correlation matrices that demonstrate the temporal stability in the rank ordering of variable scores over time are found in Appendix E – Figure 21-24.

Data Analysis Procedure

Data were analyzed using the Statistical Package for Social Sciences (SPSS) 20.0 version. For evaluating the equality of groups, an omnibus MANOVA was performed on all the pre-test outcome variables for the intervention and control groups to determine the between group difference during the pre-testing. A two-way repeated measures ANOVA (pre-test, post-test, and follow-up) was used to evaluate the between group difference in all the outcome variables over time for assessing change related to participation in the yoga intervention immediately after program completion and change related to participation in relapse prevention intervention at one month follow-up. To assess adherence to yoga exercise recommendations during the follow-up period (post-test to follow-up), the total number of weeks each participant reached the120 minutes/week goal were calculated. In addition, the average minutes of yoga practice/week also was calculated. Independent t-tests were performed on (1) the mean minutes/week of yoga participation and (2) the total number weeks in which participants met to yoga recommendations to determine whether there was a difference in yoga participation between the two groups after completion of the behavioral intervention. To evaluate effect size Cohen's *d* was calculated and interpreted as small (d =0.20), medium (d =0.5), and large (d=0.80) effect size.[52]

Equality of Study Groups

A total of 20 adults with osteoarthritis were included in the final analyses for this study, with n=10 randomly assigned to the intervention group and n=10 randomly assigned to the control group. A comparison of all the study variables between both groups at the time of pretest is presented in Table 4.13 and 4.13a. For testing the equality of groups an omnibus MANOVA was performed on all the pre-test dependent variables of the intervention and control groups to determine the between group difference during the pre-testing. Table 4.13 shows the results of an omnibus multivariate test, using all the study variables as dependent variables, and group (intervention and comparison) as the independent variable. Table 4.13a shows the result of univariate pair wise comparisons of all the variables. From this test there appeared to be no difference between groups for the variables. It was concluded that at the time of pretest no study variable appeared to be different between the intervention and control groups, therefore there does not appear to be a need to control for the variables in subsequent analyses.

Table 4.13: A comparison of all study variables between intervention and control group at pretest using an omnibus multivariate test

Effect Group	Value	F statistics	degrees of freedom	Sig. (p value)	Power (1- β)
Pillai's Trace	.051	1.035[a]	18.000	.661	.072
Wilk's Lambda	18.631	1.035[a]	18.000	.661	.072
Hotelling's Trace	18.631	1.035[a]	18.000	.661	.072
Roy's Largest Root	.051	1.035[a]	18.000	.661	.072

Table 4.13a: A comparison of study variables between intervention and control group at pretest using separate univariate test

Dependent Variable	F statistics	Sig. (p value)	Power (1 – β)
Total Functional Performance	3.484	.068	.518
Lower Body Strength	3.605	.064	.528
Balance and Coordination	2.983	.101	.373
Physical Function WOMAC	.928	.348	.150
Pain WOMAC	3.130	.085	.486
Stiffness WOMAC	1.424	.248	.204
Sit to Stand	.258	.617	.077
Tandem Walk	.104	.751	.061
Step Quick Turn	4.050	.060	.478
Ankle Plantarflexion	.216	.648	.072
Ankle dorsiflexion	.002	.962	.050
Knee Extension	1.586	.224	.222
Knee Flexion	.291	.596	.080
Hip Extension	.085	.775	.059
Hip Flexion	.002	.964	.050
Physical Activity Total	.231	.636	.074
Exercise Self-efficacy Score	.066	.801	.057
Exercise Intention Score	.016	.901	.052
Social Support Family	.051	.825	.055
Social Support Friends	2.120	.163	.281

Abbreviations: WOMAC (The Western Ontario and McMaster Universities Osteoarthritis Index)

Assumption Testing on Outcome Variables

The assumptions tested for this study on all study variables were independence of observations, normality, homogeneity of variance, and sphericity. Observations were independent between participants. Normality was tested using the Shapiro Wilk test. As presented on Table 4.14 it was found that this assumption appears to have been violated a few times. However, skewness and kurtosis have only a slight impact on significance or power of statistical tests, and variances are robust against slight deviations from normality. [52] Moreover, the F-statistic is quite robust with respect to violations of the normality assumption.[53] The only variable that violated the assumptions of normality was *social support for exercise from friends (SSFRI).* After visually inspecting the histograms and Q-Q plots of *SSFRI*, it was found that the *SSFRI* showed only slight deviation from normality at pre-test, post-test, and follow-up. Therefore, it was decided to keep all study variables untransformed in subsequent analyses.

Homogeneity of variance was tested using the Levene's Test of Equality of Error Variances and is presented on Table 4.15. It was found that this assumption appears to have been violated a number of times: *Stiffness measured by WOMAC* (*SWOMAC*) at the time of posttest and follow-up test. Violations of this assumption can be resolved in two ways: transformation of the variable or by using a more stringent alpha for untransformed data. [54] In this cases where this assumption has been violated an alpha of 0.01 will be used.

Finally, the assumption of sphericity was tested using Mauchly's sphericity test and is presented on Table 4.16. It was found that this assumption appears to have been violated for Total Functional Performance, Balance and Coordination, Physical Function WOMAC, Sit to Stand, Tandem Walk, Ankle Plantarflexion, Knee Flexion, Hip Flexion, Pain WOMAC, and Exercise Self-efficacy Score. Violations of this assumption can be resolved by using the Greenhouse & Geisser estimate.[54] Therefore, this estimate was used throughout subsequent analyses.

Table 4.14: A summary of the assumption of normality using Shapiro-Wilk test

Variable	Test	Pretest Statistics (p value)	Posttest Statistics (p value)	Follow-up test Statistics (p value)
Total Functional Performance	Shapiro-Wilk	.959 (.525)	.980 (.932)	.938 (.217)
Lower Body Strength	Shapiro-Wilk	.953 (.407)	.977 (.885)	.956 (.466)
Balance and Coordination	Shapiro-Wilk	.967 (.697)	.953 (.413)	.943 (.278)
Physical Function WOMAC	Shapiro-Wilk	.925 (.126)	.907 (.066)	.921 (.104)
Pain WOMAC	Shapiro-Wilk	.944 (.279)	.908 (.069)	.923 (.114)
Stiffness WOMAC	Shapiro-Wilk	.969 (.727)	.910 (.063)	.920 (.097)
Sit to Stand	Shapiro-Wilk	.952 (.405)	.923 (.114)	.956 (.459)
Tandem Walk	Shapiro-Wilk	.959 (.530)	.966 (.660)	.957 (.495)
Step Quick Turn	Shapiro-Wilk	.947 (.319)	.947 (.323)	.935 (.192)
Ankle Plantarflexion	Shapiro-Wilk	.935 (.196)	.913 (.071)	.921 (.105)
Ankle dorsiflexion	Shapiro-Wilk	.931 (.160)	.912 (.071)	.926 (.131)
Knee Extension	Shapiro-Wilk	.936 (.202)	.909 (.061)	.908 (.069)
Knee Flexion	Shapiro-Wilk	.964 (.627)	.919 (.095)	.936 (.200)
Hip Extension	Shapiro-Wilk	.955 (.455)	.950 (.360)	.914 (.076)
Hip Flexion	Shapiro-Wilk	.916 (.082)	.914 (.075)	.919 (.094)
Physical Activity Total	Shapiro-Wilk	.951 (.383)	.912 (.069)	.918 (.091)
Exercise Self-efficacy Score	Shapiro-Wilk	.949 (.355)	.953 (.415)	.952 (.406)
Exercise Intention Score	Shapiro-Wilk	.918 (.091)	.908 (.068)	.915 (.079)
Social Support Family	Shapiro-Wilk	.906 (.054)	.940 (.235)	.913 (.071)
Social Support Friends	Shapiro-Wilk	.907 (.056)*	.908 (.059)*	.907 (.057)*

Table 4.15: A summary of the assumption of homogeneity of variance using Levene's test

Variable	Test	Pretest Statistics (p value)	Posttest Statistics (p value)	Follow-up test Statistics (p value)
Total Functional Performance	Levene	.568 (.461)	1.627 (.218)	1.963 (.178)
Lower Body Strength	Levene	1.019 (.326)	1.426 (.248)	.133 (.720)
Balance and Coordination	Levene	.124 (.729)	3.476 (.071)	3.953 (.062)
Physical Function WOMAC	Levene	.531 (.476)	1.790 (.198)	2.488 (.132)
Pain WOMAC	Levene	.263 (.614)	1.918 (.183)	1.716 (.207)
Stiffness WOMAC	Levene	1.441 (.246)	7.875 (.022)	10.061 (.035)
Sit to Stand	Levene	.401 (.535)	.009 (.926)	1.333 (.263)
Tandem Walk	Levene	.754 (.397)	2.692 (.118)	.257 (.618)
Step Quick Turn	Levene	.699 (.414)	.497 (.490)	.843 (.371)
Ankle Plantarflexion	Levene	.245 (.627)	.035 (.854)	2.215 (.154)
Ankle dorsiflexion	Levene	2.253 (.151)	.746 (.399)	3.317 (.085)
Knee Extension	Levene	.100 (.755)	.675 (.422)	.140 (.713)
Knee Flexion	Levene	.964 (.627)	.919 (.095)	.936 (.200)
Hip Extension	Levene	1.682 (.211)	.077 (.785)	1.706 (.208)
Hip Flexion	Levene	1.322 (.265)	2.781 (.113)	2.563 (.127)
Physical Activity Total	Levene	.590 (.452)	1.483 (.239)	1.114 (.305)
Exercise Self-efficacy Score	Levene	1.243 (.641)	.012 (.913)	3.171 (.092)
Exercise Intention Score	Levene	.922 (.350)	.081 (.780)	1.058 (.317)
Social Support Family	Levene	.007 (.932)	.174 (.681)	2.193 (.156)
Social Support Friends	Levene	.427 (.522)	.005 (.943)	.400 (.535)

Table 4.16: A summary of the assumption of sphericity using Mauchly's test

Variable	Test	Mauchly's W	p value
Total Functional Performance	Mauchly's sphericity	0.710	0.054*
Lower Body Strength	Mauchly's sphericity	0.793	0.139
Balance and Coordination	Mauchly's sphericity	0.653	0.021*
Physical Function WOMAC	Mauchly's sphericity	0.337	0.000*
Pain WOMAC	Mauchly's sphericity	0.630	0.020*
Stiffness WOMAC	Mauchly's sphericity	0.780	0.121
Sit to Stand	Mauchly's sphericity	0.303	0.000*
Tandem Walk	Mauchly's sphericity	0.697	0.047*
Step Quick Turn	Mauchly's sphericity	0.920	0.493
Ankle Plantarflexion	Mauchly's sphericity	0.705	0.051*
Ankle dorsiflexion	Mauchly's sphericity	0.936	0.626
Knee Extension	Mauchly's sphericity	0.968	0.761
Knee Flexion	Mauchly's sphericity	0.701	0.049*
Hip Extension	Mauchly's sphericity	0.897	0.398
Hip Flexion	Mauchly's sphericity	0.466	0.002*
Physical Activity Total	Mauchly's sphericity	0.895	0.390
Exercise Self-efficacy Score	Mauchly's sphericity	0.646	0.036*
Exercise Intention Score	Mauchly's sphericity	0.837	0.221
Social Support Family	Mauchly's sphericity	0.792	0.138
Social Support Friends	Mauchly's sphericity	0.928	0.529

Results for Research Questions

This study attempted to answer seven research questions. The results for each research question are presented in this section.

Physical Functional Performance:

RQ1: Will participation in 8 weeks of Hatha yoga be associated with improved physical functional performance from pre- to post-yoga intervention in middle-aged adults with lower limb OA?

A summary of the two-way ANOVA for physical functional performance by group (intervention vs control) and time (pre-test, post-test, follow-up) is provided in Table 4.17. Post hoc analyses are presented in Table 4.17a. To evaluate the improvement in physical functional performance, four variables were used: Total Functional Performance (TFP), Lower Body Strength (LBS), Balance and Coordination (BAC) and Physical Function WOMAC (PF WOMAC). There was a significant increase in mean total functional performance score from pre-test to post-test (p<0.001) with mean scores of 56.9 at pre-test and 68.7 at post-test. There also was a significant increase in lower body strength scores from pre-test to post-test (p<0.001) with scores of 47.8 at pre-test and 62.0 at post-test. The balance and coordination score also increased significantly from pre-test to post-test (p<0.001) with mean scores of 56.3 at pre-test and 70.1 at post-test. Similarly, the physical function WOMAC score decreased significantly from pre-test to post-test (p<0.001), with mean scores of 16.05 at pre-test and 3.80 at post-test. The results indicated that there were no significant between group or group*time effects for the physical functional performance variables (TFP [group p=0.086; time x group p=0.396]; LBS [group p=0.087; time x group p=0.383]; BAC [group p=0.903; time x group p=0.588]; PFWOMAC [group p=0.420; time x group p=0.332]). The main effect for time was significant (p<0.001) for all variables indicating that there was a significant increase in physical functional performance from pre-testing to post-testing among all participants. The differences from pre- to post-intervention for all four variables produced large effect sizes (*d* >1.0 and above). Overall, the results from pre- to post-test indicate that participation in the 8-week yoga intervention resulted in beneficial improvements in functional performance in middle-aged adults with lower limb OA.

Table 4.17: A summary of the analysis of variance (ANOVA) for physical functional performance by group (intervention vs control) and time (pre-test vs. post-test vs. follow-up)

Variables	Source	SS	MS	F	p-value	Power
TFP	Group	914.551	914.551	3.303	0.086	0.405
	Within Subjects					
	Time	2279.760	1490.796	30.354	0.000*	1.000
	Time*Group	67.629	43.618	0.896	0.396	0.173
LBS	Group	1217.251	1217.251	3.071	0.097	0.382
	Within Subjects					
	Time	3724.143	1862.071	29.926	0.000*	1.000
	Time*Group	122.659	61.329	0.985	0.383	0.208
BAC	Group	1.600	1.600	0.015	0.903	0.052
	Within Subjects					
	Time	2871.461	1945.322	29.940	0.000*	1.000
	Time*Group	43.378	29.616	0.439	0.588	0.106
PF WOMAC	Group	45.067	45.067	0.681	0.420	0.122
	Within Subjects					
	Time	1755.833	1459.823	53.221	0.000*	1.000
	Time*Group	34.433	28.628	1.046	0.332	0.175

Table 4.17a: A summary of pair wise comparisons for all physical functional performance variables from pre-test to post-test to follow-up using the Bonferroni adjustment

Variables	Within (i)	Within (j)	Mean Difference	Standard Error	p-value	Effect Size Cohen's *d*
TFP	Pre	Post	-11.849	1.981	0.000*	-1.08
		Follow-up	-14.029	2.338	0.000*	-1.16
	Post	Follow-up	-2.180	1.368	0.383	-0.21
LBS	Pre	Post	-14.259	2.472	0. 000*	-1.06
		Follow-up	-18.391	2.979	0.000*	-1.26
	Post	Follow-up	-4.132	1.919	0.133	-0.32
BAC	Pre	Post	-13.773	2.131	0.000*	-1.28
		Follow-up	-15.436	2.718	0.000*	-1.25
	Post	Follow-up	-1.663	1.568	0.906	-0.15
PF WOMAC	Pre	Post	12.250	1.483	0.000*	2.16
		Follow-up	10.500	1.545	0.000*	1.65
	Post	Follow-up	-1.750	0.602	0.027*	-0.46

***Pain and Stiffness**:*

RQ2: Will participation in 8 weeks of Hatha yoga be associated with reduced pain and stiffness from pre to post yoga intervention in middle-aged adults with lower limb OA?

A summary of the two-way ANOVA for pain variables by group (intervention vs control) and time (pretest, posttest, follow-up test) is provided in

Table 4.18. Post hoc analyses are presented in Table 4.18a. To assess changes in pain and stiffness, two variables were used: Pain WOMAC and Stiffness WOMAC. There was a significant decrease in mean pain score measured by the WOMAC from pre-test to post-test (*p*<0.001) with scores of 6.8 at pretest and 2.1 at posttest. There also was a significant decrease in stiffness scores as measured using WOMAC from pre-test to post-test (*p*<0.001) with scores of 4.2 at pretest and 1.65 at posttest. The results indicated that there were no significant between group or group*time effects for pain and stiffness variables. The main effect of time was significant (*p*<0.001), indicating that the pain and stiffness variables significantly decreased from pre-testing to post-testing among all participants. These differences from pre- to post-intervention for both variables produced large effect sizes (*d*>1.0). Results from pre-test to post-test indicate that participation in the 8-week yoga intervention resulted in beneficial reductions in self-reported pain and stiffness in middle-aged adults with lower limb OA.

Table 4.18: A summary of the analysis of variance (ANOVA) for all pain and stiffness variables by group (intervention vs control**) and time (pretest vs. posttest vs. follow-up test)**

Variables	**Source**	**SS**	**MS**	**F**	**p-value**	**Power**
PWOMAC	Group	28.017	28.017	2.768	0.113	0.350
	<u>Within Subjects</u> Time Time*Group	 251.433 29.633	 172.176 20.292	 27.777 3.274	 0.000* 0.067	 1.000 0.494
SWOMAC	Group	10.417	10.417	2.200	0.155	0.290
	<u>Within Subjects</u> Time Time*Group	 68.113 2.133	 36.067 1.067	 20.083 0.629	 0.000* 0.539	 1.000 0.147

Table 4.18a: A summary of pair wise comparisons for all pain and stiffness variables from pre-test to post-test to follow-up using the Bonferroni adjustment

Variables	Within (i)	Within (j)	Mean Difference	Standard Error	p-value	Effect Size Cohen's *d*
PWOMAC	Pre	Post	4.650	.898	0.000*	1.81
		Follow-up	3.950	.701	0.000*	1.36
	Post	Follow-up	-.700	.471	0.460	-0.42
SWOMAC	Pre	Post	2.500	.473	0.000*	1.47
		Follow-up	1.900	.422	0.001*	0.86
	Post	Follow-up	-.600	.311	0.207	-0.62

Postural Sway:

RQ3: Will participation in 8 weeks of Hatha yoga associated with a decrease in postural sway from pre- to post-yoga intervention in middle-aged adults with lower limb OA?

A summary of the two-way ANOVA for balance variables by group (intervention vs control) and time (pre-test, post-test, follow-up) is provided in Table 4.19. Post hoc analyses are presented in Table 4.19a. To evaluate the improvement in postural sway, three variables were used: Sit-to-Stand (STS) center of gravity (COG) sway velocity, Tandem Walk (TW) end sway velocity, and Step Quick Turn (SQT) turn sway velocity. There was no significant time or group main effects for TW and SQT. Likewise, there was no group*time interaction effects for any of the balance variables. The main effect of time was significant (p=0.001) for STS. However, the post-hoc analysis indicated a significant increase in sway from pre-test to follow-up and from post-test to follow-up among all participants. These differences from pre-intervention to follow-up and post- intervention to follow-up for STS also produced medium effect sizes (d>0.5). The results indicate that postural sway measures (STS, TW, and SQT) did not decrease after participation in the 8-week yoga intervention, indicating no significant improvement in postural balance from pre- to post-yoga intervention in middle-aged adults with lower limb OA after participating in 8 weeks of Hatha yoga.

Table 4.19: A summary of the analysis of variance (ANOVA) for all postural balance variables by group (intervention vs control**) and time (pre-test vs. post-test vs. follow-up)**

Variables	Source	SS	MS	F	p-value	Power
STS	Group	0.353	0.353	0.045	0.835	0.055
	Within Subjects					
	Time	11.321	5.661	8.346	0.001*	0.949
	Time*Group	0.609	0.305	.449	0.642	0.117
TW	Group	10.837	10.837	1.135	0.301	0.172
	Within Subjects					
	Time	13.296	6.648	1.191	0.315	0.244
	Time*Group	5.524	2.762	0.495	0.614	0.125
SQT	Group	996.745	996.745	5.216	0.082	0.580
	Within Subjects					
	Time	114.783	83.353	0.818	0.411	0.154
	Time*Group	58.282	42.323	0.415	0.590	0.101

Table 4.19a: A summary of pair wise comparisons for all postural balance variables from pre-test to post-test to follow-up test using the Bonferroni adjustment

Variables	Within (i)	Within (j)	Mean Difference	Standard Error	p-value	Effect Size Cohen's *d*
STS	Pre	Post	-.060	.179	1.000	-0.06
		Follow-up	-.950	.249	0.014*	-0.59
	Post	Follow-up	-.890	.292	0.021*	-0.51
TW	Pre	Post	-.420	.566	1.000	-0.26
		Follow-up	-1.140	.877	0.630	-0.42
	Post	Follow-up	-.720	.765	1.000	-0.26
SQT	Pre	Post	-2.195	1.635	0.589	-0.22
		Follow-up	-3.322	2.753	0.725	-0.11
	Post	Follow-up	-1.137	3.284	1.000	-0.27

Flexibility:

RQ4: Will participation in 8 weeks of Hatha yoga associated with improvement in flexibility from pre- to post-yoga intervention in middle-aged adults with lower limb OA?

A summary of the two-way ANOVA for flexibility variables by group (intervention vs control) and time (pre-test, post-test, follow-up) is provided in Table 4.20. Post hoc analyses are presented on Table 4.20a. To evaluate the improvement in flexibility, six variables were used: Ankle Plantarflexion, Ankle Dorsiflexion, Knee Extension, Knee Flexion, Hip Extension, and Hip Flexion.

The results indicate that there was no significant main effect for time or group, and no group*time interaction for ankle plantarflexion, knee extension, or hip extension. However, there were significant increases in ankle dorsiflexion (p=0.002) and knee flexion (p=0.014), and a significant decrease in hip flexion (p=0.049). Mean ankle dorsiflexion increased from16.1 degrees at pre-test to 18.6 degrees at post-test and knee flexion increased from 131.6 degrees at pre-test to 137.6 degrees at post-test. Both indicate significant improvements in ROM. On the other hand, hip flexion decreased from 119.9 degrees at pre-test to 112.8 degrees at post-test indicating a significant decline in hip ROM. There were no significant between group or group*time effects for ADORSIFLEX, KFLEX or HFLEX. The difference from pre- to post-intervention produced medium to large effect sizes for ankle dorsiflexion (d=-0.75), knee flexion (d=-0.64), and hip flexion (d=0.61).

Table 4.20: A summary of the analysis of variance (ANOVA) for all flexibility variables by group (intervention vs comparison) and time (pretest vs. posttest vs. follow-up test)

Variable	Source	SS	MS	F	p-value	Power
APLANFLEX	Group	1.067	1.067	0.016	0.902	0.052
	Within Subjects					
	Time	109.433	70.868	2.775	0.091	0.444
	Time*Group	24.033	15.564	0.609	0.510	0.131
ADORSIFLEX	Group	13.067	13.067	0.471	0.501	0.100
	Within Subjects					
	Time	182.500	91.250	7.328	0.002*	0.928
	Time*Group	7.233	3.617	0.290	0.750	0.093
KEXT	Group	2.817	2.817	0.378	0.546	0.090
	Within Subjects					
	Time	8.400	4.200	0.965	0.391	0.204
	Time*Group	8.933	4.467	1.026	0.361	0.215
KFLEX	Group	24.067	24.067	0.092	0.766	0.059
	Within Subjects					
	Time	368.533	239.412	5.642	0.014*	0.749
	Time*Group	25.733	16.717	0.394	0.624	0.101
HEXT	Group	0.600	0.600	0.087	0.771	0.059
	Within Subjects					
	Time	22.933	11.467	2.287	0.116	0.434
	Time* Group	1.200	0.600	0.888	0.888	0.067
HFLEX	Group	70.417	70.417	0.380	0.546	0.090
	Within Subjects					
	Time	691.600	530.395	3.937	0.049*	0.538
	Time* Group	186.133	142.748	1.060	0.334	0.182

In addition, the difference from pre- to post-intervention for hip extension also produced medium effect sizes (d=0.60). However, it should be noted that even though there was medium effect size for HEXT, there was no significant main effect for time. Overall, results indicate that there was significant improvement in knee and ankle ROM, and a reduction in ROM in the hip post-intervention.

Table 4.20a: A summary of pair wise comparisons for all flexibility variables from pretest to posttest to follow-up test using the Bonferroni adjustment

Variables	Within (i)	Within (j)	Mean Difference	Standard Error	p-value	Effect Size Cohen's *d*
APLAN FLEX	Pre	Post	-2.550	1.232	0.157	-0.44
		Follow-up	-3.100	1.720	0.262	-0.53
	Post	Follow-up	-0.550	1.148	1.000	-0.11
ADORSI FLEX	Pre	Post	-2.500	0.972	0.056	-0.75
		Follow-up	-4.250	1.203	0.007*	-0.88
	Post	Follow-up	-1.750	1.098	0.382	-0.47
KEXT	Pre	Post	0.600	0.622	1.000	0.33
		Follow-up	0.900	0.725	0.689	0.35
	Post	Follow-up	0.300	0.629	1.000	0.10
KFLEX	Pre	Post	-6.000	1.279	0.000*	-0.64
		Follow-up	-3.800	2.163	0.285	-0.33
	Post	Follow-up	2.200	1.781	0.695	0.24
HEXT	Pre	Post	1.400	0.759	0.242	0.60
		Follow-up	1.200	0.728	0.347	0.47
	Post	Follow-up	-0.200	0.574	1.000	-0.11
HFLEX	Pre	Post	7.100	3.553	0.181	0.61
		Follow-up	7.300	3.266	0.113	0.65
	Post	Follow-up	0.200	1.771	1.000	0.02

Physical Activity level:

RQ5: Will participation in 8 weeks of Hatha yoga be associated with an increase in physical activity level from pre- to post-yoga intervention in middle-aged adults with lower limb OA?

A summary of the two-way ANOVA for total physical activity level by group (intervention vs control) and time (pre-test, post-test, follow-up) is provided in Table 4.21. The result indicated that main effect of time was significant for total physical activity level (*p=0.003*). However, there were no significant between group or group*time effects for total physical activity level. There was a significant increase in physical activity level from pre-test to post-test (*p*=0.017). The total physical activity score increased from 3295.1 MET/minutes at pretest to 5883.6 MET/minutes at posttest. Post hoc analysis presented in Table 4.21a, indicates physical activity level significantly improved from pre-intervention to post-intervention. These differences also produced a large effect size (*d*=-0.97). These results indicate that there was significant improvement in physical activity level from pre- to post-participation in this 8-week Hatha yoga intervention in middle-aged adults with lower limb OA.

Table 4.21: A summary of the analysis of variance (ANOVA) for physical activity by group (intervention vs control) and time (pre-test vs. post-test vs. follow-up)

Variable	Source	SS	MS	F	p-value	Power
PATOT	Group	3713588.817	3713588.817	0.259	0.617	0.077
	Within Subjects					
	Time	84611074.85	42305537.42	6.907	0.003*	0.901
	Time*Group	7264878.858	3632439.429	0.593	0.558	0.141

Table 4.21a: A summary of pair wise comparisons for physical activity variable from pre-test to post-test to follow-up using the Bonferroni adjustment

Variables	Within (i)	Within (j)	Mean Difference	Standard Error	p-value	Effect Size Cohen's *d*
PATOT	Pre	Post	-2588.450	830.616	0.017*	-0.97
		Follow-up	-2443.475	638.065	0.003*	-0.97
	Post	Follow-up	144.975	837.275	1.000	0.04

Predictors of Exercise:

RQ6: Will participation in a 4-week relapse prevention intervention be associated with improvement in exercise self-efficacy, exercise intention and social support for exercise when compared to control group?

A summary of the two-way ANOVA results for predictors of exercise by group (intervention vs comparison) and time (pretest, posttest, follow-up test) is provided in Table 4.22. Post hoc analysis is presented in Table 4.22a. To evaluate the improvement in predictors of exercise, change in four variables was assessed: Exercise self-efficacy (ESE), Exercise intention (EIS), Social support from family (SSFAM), and Social support from friends (SSFRI). These results indicate that there were no significant between group or group*time effects for exercise self-efficacy; however, the main effect of time was significant ($p=0.025$). Mean exercise self-efficacy increased from 116 units at pretest to 129.6 at posttest and then decreased to 102.3 at one-month follow-up, with exercise self-efficacy significantly decreasing ($p=0.007$) from post-intervention to follow-up among all participants. This decrease in ESE was unexpected and suggests that participation in the behavioral intervention had a detrimental rather than beneficial effect on self-efficacy. It was noted that the ESE scores increased from pre-test to post-test, indicating an increase in ESE in after participation in the 8-week yoga intervention. One possible explanation for the improvement post-yoga intervention is that the strongest beneficial influence on self-efficacy is success in carrying out the target behavior. In this case, all participants in the yoga intervention participated regularly and experienced a variety of beneficial effects from this participation. The intrinsic value of improvements in their pain, stiffness, and physical function that were associated with participation in the intervention appears to have boosted self-efficacy more than the support provided during the behavioral intervention. This may be explained by the fact that participants experienced less benefit as the regularity of their yoga practice varied during the follow-up period, which may have resulted in a decline in participant perception of personal success.

The results for EIS indicate that there was a significant time*group interaction for exercise intention ($p=0.046$). For the intervention group, the mean score for EIS decreased from 18.1 at pre-test to 17.6 at post-test and then increased to 17.9 at follow-up. For the control group, the mean score for EIS increased from 18.0 at pre-test to 18.5 at post-test and then decreased to 15.9 at follow-up. These results indicate that there was a significant decrease in exercise intention in the control group when compared to the intervention group from post-test to follow-up, with a medium effect size ($d=0.5$). This suggests that participation in the behavioral intervention had a beneficial buffering effect in the intervention group, since they slightly increased, though not significant, their level of intent to continue practicing yoga.

For SSFAM, there was no significant main effect for time or group, and no time*group interaction in the level of social support provided by family. For intervention group, the mean score for SSFAM increased slightly from 20.3 at pre-test to 20.8 at post-test and then decreased to 19.9 at follow-up. For control group, the mean score for SSFAM decreased from 21.2 at pre-test to 20.0 units at post-test and increased 21.5 at follow-up. As expected when there is a non-significant interaction, there was a very small effect size ($d \leq 0.01$). This suggests that participation in the behavioral intervention did not impact the level of social support provided to participants by family members. This is not surprising since family members were not directly engaged in the intervention and none of the support materials focused on obtaining support from family members.

For SSFRI, there was no significant main effect for group and no time*group interaction in the level of social support provided by family. However, there was significant main effect for time ($p=0.029$). Mean social support for exercise provided by friends increased from 17.8 units at pretest to 21.86 at posttest and to 22.2 at one-month follow-up, with the level of social support for exercise provided to participants by friends significantly increasing ($p=0.050$) from pre-intervention to follow-up among all participants. This difference also produced a medium effect size ($d=-0.58$). This may be explained by the fact that most participants had friends who also participated in the yoga intervention, and they encouraged and supported one another throughout the structured yoga class. Moreover, it should also be noted that SSFRI scores increased from post-test to follow-up in the relapse prevention group, while they dropped in the control group. This suggests that behavioral intervention group continued to participate in yoga together after the completion of the class. Intervention group received continued friend support after the completion of structure yoga class suggesting that the behavioral intervention may have provided a motivation for their actual gain of friend support.

Overall, there were no significant gains from post-test to follow-up in the predictors of exercise among those who participated in the relapse prevention intervention except for the exercise social support from friends. However, participation appears to have provided a buffering effect for exercise intention since the intentions of the control group dropped significantly more than those of the relapse prevention group. This may also be the case of exercise self-efficacy. Even though the drop in ESE over time was not significantly different between groups, ESE dropped less in the intervention group.

Table 4.22: A summary of the analysis of variance (ANOVA) for all predictors of exercise variables by group (intervention vs. comparison) and time (posttest vs. follow-up test)

Variables	Source	SS	MS	F	p-value	Power
ESE	Groups	248.067	248.067	0.073	0.790	0.058
	Within Subjects					
	Time	7863.600	5206.966	4.728	0.025*	0.644
	Time*Group	195.733	129.607	0.118	0.833	0.065
EIS	Groups	2.400	2.400	0.268	0.611	0.078
	Within Subjects					
	Time	17.225	8.817	2.721	0.079	0.504
	Time*Group	21.025	10.850	3.348	0.046*	0.596
SSFAM	Groups	4.817	4.817	0.029	0.867	0.053
	Within Subjects					
	Time	1.433	0.717	0.026	0.975	0.054
	Time*Group	15.400	7.617	0.273	0.763	0.090
SSFRI	Groups	0.267	0.267	0.003	0.960	0.050
	Within Subjects					
	Time	240.033	120.017	3.930	0.029*	0.670
	Time*Group	197.233	98.617	3.229	0.061	0.579

Table 4.22a: A summary of pair wise comparisons for all predictors of exercise variables from pretest to posttest to follow-up test using the Bonferroni adjustment

Variables	Within (i)	Within (j)	Mean Difference	Standard Error	p-value	Effect Size Cohen's *d*
ESE	Pre	Post	-8.100	7.663	0.913	-0.33
		Follow-up	19.200	11.424	0.330	0.30
	Post	Follow-up	27.300	7.762	0.007*	-0.68
EIS	Pre	Post	0.000	0.456	1.000	0.00
		Follow-up	1.150	0.659	0.295	0.50
	Post	Follow-up	1.250	0.574	0.050*	0.49
SSFAM	Pre	Post	0.350	1.321	1.000	0.02
		Follow-up	0.050	1.640	1.000	-0.01
	Post	Follow-up	-0.300	1.986	1.000	-0.04
SSFRI	Pre	Post	-4.000	1.573	0.061	-0.64
		Follow-up	-4.450	1.685	0.050*	-0.58
	Post	Follow-up	-.450	1.961	1.000	-0.05

Exercise Adherence:

RQ7: Will participation in a 4-week relapse prevention intervention be associated with an increase in the rate of continued participation in yoga (exercise adherence) when compared to those that did not participate?

The yoga exercise recommendation provided to the participants was to practice yoga 120 minutes/week for the 4-week follow-up period. To assess the adherence to yoga exercise recommendations during the follow-up period (posttest to follow-up), the total number of weeks that each participant reached 120 minutes/week of yoga exercise goal was calculated. They were asked to maintain a yoga exercise log every week for 4 weeks. An independent t-test was performed with the number of weeks of adherence as dependent variable and group as independent variable. As presented in Table 4.23, the mean number of weeks in which each participant reached the 120 minutes/week goal was 1.9 for the intervention group and 0.8 for control group, with the intervention group meeting the weekly goal in more weeks during the follow-up period than the control group. However, this change was not statistically significant ($p=0.06$). Three out of 10 participants from the intervention group achieved the recommended yoga exercise goal of 120 minutes/week during every week of the four week follow up period. None of the participants from the control group reached the exercise goal during all four weeks. Forty percent (4 of 10) of intervention group participants and 50% (5 of 10) of control group participants did not meet this goal in any of the four weeks. As another measure of adherence, the average minutes of yoga practice/week were calculated. An independent t-test was performed with total minutes/week as the dependent variable and group as the independent variable. As presented in Table 4.23, the average number of minutes of yoga practice/week for intervention group was 103.51 minutes and 75.5 minutes for control group. The intervention group practiced yoga for more minutes per week than did the control group, though this difference was not statistically significant (p=0.08). These findings suggest that the behavioral intervention in terms of behavioral adherence during the follow-up period did not show significant improvement when compared to the control group. Moreover, as noted previously, the effectiveness of the intervention does not appear to be related to changes in the predictors of exercise that were targeted in the intervention.

Table 4.23: Between group difference for yoga exercise total minutes/week (posttest vs. follow-up)

Variable	Group	Mean ±SD	T	Sig. (p)
Total minutes/week	INT	103.5±54.4	1.47	0.08
	COM	75.5±26.1		
Number of weeks of adherence	INT	1.9±1.9	1.64	0.06
	COM	0.8±1.0		

Abbreviation: INT- Intervention group; CON- Control group

Retention of benefits of yoga exercise at 1-month follow-up:

RQ8: Will the beneficial outcomes associated with participation in yoga be maintained at 1-month follow-up testing?

The physical functional performance variables (TFP, LBS, BAC, and PFWOMAC) produced main effects for time indicating a significant improvement from pre- to follow-up testing (Table 4.17). Post hoc analysis table (Table 4.17a) indicated that there were no significant differences in TFP, LBS, or BAC scores from post-intervention to follow-up except for PF WOMAC (p=0.027). PF WOMAC, which is a subscale of a self-report instrument, showed a significant reduction in physical function from post- to follow-up testing. No significant difference in the performance based measures of physical function variables from post- to follow-up testing suggests that the improvements in physical functional performance were maintained at 1-month follow up.

The results obtained for the pain and stiffness variables (Table 4.18 and 4.18a) also indicated no significant difference in PWOMAC and SWOMAC scores from post-intervention to follow-up, suggesting that the reduction in perception of pain and stiffness was maintained at 1-month follow up. However, it should be noted that scores for both increased slightly from post-test to follow-up, even though this change was not statistically significant. This may suggest that there could be a significant decay of benefits at a future time if yoga practice continues at a dose that is lower than practiced during the intervention. Similarly, there was a time main effect for physical activity level indicating a significant improvement from pre-test to follow-up (p=0.003) (Table 4.21). PATOT scores decreased slightly from post-intervention to one-month follow-up but this decrease was not statistically significant. Because there was no significant change in physical activity level from post-test to 1-month follow up, it can be concluded that the improvement associated with participation in the intervention was sustained post intervention. Again, this also may suggest that a significant decay in benefits could occur at a future time if yoga practice continues at a dose that is lower than practiced during the intervention.

Since there were no significant changes in balance variables (Tables 4.19, 4.19a) post-participation in yoga, these variables were not included in the post-intervention to follow-up analysis. For flexibility variables, the main effect of time indicated significant improvement in ROM only for ankle dorsiflexion and knee flexion (Table 4.20 and 4.20a) from pre- to post-intervention. There were no significant differences in scores for these variables from post-intervention to follow-up indicating residual retention of benefits at follow-up. However, again there was a non-significant decrease in knee flexion from post-intervention to follow-up. This also may suggest that a significant decay in ROM benefits could occur at a future time. Overall, the results from post-test to follow-up indicate that participants maintained the beneficial effect of yoga practice on physical health at 1-month follow up. Also, there were no significant main effects from group and no group*time interaction effects for any of the variables suggesting both intervention and control group retained the benefits of yoga participation at 1-month follow-up.

Process Evaluation:

Process evaluation was conducted at the level of the participants and the program implementation strategies. With regards to the participants, yoga class attendance was registered and participant satisfaction was assessed by a participant satisfaction survey that was filled out after completion of the program. Implementation of program strategies was evaluated using a process evaluation checklist that indicated that the program was implemented in accordance with the plan. There was an excellent attendance rate (95%) for the yoga class, which is important given the progressive nature of the program. For the relapse prevention program, 100% of the intervention dose was delivered in terms of sending one email and one phone call a week for 4 weeks to all participants in the relapse prevention intervention. The dose in terms of email receipt was not recorded. However, 87.5% of the intervention dose in terms of phone calls was received by the participants. Five phone calls (12.5%) were not answered and none of those individuals returned the calls. However, a voicemail message was delivered to each of them. The result from the participant satisfaction survey indicated that participants were satisfied in general with the organization of the yoga training sessions (100%), the duration of the sessions (100%), and the 5 to 6 pm timeframe during which the sessions were conducted (100%). The majority (85%) was satisfied with the duration of the yoga program. However, three people considered the duration of the yoga program to be too short to remember and practice the yoga poses properly. In addition, 90% of participants were dissatisfied with the availability of parking and the training location. Participants (100%) were completely satisfied with the exercise classes and the trainer's knowledge of training materials, preparedness, cultural sensitivity, and time management. The majority (80%) expressed that all of the yoga training was new for them and exceeded their expectations. With regards to the relapse prevention program, 80% were satisfied with the delivery of the training (emails and phone calls). The majority (90%) found the topics related to long-term osteoarthritis self-care and improving goal setting most useful. They felt that topics related to improving social support were the least useful. Most of them (80%) reported that topics related to managing an effective yoga routine and improving exercise self-efficacy were somewhat useful. Overall, participants reported that they liked both phases of the program (yoga intervention and relapse prevention intervention) and that they found it very useful. Most of them reported that their pain and stiffness was reduced after participation in the program and that they felt they had improved balance control and flexibility. The perceived improvements in flexibility and balance confidence were promising, and it is for future research to objectify these effects as well.

Discussion of Results

The experimental results obtained from this study indicated that participation in an 8-week yoga exercise program was associated with an improvement in physical functional performance and a reduction in pain and stiffness in middle-aged adults with osteoarthritis, which is consistent with the findings of earlier studies[12, 13, 27] that were carried out with elderly adults with osteoarthritis who practiced yoga. This suggests middle-aged individuals with OA can achieve similar benefits from participating in yoga as older adults.

The physical threshold value (physical reserve) identified for physical functional performance associated with CS-PFP score is > 57.[36] Physical reserve is conceptualized as a "margin of safety" that acts as a buffer against unexpected demands or temporary declines in functional performance.[37] Individuals with a Total Functional Performance (TFP) score that is greater than 57 can lose physical function without losing their ability to live independently until they reach or decline below this threshold. For the present study, all participants had TFP scores that were greater than or equal to this benchmark (57) at baseline (pre-test), and therefore, all had an adequate physical reserve. However, after participation in the yoga intervention, there was significant improvement ($p<0.001$) in TFP scores. The mean post-test score was 68.7 and the mean follow-up test score was 70.9. This result also supports the positive effect of yoga practice on the physical functional performance.

Similarly, the results of physical activity level indicated increased participation level after an 8-week yoga exercise program in middle-aged adults with osteoarthritis. Previous studies[33, 34] carried out among elderly adults with osteoarthritis also resulted in increased physical activity level after practicing yoga, again suggesting that middle-aged individuals with OA can achieve similar benefits from participating in yoga as older adults. However, the postural sway and flexibility results of this study differed from the outcomes of some earlier studies. In this study, the postural sway outcome measures obtained using the NeuroCom Balance Master® did not indicate significant improvement after participation in the yoga intervention. Also, lower body flexibility variables measured by goniometer indicated no significant improvement after participation in the intervention. However, earlier literature reported that participation in yoga exercise was associated with improvements in balance and flexibility in adults with OA.[28, 29, 31]

A possible explanation for the inconsistency of the balance findings of this study with previous literature may be related to differences in measurement techniques used to assess balance. The NeuroCom Balance Master® is a laboratory-based balance measure that provides a direct measure of postural sway, and indicator of balance, and yields a highly sensitive measure of sway around the center of gravity. The instrument measures sway in a much more sensitive manner than most other balance measures. Each of these measures has a different sensitivity to balance. In addition, during post-testing, five yoga participants complained that they had problems with either a knee or an ankle. This may have resulted in less ankle control, which is critical to performing the assessment tasks on the NeuroCom Balance Master®. There is no standard measure for postural stability or balance. In yoga studies relating to balance, a variety of balance measures were used. Some of them were self-report, functional measures such as single or double leg stand, walking, or ability to perform ADLs. Those studies that used field test or functional based tests as balance measure showed improvement in balance after the yoga intervention.[28, 29, 31] However, none of studies that assessed the effectiveness of a yoga intervention have measured sway as balance measures. Thus, studies using different measures may report different results. With regards to the lower body flexibility, the physical pain experienced by some participants during the post-test could have affected their flexibility. In summary, the fact that this study assessed balance (postural sway) and flexibility directly rather than by means of self-report or field test may help explain this inconsistency, since self-report and field assessments may produce greater measurement error. Also, the aspects of balance than was measured in this study (postural sway) may be different than the measures of balance used in previous studies.

In this study, the predictors of exercise included exercise self-efficacy, exercise intentions, and social support for exercise showed some improvement after practicing yoga for 8 weeks (pre- to post-test) and after participating in the relapse prevention intervention. Likewise, the yoga exercise adherence rate of the intervention group also showed some improvement after practicing yoga for 8 weeks and then participating in relapse prevention intervention when compared to the control group. Only a handful of studies have been conducted to assess the effectiveness of yoga exercise on exercise self-efficacy and other predictors of exercise. One study examined the effects of a Social Cognitive Theory-based Kundalini Yoga intervention on self-reported pain, stiffness, functional independence, self-efficacy for performing yoga, and frequency of yoga behaviors performed in the past week among arthritis patients.[14] The results indicated statistically significant difference only for increase in frequency of performing yoga behavior ($p<0.001$). However, self-efficacy for performing yoga and other outcome variables did not show any improvement after performing yoga for 6 weeks. To date, no studies have been performed on adults with OA to evaluate the effectiveness of a behavioral intervention that includes yoga exercise on exercise intention and social support for exercise. Therefore, to compare the results of the predictors of exercise and yoga exercise adherence rate from this study with the previous literature was difficult.

Overall, the results of this study showed that laboratory measures of balance showed no improvement, but the performance-based measure of balance improved significantly after participation in the yoga intervention. Therefore, the benefits achieved by participating in yoga exercise in the area of physical functional performance, pain, stiffness and physical activity level were consistent with the findings of previous studies; however, comparison of the results for the balance, flexibility, and predictors of exercise variables to the findings of the previous studies was inconsistent and inconclusive.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The objectives of this study were twofold. One objective was to determine the effect of participation in an 8-week yoga exercise program on pain, stiffness, physical functional performance, balance, flexibility, and physical activity level in middle aged adults with lower limb OA. The second objective was to assess the impact of participation in a relapse prevention intervention on predictors of exercise, yoga exercise adherence rate, and maintenance of beneficial effects of yoga exercise on physical health outcomes (pain, stiffness, physical function, balance, flexibility and physical activity level) at 1-month follow-up in middle aged adults with lower body OA. Several conclusions can be drawn from these results. Conclusions based on study results are organized by Research Question.

RQ1: Will participation in 8 weeks of Hatha yoga be associated with improved physical functional performance from pre to post yoga intervention in middle-aged adults with lower limb OA?

H_R1: Participation in Hatha yoga will be associated with improvement (increase) in physical functional performance from pre to post in middle-aged adults with lower limb OA.

This hypothesis was strongly supported by the study results. Comparison of the scores for Total Physical Function, Lower Body Strength, Balance and

Coordination and Physical Function WOMAC from pretest to posttest indicated significant improvement in all the physical functional performance variables in middle-aged adults with lower limb OA after participating in 8 weeks of Hatha yoga. A possible reason for the positive impact of yoga exercise on physical functional performance may be the low intensity, but challenging training activities involved in Hatha yoga that motivated the participants to attend the class regularly. Their 95% attendance rate contributed to making them more physically active in general. Different standing poses (asanas) involved in the exercise require constant use of leg and thigh muscles. This contributed to increased leg and thigh muscle work, thereby improving their lower body strength and balance. The gentle hand and body stretches could have enhanced their range of motion and muscle power, thus improving flexibility and strength. Practicing hatha yoga twice a week for 1 hour could have increased their stamina/endurance making them active enough to improve their overall physical functional performance. In addition, the sample included a fairly robust group of middle-aged adults. The mean age of the study population was 57. Other trials of yoga with positive effects on physical functional performance have also involved subject groups with mean ages of 50 years and older.[29, 30] Most participants of this study rated their health as good to excellent at the start of the study, and almost all the participants had no limitations with instrumental activities of daily living. These results should only be generalized to groups of relatively healthy middle-aged people.

RQ2: Will participation in 8 weeks of Hatha yoga be associated with reduced pain and stiffness from pre to post yoga intervention in middle-aged adults with lower limb OA?

H_R2: Participation in Hatha yoga will be associated with improvement (decrease) in pain & stiffness from pre to post intervention in middle-aged adults with lower limb OA.

This hypothesis also was strongly supported by the study results. Comparison of the scores obtained using the Pain WOMAC and Stiffness WOMAC from pretest to posttest indicated significant improvement in all the pain and stiffness variables from pre to post yoga intervention in middle-aged adults with lower limb OA after participating in 8 weeks of Hatha yoga. Again, a possible reason for the positive impact of yoga exercise on pain and stiffness may be the low intensity, but challenging training activities involved in Hatha yoga. Being physically active helps keep muscles and surrounding tissues strong, which is crucial to maintain and support joints and reduce pain and stiffness.

RQ3: Will participation in 8 week Hatha yoga be associated with in improved balance from pre to post yoga intervention in middle-aged adults with lower limb OA?

H_R3: Participation in Hatha yoga will be associated with improvement (decrease) in postural sway from pre to post intervention in middle-aged adults with lower limb OA.

The null hypothesis was retained for this research question in relation to NeuroCom Balance Master® scores for postural sway. Comparison of the scores for Sit-to-Stand, Tandem Walk, and Step Quick Turn from pretest to posttest indicated no significant improvement in these balance variables from pretest to posttest in middle-aged adults with lower limb OA after participating in 8 weeks of Hatha yoga. One of the possible explanations for the lack of change in laboratory measures of balance in this study may be the use of a balance test (NeuroCom Balance Master) that is much more sensitive than are the instruments used in most studies. Likewise, static and dynamic balance measures have been shown to measure different underlying constructs.[16] The NeuroCom Balance Master® measures sway in a more sensitive manner than field balance tests. The tests used in the previous literature did not take sway into account, only falls.[28, 29] Those studies typically used field based tests to measure balance. The NeuroCom Balance Master® measures the change in pressure applied to a force platform around the center of gravity, so it depends heavily on fine muscle control in the ankles and feet. During this test, subjects were placed in specific position that negates the compensatory mechanisms that often are used to maintain balance, such as the use of the hands, shifts in body position, and an increase in the width of the base of support. Performance measures of balance like those yielded by the CS-PFP allow for the use of compensatory strategies. Again, the NeuroCom

Balance Master® measures degrees of sway from the center of gravity, but the CS-PFP Balance and Coordination subscale is based on the performance of tasks that require balance in order to perform the tasks. This score is a prediction of balance based on an algorithm, not a direct measurement of balance. There is a clear need for further well designed studies that use the NeuroCom Balance Master® in order to more rigorously examine the effectiveness of yoga in improving postural sway among people with OA. Results of this study add to the growing literature supporting yoga as a beneficial form of exercise for people with arthritis, however, it does not indicate that yoga is associated with improvements in balance.

The other possible factor for non-significant change in the direct measures of balance could be related to the type of yoga practiced, the duration of the intervention, and dose of exercise (the amount of time practiced, level of intensity and frequency). Other forms of yoga, such as Kundalini yoga, incorporate dynamic yoga poses with precise body alignment. Therefore, this is good exercise for improving strength and flexibility of the lower leg muscle. Another form called Ashtanga yoga involves synchronizing breathing with a progressive and continuous series of postures to produce intense internal heat that may be a better exercise for improving balance, strength, and flexibility. In contrast, Hatha yoga is an easy-to-learn basic yoga with gentle stretches that is good for beginners. Therefore, it might require less balance and strength than the other styles. Nonetheless, the participants in the current study reported the program to be very challenging from a balance and memory perspective. According to their comments, the 8-week timeframe of class was not sufficient to memorize and practice all of the movements. In addition, a few yoga participants complained that they had problems with either a foot or knee during the post-testing. This may have resulted in less ankle control, which is critical to performing the assessment tasks on the Balance Master®.

RQ4: Will participation in an 8-week Hatha yoga intervention be associated with improvement in flexibility from pre to post yoga intervention in middle-aged adults with lower limb OA?

H_R4: Participation in Hatha yoga will be associated with improvement (increase) in flexibility from pre- to post-intervention in middle-aged adults with lower limb OA.

The null hypothesis was retained for this research question in relation to flexibility scores for the majority of the variables measured by goniometer. Comparison of the scores for Ankle Plantarflexion, Ankle Dorsiflexion, Knee Flexion, Knee Extension, Hip Flexion, and Hip Extension from pre-test to post-test indicated no significant improvement in flexibility variables over time with the exception of ankle dorsiflexion and knee flexion. One possible reason for the minimal changes in flexibility could be related to the type of yoga practiced, the duration of the intervention, and the total dose (the amount of time, frequency, and level of intensity) of yoga practiced. As specified earlier, other forms of yoga such as Kundalini and Ashtanga yoga incorporate dynamic yoga poses with precise body alignment or a progressive and continuous series of postures. These forms may be a better exercise for improving balance, strength, and flexibility. In contrast, Hatha yoga is an easy-to-learn basic yoga that is good for beginners that involves slow and gentle stretches. Therefore, it might require less flexibility, balance, and strength than the other styles. In other words, it might require more Hatha yoga practice to gain improvement in joint flexibility in adults with OA. Another possible reason could be the way the flexibility test was performed. During the flexibility testing, participants were instructed to actively perform flexion and extension through a maximum range of motion. Instead if they were asked to slowly flex or extend their joints through a comfortable range of motion, this may have produced greater changes in flexibility, especially, since this was young and self-reported healthy group of people. Since participants reported less pain and stiffness, the range of motion that could be produced with comfort may have increased more than their maximum range of motion.

RQ5: Will participation in 8 weeks of Hatha yoga be associated with an increase in physical activity level from pre to post yoga intervention in middle-aged adults with lower limb OA?

H_R5: Participation in Hatha yoga will be associated with improvement (increase) in physical activity level from pre to post intervention in middle-aged adults with lower limb OA.

This hypothesis was strongly supported by study results. Comparison of the total physical activity (PA) scores from pre-test to post-test indicate a significant increase in total PA from pre- to post-participation in in the Hatha yoga intervention in middle-aged adults with lower limb OA. Once again, the positive impact of yoga exercise on total PA may be related to the fact that the low intensity training activities involved in Hatha yoga can be accomplished relatively easily, while still producing benefits that motivate participants to continue class attendance. Also, improved overall physical function, fitness, and reduction in pain and stiffness levels after participating in regular yoga classes may have made regular activity easier to accomplish, which may have encouraged the participants to increase their PA level in general. In addition, change in season could also have influenced the PA level. During pre-testing the weather was cold (the month of February) and during post-testing the weather was warm and pleasant (the month of May). This alone may have lead to increased participation in regular activity.

RQ6: **Will participation in a relapse prevention intervention associated with improvement in exercise self-efficacy, exercise intention, and social support for exercise when compared to control group?**

H_R6: Participation in a relapse prevention intervention will be associated with improvement (increase) in exercise self-efficacy, exercise intention, and social support for exercise when compared control group.

The null hypothesis was retained for this research question in relation to predictors of exercise variables. Comparison of the scores for Exercise Self-efficacy, Exercise Intention, and Social Support for Exercise between the intervention and control groups after participating in a 4-week relapse prevention intervention indicates that there was no significant improvement from post-test to follow-up in middle-aged adults with lower limb OA. The possible reason for non-significant change in these variables could be the type of intervention activities, short intervention duration, and the limited dose (the amount of time and frequency) of intervention activities. Exercise self-efficacy showed improvement from pre-test to post-test after participating in yoga classes. The intrinsic value of improvements in their pain, stiffness, and physical function that were associated with yoga participation likely resulted in personal success experiences, whereas the intervention activities utilized vicarious experience (tips, advice) and social persuasion (encouraging communication), which are less potent sources of self-efficacy than personal behavioral success. Also, one email and a phone call once a week for 4 weeks may not be a sufficient stimulus for the participants to continue practicing yoga by themselves in an unstructured environment. To promote continuation of practicing yoga, a stronger stimulus control is needed. This appears to be critical to long-term adoption of yoga as an ongoing exercise modality after completion of the intervention. Some of the participants commented that "it is boring to practice yoga alone at home. It was fun when they did it in a class with a group of people." Some of them said 8 weeks of yoga practice was not enough for them to be familiar with all of the yoga poses that were taught and to practice them at home alone. As part of the relapse prevention intervention, participants were provided with information about affordable yoga classes offered in the Norman area. However, only 2 participants reported joining a yoga class after the intervention. As specified earlier, almost all the predictors of exercise showed an increase in scores after participating in the yoga intervention (from pre- to post-test) when compared to the relapse prevention intervention (from post- to follow-up). This could suggest that the greatest change in exercise predictors may be associated with the internalization of the benefits related to participation in yoga exercise compared to extrinsic reinforcements such as emails and phone calls.

RQ7: Will participation in a relapse prevention intervention be associated with an increase in the rate of continued participation in yoga exercise adherence when compared to control group?

H_R7: Participation in a relapse prevention intervention will be associated with a higher yoga exercise adherence rate when compared to control group.

The null hypothesis was retained for this research question in relation to the yoga exercise adherence rate. The total minutes of yoga practice per week and the number of weeks in which participants met the 120 minute/week goal for practice were not significantly different between the intervention and control groups. However, both measures were higher for intervention group when compared to the control group and the difference produced a medium effect size (Cohen's d>0.7). The possible reason for non-significant change in yoga exercise adherence rate could be related to the intervention duration and dose (the amount of time and frequency). As specified earlier, one email and a phone call once a week for 4 weeks may not be sufficient for participants to continue practicing yoga on their own, especially if they continued to experience residual benefits from participating yoga during the intervention throughout the follow-up period. Since many of the changes in clinical outcomes were maintained during the follow-up period, this may be the case. A stronger stimulus control (such as reminders, incentives or verbal reinforcements) that would trigger the exercise behavior is needed for promoting such exercises in adults with OA. This appears to be critical to long-term adoption of yoga as an ongoing exercise modality after completion of the intervention. Another likely possibility is the small sample size and low power for these analyses.

RQ8: Will the beneficial outcomes associated with participation in yoga be maintained at 1-month follow-up testing?

H_R8: The beneficial outcomes associated with yoga intervention will be maintained at 1-month follow-up.

This hypothesis was strongly supported by study results. Comparison of the results for physical health outcomes (physical function, pain, stiffness, balance, flexibility and physical activity) from post-test to follow-up indicate that participants maintained the beneficial effect of yoga practice at 1-month follow up. Moreover, there were no significant main effects from group and no group*time interaction for any of the variables, which suggests that both intervention and control group retained the benefits of yoga participation at 1-month follow-up. It is believed that retention of the benefits of participation in yoga exercise was a residual effect of the yoga intervention rather than the relapse prevention intervention. Even with a much lower dose of yoga (>75 minutes/week) participants retained the benefits gained after practicing 120 minutes/week of yoga for 8-weeks. However, the effects were beginning to decrease for many variables at follow-up. It is believed that if the follow-up period was extended, the beneficial results in the physical health outcome would have diminished further. This suggests that even a lower of yoga can be beneficial in maintaining some benefits related to physical function, pain, and stiffness in people with OA. However, to retain the full level of benefit, it appears that these individuals needed to maintain an exercise dose that was closer to the recommendation of 120 minutes of practice per week.

Significance of Results

The results from the study indicate that yoga exercise improved pain, stiffness, physical functional performance, the performance based measure of balance, and physical activity level of the participants after the yoga intervention. There was no statistically significant improvement in laboratory measures of balance and flexibility from pretest to posttest and from posttest to follow-up. Moreover, participation in the relapse prevention intervention was not associated with differences in predictors of exercise (exercise self-efficacy, exercise intention, and social support for exercise) and yoga exercise adherence rate when compared to the control group. While a large body of literature on yoga exercise demonstrated a variety of health benefits for yoga practitioners, the majority of the early literature involves anecdotal reports, and lacks scientific evidence from controlled studies.[12, 21] In this study, there was no significant improvement in the measures of postural sway. These results appear to be contradictory with regards to the results from previous literature, but this inconsistency is likely related to the highly sensitive measurement capability of the NeuroCom Balance Master® as compared to the performance based measures used in other studies. It should also be noted that the tasks performed during the measures of sway using the NeuroCom Balance Master® were not directly replicated during yoga training. Because of this, other areas of balance/sway that were not assessed in this study may have been more affected than the movements that were involved in testing.

Most of the previous studies mentioned a beneficial effect of yoga on pain, stiffness, physical function, balance, flexibility, and physical activity level.[27, 29, 32] In most of these studies, this conclusion was based on a pre-to post-intervention analysis. Some of the studies also failed to demonstrate evidence of the benefits of yoga on the above mentioned outcome variables. Varied results from different studies may result from the use of different measures to assess the outcome variables, different research designs, differences in the type of yoga practiced, and differences in the duration of interventions. Furthermore, non-significant changes in all of the predictors of exercise and yoga exercise adherence rate between members of the relapse prevention group versus the control group also were inconclusive when compared to previous literature. From previous literature it was found that the use of cell phones and text messaging are advantageous for promoting healthy behaviors because: (a) of their high penetration across income and ethnic groups; (b) they are popular, and convenient; and (c) information can be delivered quickly.[55] Behavior modification techniques, and specifically, stimulus control frequently have been incorporated into health behavior interventions.[56]

Strengths and Limitations:

This study had a number of strengths and limitations. The major strengths of the study are:

- use of a real world intervention site
- use of a sample from a younger age group than most of the previous studies, and
- use of information related to the predictors of exercise associated with yoga exercise
- use of direct/performance based protocols for many outcome measures

Some of the limitations are:

- use of convenient sampling for recruitment of participants,
- use of a control group for the relapse prevention intervention and not for the yoga intervention,
- use of small sample size even though it was actually larger than needed based on sample size computations,
- limitation in the generalizability based on the sample being predominantly caucasian,
- the interpretation of results for the predictors of exercise (exercise self-efficacy, exercise intention and social support for exercise) was difficult because each questionnaire reported a responses for a different time frame.

For example, exercise intention was measured for a time frame of next two months, while social support was measured for last three months, and

- use of Greenhouse-Geisser correction for testing the assumption of sphericity could have affected the interpretation of results. The Greenhouse-Geisser correction is believed by some to be an overly conservative test. Because of this, its use could result in incorrectly rejecting the null hypothesis if the assumption of sphericity is actually met.

The information gained in this research improves understanding of the impact of participation in Hatha yoga on postural stability, flexibility, pain, stiffness, physical functional performance, and physical activity level. However, more research needs to be conducted to expand our understanding of the relationship between yoga exercise and the above said outcome variables.

Recommendations for Future Research and Practice:

Currently, the existing literature provides only scattered evidence to support the positive effect of yoga on postural stability, flexibility, and physical activity level in this age group. Findings related to study outcomes in this study are inconsistent with previous literature because of wide variations in the participant populations, the type and duration of yoga exercise, and the choice of measurement tools used in the limited number of previous studies. Because of this, many questions are left unanswered. It is suggested that future studies focus on the following areas:

- comparison of participants of various age groups,
- identification of the optimal duration and frequency of yoga programs,

- search for the optimal yoga style or movements for improvement in balance, flexibility, physical function, and physical activity level,
- use of consistent and sensitive balance tests,
- use of larger, more diverse samples with extended training periods,
- comparison of the balance measures of CS-PFP and NeuroCom Balance Master®,
- use of mobile/email technology to confirm the study findings using a randomized between-subjects design with a larger sample size of older adults across different income levels, educational backgrounds, and ethnicities,
- assessment of the use of prompts delivered via cell phones to determine if they are a feasible, cost effective, and convenient method to increase physical activity among older adults with OA, and
- use of cell phones by practitioners to deliver reminder, informational, and even instructional prompts to patients and clients.

Major potential health benefits and the low-intensity movements of yoga have made it an increasingly popular exercise modality among older adults. There is evidence from previous research on the positive effects of yoga practice in improving pain, stiffness, balance, flexibility, physical functional performance and preventing falls in older people.[13, 21, 29, 31] This study also has documented the positive impact of yoga exercise on pain, stiffness and physical functional performance. Therefore, the consistent pattern observed in the current investigation with extended intervention period, can be used in the real world setting in the following ways:

- It would be beneficial to develop yoga exercise/ health promotion programs in worksites for middle-aged people and/or for senior citizens with arthritis as a means of improving physical functional performance and balance. The gentle movements, meditation, and relaxation associated with yoga exercise could also make them feel more relaxed, younger, and more agile and improve balance, flexibility physical function, and overall health and prevent falls.
- Yoga exercise programs could also be implemented as therapeutic applications for special populations, such as orthopedic patients. However, in this case, a more stringent research design is needed as the participants may be frail and require more supervision.
- Specific yoga movements from Ashtanga, Kundalini, Bikram, and Hatha yoga could be introduced into other types of exercise programs that are focused on reducing fall risks, pain, and stiffness, and improving balance, flexibility, and physical function in older or middle-aged adults with arthritis. The slow and gentle stretches with regulated breathing are designed to improve posture, balance, muscle mass, flexibility, stamina, and strength, while omitting the more physically vigorous poses of some other styles.
- Including health education classes to a yoga intervention would help participants to prepare for relapse prevention. The classes may include topics such as discussing challenges to continued yoga practice, strategies on how to overcome challenges, identifying location of yoga practice at home, etc.
- Mobile technology for prompt delivery may be another cost-effective way to promote behavior change that warrants future research. Using behavior

modification strategies such as stimulus control along with yoga interventions would be an effective method for increasing physical activity.

In all of the above practices, yoga exercise can be easily integrated as a health promotion program in different settings. However, it is important to identify a type of yoga that focuses on improvement of balance, flexibility, and physical function. Duration and dose (amount of time practiced, level of intensity, and frequency) of the intervention were not consistently reported, making it difficult to know exactly what level of practice (dose of intervention) might be needed to achieve maximum results.

Summary

In conclusion, the findings from this study indicate that participation in an 8 week yoga class can improve physical functional performance, reduce pain and stiffness, improve performance based balance, and increase physical activity level significantly in community dwelling middle aged adults with OA. Yoga incorporates the advantages of a low cost and versatile training activity that can be suggested for elderly people for prevention of falls.[40] Results of this study add to the growing literature supporting yoga as a beneficial form of exercise for middle aged people with arthritis. It has the strength of documenting the health benefits of yoga exercise using a more stringent research design, compared with previous studies. Future research is advised to further explore the most beneficial modes of yoga, particularly for the middle-aged adults with arthritis. Regarding future research on behavioral interventions, practitioners should consider using cell phones to deliver reminder, informational, and even instructional prompts to patients and clients.

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APPENDIX - A

- **IRB Approval**
- **Recruitment Announcement**
- **Screening Questions**
- **Screening Questions for undiagnosed OA**
- **Medical History form**
- **Medical Clearance Form**
- **Informed Consent**
- **Demographic Information**

IRB Approval

The UNIVERSITY of OKLAHOMA

Institutional Review Board for the Protection of Human Subjects

Approval of Initial Submission – Expedited Review – AP01

Date: January 07, 2015

IRB#: 5078

Principal Investigator: Susan Zacharia, MS

Approval Date: 01/07/2015

Expiration Date: 12/31/2015

Study Title: THE EFFECT OF AN 8-WEEK YOGA EXERCISE PROGRAM AND RELAPSE PREVENTION PROGRAM ON PAIN, PHYSICAL FUNCTION, BALANCE, STRENGTH, FLEXIBILITY, PHYSICAL ACTIVITY LEVEL, AND PREDICTORS OF EXERCISE IN ADULTS WITH OSTEOARTHRITIS

Expedited Category: Categories 4 & 7

Collection/Use of PHI: Yes

On behalf of the Institutional Review Board (IRB), I have reviewed and granted expedited approval of the above-referenced research study. To view the documents approved for this submission, open this study from the *My Studies* option, go to *Submission History*, go to *Completed Submissions* tab and then click the *Details* icon.

As principal investigator of this research study, you are responsible to:

- Conduct the research study in a manner consistent with the requirements of the IRB and federal regulations 45 CFR 46.
- Obtain informed consent and research privacy authorization using the currently approved, stamped forms and retain all original, signed forms, if applicable.
- Request approval from the IRB prior to implementing any/all modifications.
- Promptly report to the IRB any harm experienced by a participant that is both unanticipated and related per IRB policy.
- Maintain accurate and complete study records for evaluation by the HRPP Quality Improvement Program and, if applicable, inspection by regulatory agencies and/or the study sponsor.
- Promptly submit continuing review documents to the IRB upon notification approximately 60 days prior to the expiration date indicated above.
- Submit a final closure report at the completion of the project.

If you have questions about this notification or using IRIS, contact the IRB @ 405-325-8110 or irb@ou.edu.

Cordially,

Fred Beard, Ph.D.
Vice Chair, Institutional Review Board

Recruitment Announcement

(The University of Oklahoma is an equal opportunity institution)

Are you an adult with osteoarthritis who is 40-65 years old?

Are you interested in participating in a research study that looks at the effect of yoga exercise on pain, physical function, balance, flexibility, strength and physical activity level?

The intervention will include 8 weeks of yoga classes in the Huston Huffman Center of University of Oklahoma. You will be asked to complete 6 questionnaires and a series of activities that evaluate your physical functional performance, postural stability, strength and flexibility. Postural stability will give your current balance status and the physical functional performance will evaluate your status to perform your activities of daily living (ADL).

If you are interested, please contact:

Susan Zacharia

szacharia@ou.edu

Department of Health and Exercise Science

405-325-5211

Screening Questions

I'm glad you are interested in participating in the study with us. I need to ask you a few questions before we schedule a time for testing.

****Ask questions 2-5 then inform the caller if they are eligible. ****

1. What is your name? ____

2. How old are you? ____

Y N **If caller age <40 or >65** then the caller is not eligible for participation.

3. Has your health care provider diagnosed you with osteoarthritis? _____

Y N **If no**, use the screening questions for undiagnosed OA patients

4. How long have you been experiencing these symptoms? _____________

Y N **If the caller answered < 6 months,** then they do not meet the criteria for participation.

5. Have you ever had joint replacement surgery? __________________

Y N **If yes,** then they need to get medical clearance from their doctor

6. Are you currently limited in the type or amount of physical activity (work or leisure) you can do because of osteoarthritis?

Y N **If yes,** then they need to get medical clearance from their doctor

7. Has a physician ever said you have a heart condition and you should only do physical activity recommended by a physician?

Y N **If yes,** then they need to get medical clearance from their doctor

8. During physical activity, do you feel pain in your chest?

Y N **If yes,** then they need to get medical clearance from their doctor

9. Do you ever lose you consciousness or do you lose your balance because of dizziness?

Y N **If yes,** then they need to get medical clearance from their doctor

10. Is your physician currently prescribing medication for your blood pressure or heart condition?

Y N **If yes,** then they need to get medical clearance from their doctor

11. Do you currently exercise? Yes _________ No_______

If yes, What do you do? ______________________________

How often? ___________________________________

How long? ____________________________________

If caller participates in moderate intensity aerobic activity 30 minutes a day, five days a week or at least 150 minutes a week, then they do not meet the criteria for participation

If the caller meets all of the criteria,

Then schedule appointment

When is a convenient time to schedule for testing? __________________

Screening Criteria for Undiagnosed OA Individuals (5/7)

1. Do you feel persistent pain in one or more joints, which worsens with movement or activity?
   - Yes
   - No
2. Do you feel stiffness in your joints when you first wake in the morning or sit for a long time?
   - Yes
   - No
3. Does one or more of your joints appear swollen and/or tender or feel warm to the touch?
   - Yes
   - No
4. Have you noticed a change in the range of motion of any of your joints?
   - Yes
   - No
5. Do you feel grating sensation or crackling or popping sound in your joints?
   - Yes
   - No
6. Do you get pain relief from anti-inflammatory medications (i.e. aspirin or ibuprofen)?
   - Yes
   - No
7. Do other members of your family have arthritis?
   - Yes
   - No

Medical History

Name: ________________________ Date: ____________________

Age: ______________________

Participation in this study involves a series of activities that are similar to those performed in everyday life. However, whenever timed activities are carried out, there is the possibility that you may push yourself beyond "normal activity level". All activities are self-pace, so you can control the time taken to complete the task. You can rest between tasks if desired and safety precautions (use of spotters) will be used to minimize the chance of fall during performance of tasks. Still, we want to determine if you have any conditions that require caution when performing even activities of daily living.

Completion of this questionnaire is important to determine if you need to get clearance from your physician to participate. Please consider each question carefully and answer every question honestly.

1. In general how would you describe your current, overall state of health?

a. Excellent b. Good

c. Fair d. Poor

2. Has your health care provider diagnosed you with any other condition other than osteoarthritis?

a. Yes b. No

4. Are you currently limited in the type or amount of physical activity (work or leisure) you can do because of osteoarthritis?

a. Yes b. No

5. Has a physician ever said you have a heart condition and you should only do physical activity recommended by a physician?

a. Yes b. No

5. During physical activity, do you feel pain in your chest?

a. Yes b. No

6. Do you ever lose you consciousness or do you lose your balance because of dizziness?

a. Yes b. No

7. Do you think that a change in your physical activity may worsen your pain?

a. Yes b. No

8. Has your doctor ever told you that you should limit lifting or stair climbing?

a. Yes b. No

9. Is your physician currently prescribing medication for your bold pressure or heart condition?

a. Yes b. No

If you have answered yes to any of the above question or have been diagnosed of any health problem, you must obtain clearance from your doctor BEFORE you can volunteer for this study. We can assist you in this process. If you have honestly answered no to all questions, you can be reasonably positive that you can safely participate without physical risk.

I have read these items carefully and answered all questions truthfully.

Participants Signature: ________________________________ Date: _____________

Department of Health and Exercise Science - University of Oklahoma-Norman Campus

The Effect of an 8-week Yoga Exercise and a 4 week Relapse Prevention Program on Pain, Physical Function, Balance, Flexibility, Physical Activity Level, Predictors of Exercise and Exercise Adherence in Adults with Osteoarthritis

MEDICAL CLEARANCE FORM

To the Attending Physician of: ________________________________

This individual has indicated that she wishes to participate in a research study investigating the impact of yoga participation on pain, physical function, balance, strength, flexibility and physical activity level. This project has been approved by the Institutional Review Board at the University of Oklahoma.

Description of the Study: Participants will complete three questionnaires and complete a series of 10 activities (Physical Functional Performance test) that are designed to simulate activities of daily living, 5 tasks that are designed to evaluate moving balance and perform leg press and bench press to evaluate upper and lower body strength. All tests will be conducted in the Functional Assessment Lab in the Department of Health and Exercise Science, which has a set-up typical to a "normal" home environment, but is free of hazards and has restricted access during testing.

Physical Function: Subjects will participate in 10 structured, timed activities. The activities that make up the PFP are designed to replicate regular activities of daily living such as laundry tasks, sweeping the floor, and carrying groceries that will help estimate your level physical functioning. These activities progress from fairly easy tasks (low effort) to more challenging tasks (high effort). The specific testing protocols include:

Low effort tests include: (1) **weight carry** – movement of a pan carrying a designated weight from one counter surface to another; (2) **jacket** – pick up a jacket from a location, put it on, close the front, and remove the jacket and place it back in the original location; and (3) **reach** – reach as high as possible (untimed) and pace a sponge on the highest shelf that can be reached without loss of balance

Medium effort tests include: (1) **floor sweep** – sweep ½ cup of material from floor and collect in a dust pan and then place dust pan on a counter top; (2) **laundry 1** – open washer and transfer clothes and 9 lbs of sand weight from washer to dryer and then close dryer door and **laundry 2** – open dryer and remove only the clothes from the dryer and place them in a clothes basket, place the filled clothes basket on the counter; and (3) **scarves** – from a standing location, pick up 4 scarves from the floor and return to the original standing location

Hard effort tests include: (1) **floor down/up** – from a standing position, sit down on the floor, stretch legs out in front, and then stand placing hands at the side (a chair may be use for balance); (2) **grocery** – in a simulated space, carry a weighted grocery bag to the bus stop, up and down the steps, walk back to the "house", open the door, enter and place the bag on the counter top; (3) **stair climb** – walk up one flight of stairs; hand rail may be used for balance, but should not be used to pull body weight up the stairs; and (4) **endurance walk** – walk as far as possible in 6 minutes

Performance-based Measures of Balance and Sway: The NeuroCom BalanceMaster® will be used to assess balance and sway. The protocols are broken down into two categories, Impairment (standing still) and Functional (moving), depending on the aspect of balance the test measures. Balance measures will be taken while performing 5 tasks on a force platform (measures changes in surface pressure and force due to body movement). All balance tests will be closely monitored with at least 1 spotter to guard against falls. The balance tests include:

a. **Tandem Walk (TW)** – quantifies characteristics of gait as the patient walks heel to toe from one end of the forceplate to the other. Measured parameters are step width, speed, and endpoint sway velocity. **Tandem walk Conditions:** Three trials were performed in which the subject was asked to walk heels to toe of forceplate.

b. **Forward Lunge (FL)** – quantifies movement characteristics as the patient lunges or steps forward onto one leg, then pushes back with that leg to return to a standing position. The parameters measured are distance, time, impact index (impact force), and force impulse. **Forward Lunge Conditions.:** Three trials were performed in which the subject steps forward onto one leg, then pushes back with that leg to return to a standing position.

c. **Sit-to-Stand (STS)** – quantifies several movement characteristics as the subject rises from a seated to a standing position including: weight transfer time, rising index (force exerted to rise), and sway velocity. **Sit-to-Stand Conditions**. Three trials were performed in which the subject sat on a wooden box and then stood up as quickly as possible when cued.

d. **Step/Quick Turn (SQT)** – quantifies two movement characteristics as the subject takes two forward steps, quickly turns 180 degrees, and steps back to the start location. The measured parameters are turn-time and turn-sway velocity. **Step/Quick Turn Conditions**. The SQT assessment consists of three trials of both conditions: left foot first and right foot first.

e. **Step up Over (SUO)** – quantifies motor control characteristics as the individual steps up onto a curb with one foot, lifting the body through an erect standing position over the curb, swings the other foot over the curb, and then lowers the body to land the swing leg on the forceplate. Measured parameters are rising index (force to rise), movement time, and impact index (control of impact force descending onto the swing leg). **Step up Over Conditions**. The SUO assessment consists of three trials of both conditions: left foot first and right foot first.

Upper body and lower body strength - 1-RM bench press and 1-RM leg press will be used to measure upper body and lower body strength. In both tests the participants will be asked to perform an adequate warm up with 5-10 reps of a light-to-moderate weight, then after a minute rest perform two heavier warm-up sets of 2-5 reps, with a two-minute rest between sets. The participant should then rest two to four minutes, and then perform the one-rep-max attempt with proper technique. If the lift is successful, the participant will rest for another two to four minutes and attempt another lift after an increase in load of 5-10%. This process will be repeated until a 1RM is established. If the lift is unsuccessful, the participant will rest two to four minutes and attempt a lift with a weight that is 2.5-5% lower than the unsuccessful lift. This process will be repeated until a 1RM is established. Finally, the maximum weight lifted will be recorded.

Risks Associated with Participation:

Sometimes, when timed activities are carried out, there is the possibility that participants may push themselves beyond their "normal" activity level, and as a result, experience temporary muscle fatigue and soreness. However, all testing activities are self-paced, so the subject can control both the time taken to complete tasks and the amount of weight that is lifted during tasks that include lifting and carrying activities. The tester will inform the subject that he/she can rest between tasks if desired and safety precautions (use of spotters and transfer belts) will be used minimize the possibility of fall during performance of the testing tasks.

Please advise the researcher regarding any physical limitations and/or contraindications that this patient might have for engaging in these test activities.

Please check one of the following conditions.

_____ To my knowledge, there is no reason why this patient, should not be allowed to participate in this study. I recommend that he/she be allowed to participate in the study

_____ I recommend that this patient, _______________, be allowed to participate in the study with the following restrictions:_________________________________

_____ I recommend that this patient, __________________________, **should not** be allowed to participate in the study.

_________________________ _______________

Physician's Signature Date

If you have any questions, please contact: E. Laurette Taylor, Ph.D.,

Associate Professor and Director,

The Functional Assessment Laboratory

405-325-5211

University of Oklahoma

Institutional Review Board

Informed Consent to Participate in a Research Study

Project Title:	**The effect of an 8-week yoga exercise program and a 4-week relapse prevention program on pain, physical function, balance, flexibility, physical activity levels, predictors of exercise and exercise adherence in adults with osteoarthritis**
Principal Investigator:	Susan Zacharia
Department:	Department of Health and Exercise Science

You are being asked to volunteer for this research study. This study is being conducted at the University of Oklahoma. You were selected as a possible participant because you are a man or woman who is between 40-64 years of age with osteoarthritis.

Please read this form and ask any questions that you may have before agreeing to take part in this study.

Purpose of the Research Study

The purpose of this study is to determine the relationship between yoga exercise and
(i) improvement in the physical function, balance, strength, flexibility and physical activity, and (ii) reduction in pain & stiffness. This study will also determine if relapse prevention intervention will help increase yoga exercise adherence rate, self-efficacy, intention and social support after the completion of yoga intervention.

Number of Participants

About 50 people will take part in this study.

Procedures

If you agree to be in this study, you will be asked to participate in two interventions: Yoga intervention and Relapse prevention intervention.
During the yoga intervention you will be asked to attend yoga exercise class twice a week for 8 weeks. After the completion of 8 week yoga intervention you will be randomly assigned to a relapse prevention group or control group. During the relapse prevention intervention you will receive weekly emails and bi-weekly phone calls for 8 weeks to encourage you to continue doing yoga after the completion of yoga intervention. You will also be asked to complete and submit

weekly yoga practice log for 8 weeks. During the pre-, post- and follow up testing procedure you will be asked to do the following:

i) Allow researcher to measure your body weight and height using standard scale.

ii) Perform a series of tasks on the NeuroCom Balance Master (a flat device that lies on the floor that measures changes in the surface pressure and force due to the body movement) to measure balance. All balance tests will be closely monitored with at least 1 spotter to guard against falls. The series of activities used to measure balance will include a sit to stand test ***(STS),*** tandem walk ***(TW),*** a step/quick turn ***(SQT),*** step-up/over ***(SUO),*** and forward lunge ***(FL).***

iii) Perform10 household tasks using Continuous Scale-Physical Functional Performance (CS-PFP 10) Test to measure the physical function. The test includes functional measures of tasks typically required for independent living. Tasks are quantified by time, weight and distance. You will be asked to perform 10 different tasks categorized into low, medium and high difficulty. You will do ***three low difficulty tasks*** such as, carrying a weighed pot a distance of 1 meter, donning and removing a jacket and place and remove a sponge from a shelf; ***three moderate difficulty tasks*** i.e. laundering, sweeping, and pick up four scarves from the floor and ***four high difficulty tasks*** like and standing up from the floor, carrying groceries, climbing stairs and six minutes' walk.

iv) Perform measurement to flexibility (ROM) will be measured bilaterally for hip, and knee, using a goniometer. This measurement will be taken for extension and flexion of hip and knee. For strength testing 1-RM bench press and 1-RM leg press will be used to measure upper body and lower body strength.

v) Complete few questionnaires to evaluate your current perceived pain using the ***WOMAC scale*** which asks 24 questions to determine your physical function, pain & stiffness. ***SF-MPQ*** will also be used to evaluate pain. For evaluating your physical activity level, ***IPAQ*** (27 questions) will be used which measure the participant's current physical activity participation. To evaluate your exercise self-efficacy, intention and social support measures ***Exercise Self-efficacy Scale***, ***Exercise Intention Scale*** and ***Social Support for Exercise*** survey will be used respectively.

Length of Participation: The total time taken to complete the four tests and questionnaires will be approximately 2 hours. The study is 16 weeks long which includes participation in yoga exercise class twice a week for 8 weeks and for the remaining 8 weeks you will be asked to continue practicing yoga by yourself (at least 30 minutes a week for 4 times or 120 minutes a week). You will also be asked to complete yoga exercise logs for 8 weeks that should take about 5 minutes per week.

Risks of being in the study: There is the possibility that you could lose your balance and fall while doing yoga exercise and balance/physical function tasks. In order to reduce risk, we will have a person as a spotter during all the sessions.

Benefits of being in the study: Gaining better understanding of how yoga exercise could improve your balance, physical function, strength, flexibility and pain.

Compensation: You will not be reimbursed for your time and participation in this study.

Injury: In case of injury or illness resulting from this study, emergency medical treatment is available. However, you or your insurance company will be expected to pay the usual charge from this treatment. The University of Oklahoma Norman Campus has set aside no funds to compensate you in the event of injury.

Confidentiality: In published reports, there will be no information included that will make it possible to identify you. Research records will be stored securely and only approved researchers will have access to the records. There are organizations that may inspect and/or copy your research records for quality assurance and data analysis. These organizations include the OU Institutional Review Board.

Rights: Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You can discontinue the participation at any time without penalty.

Voluntary Nature of the Study

Participation in this study is voluntary. If you withdraw or decline participation, you will not be penalized or lose benefits or services unrelated to the study. If you decide to participate, you may decline to answer any question and may choose to withdraw at any time.

Contacts and Questions

If you have concerns or complaints about the research, the researcher(s) conducting this study can be contacted at

Susan Zacharia
Phone: (405) 338-8065
Email: szacharia@ou.edu

Dr. E. Laurette Taylor
Phone: (405) 325-5211
Email: eltaylor@ou.edu

Contact the researcher(s) if you have questions or if you have experienced a research-related injury.

If you have any questions about your rights as a research participant, concerns, or complaints about the research and wish to talk to someone other than individuals on the research team or if you cannot reach the research team, you may contact the University of Oklahoma – Norman Campus Institutional Review Board (OU-NC IRB) at 405-325-8110 or irb@ou.edu.

You will be given a copy of this information to keep for your records. If you are not given a copy of this consent form, please request one.

Statement of Consent

I have read the above information. I have asked questions and have received satisfactory answers. I consent to participate in the study.

Participant Signature Print Name Date

Signature of Person Obtaining Consent
Date

Print Name of Person Obtaining Consent

Demographic Information Form

1. What is your age? _____ (years)
2. What is your gender? ________ (M/F)
2. What is your marital status?
   - Married
   - Separated
   - Divorced
   - Widowed
   - Single / Never Married
3. What would you perceive to be your ethnicity? ____________________
4. What is the highest level of education you have completed?
   - Never attended school
   - Elementary school (Grades 1-8)
   - Some high-school (Grades 9-11)
   - High school diploma (Grades 12-GED)
   - College or University diploma (College 1 year to 3 years)
   - Graduate or professional degree (College 4 years or more)
5. Which of the following best describes your current employment status?
   - Employed full time
   - Employed part-time
   - Home duties
   - Unemployed
   - Full time student
   - Part-time student
   - Retired
   - Permanently ill/ unable to work
6. Which of the following categories does your total gross annual household income from all sources fall into? That is the total income from all members of your household before tax is deducted:
   - Less than $10,000
   - $10,001 - $20,000
   - $20,001 - $40,000
   - $40,001 - $60,000
   - $60,001 - $80,000
   - Over $80,000
   - Don’t know

APPENDIX - B

- **WOMAC Questionnaire**
- **International Physical Activity Questionnaire (IPAQ)**
- **Exercise Self-efficacy Scale**
- **Exercise Intention Scale**
- **Social Support for Exercise**
- **Participant Satisfaction Survey**
- **Yoga Practice Log**

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)

Name:____ Date:_______________

Instructions: Please rate the activities in each category according to the following scale of difficulty: 0 = None, 1 = Slight, 2 = Moderate, 3 = Very, 4 = Extremely

Circle **one number** for each activity

Pain	1. Walking	0	1	2	3	4
	2. Stair Climbing	0	1	2	3	4
	3. Nocturnal	0	1	2	3	4
	4. Rest	0	1	2	3	4
	5. Weight bearing	0	1	2	3	4
Stiffness	1. Morning stiffness	0	1	2	3	4
	2. Stiffness occurring later in the day	0	1	2	3	4
Physical Function	1. Descending stairs	0	1	2	3	4
	2. Ascending stairs	0	1	2	3	4
	3. Rising from sitting	0	1	2	3	4
	4. Standing	0	1	2	3	4
	5. Bending to floor	0	1	2	3	4
	6. Walking on flat surface	0	1	2	3	4
	7. Getting in / out of car	0	1	2	3	4
	8. Going shopping	0	1	2	3	4
	9. Putting on socks	0	1	2	3	4
	10. Lying in bed	0	1	2	3	4
	11. Taking off socks	0	1	2	3	4
	12. Rising from bed	0	1	2	3	4
	13. Getting in/out of bath	0	1	2	3	4
	14. Sitting	0	1	2	3	4
	15. Getting on/off toilet	0	1	2	3	4
	16. Heavy domestic duties	0	1	2	3	4
	17. Light domestic duties	0	1	2	3	4

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE
(October 2002)

LONG LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health–related physical activity.

Background on IPAQ
The development of an international measure for physical activity commenced in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ
Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation
Translation from English is encouraged to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Further Developments of IPAQ
International collaboration on IPAQ is on-going and an ***International Physical Activity Prevalence Study*** is in progress. For further information see the IPAQ website.

More Information
More detailed information on the IPAQ process and the research methods used in the development of IPAQ instruments is available at www.ipaq.ki.se and Booth, M.L. (2000). *Assessment of Physical Activity: An International Perspective*. Research Quarterly for Exercise and Sport, 71 (2): s114-20. Other scientific publications and presentations on the use of IPAQ are summarized on the website.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?

☐ Yes

☐ No → ***Skip to PART 2: TRANSPORTATION***

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.

_____ **days per week**

☐ No vigorous job-related physical activity → ***Skip to question 4***

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?

_____ **hours per day**
_____ **minutes per day**

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

_____ **days per week**

☐ No moderate job-related physical activity → ***Skip to question 6***

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

_____ **hours per day**
_____ **minutes per day**

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.

_____ **days per week**

☐ No job-related walking → ***Skip to PART 2: TRANSPORTATION***

7. How much time did you usually spend on one of those days **walking** as part of your work?

_____ **hours per day**
_____ **minutes per day**

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

_____ **days per week**

☐ No traveling in a motor vehicle → ***Skip to question 10***

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle?

_____ **hours per day**
_____ **minutes per day**

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

☐ No bicycling from place to place → ***Skip to question 12***

11. How much time did you usually spend on one of those days to **bicycle** from place to place?

_____ **hours per day**
_____ **minutes per day**

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

☐ No walking from place to place → ***Skip to PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY***

13. How much time did you usually spend on one of those days **walking** from place to place?

_____ **hours per day**
_____ **minutes per day**

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?

_____ **days per week**

☐ No vigorous activity in garden or yard → ***Skip to question 16***

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?

_____ **days per week**

☐ No moderate activity in garden or yard → ***Skip to question 18***

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

_____ **days per week**

☐ No moderate activity inside home → *Skip to PART 4: RECREATION, SPORT AND LEISURE-TIME PHYSICAL ACTIVITY*

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

_____ **hours per day**
_____ **minutes per day**

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ **days per week**

☐ No walking in leisure time → *Skip to question 22*

21. How much time did you usually spend on one of those days **walking** in your leisure time?

_____ **hours per day**
_____ **minutes per day**

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

_____ **days per week**

☐ No vigorous activity in leisure time → *Skip to question 24*

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

_____ **hours per day**
_____ **minutes per day**

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

_____ **days per week**

☐ No moderate activity in leisure time → *Skip to PART 5: TIME SPENT SITTING*

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

_____ **hours per day**
_____ **minutes per day**

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ **hours per day**
_____ **minutes per day**

27. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

_____ **hours per day**
_____ **minutes per day**

This is the end of the questionnaire, thank you for participating.

Exercise Self-efficacy Scale

Participant ID: ________________ Pre ___ Post ___ Follow up ___

***Response format:** A number of situations are described below that can make it hard to stick to exercise regularly. On the items below, please rate your confidence that you can perform yoga exercise on a regular basis by circling a number from 0 to 10 using the scale below:*

0	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
I cannot do this activity										**I am certain that I can do**

Please rate how sure you are that you can get yourself to practice yoga regularly (four times a week for at least 30 minutes).

	I cannot do this activity										I am certain that I can do
1. When you are feeling tired	0	1	2	3	4	5	6	7	8	9	10
2. When you are feeling under pressure from work	0	1	2	3	4	5	6	7	8	9	10
3. During bad weather	0	1	2	3	4	5	6	7	8	9	10
4. After recovering from an injury that caused you to stop exercising	0	1	2	3	4	5	6	7	8	9	10
5. During or after experiencing personal problems	0	1	2	3	4	5	6	7	8	9	10
6. When you are feeling depressed	0	1	2	3	4	5	6	7	8	9	10
7. When you are feeling anxious	0	1	2	3	4	5	6	7	8	9	10
8. After recovering from an illness that caused you to stop exercising	0	1	2	3	4	5	6	7	8	9	10
9. When you feel physical discomfort when you exercise	0	1	2	3	4	5	6	7	8	9	10
10. After a holiday	0	1	2	3	4	5	6	7	8	9	10
11. When you have too much work to do at home	0	1	2	3	4	5	6	7	8	9	10
12. When visitors are present	0	1	2	3	4	5	6	7	8	9	10
13. When there are other interesting things to do	0	1	2	3	4	5	6	7	8	9	10
14. If you don't reach your exercise goals	0	1	2	3	4	5	6	7	8	9	10
15. Without support from your family or friends	0	1	2	3	4	5	6	7	8	9	10
16. During a holiday	0	1	2	3	4	5	6	7	8	9	10
17. When you have other time commitments	0	1	2	3	4	5	6	7	8	9	10
18. After experiencing family problems	0	1	2	3	4	5	6	7	8	9	10

Exercise Intention Scale

Participant ID: ________________ **Pre ___ Post ___ Follow up ___**

Questions in this survey make use of rating scales with 7 places; you are to circle the number that best describes your opinion.
For example, if you were asked to rate "The taste of the chocolate fudge" on such a scale, the 7 places should be interpreted as follows: The taste of the chocolate fudge is:

good :__1___:___2___:___3____:___4___:__5___:__6__:__7__: bad

extremely quite slightly neither slightly quite extremely

<u>There is no right or wrong answers.</u>

- ***Be sure to answer all items-please do not omit any***
- ***Never circle more than one number on a single scale***

1. I intend to engage in yoga exercise for at least 30 minutes, 4 times a week for next 2 months.
   Strongly disagree: __1__:__2_:__3__:__4__:__5__:__6_:__7_: Strongly agree

2. I will try to engage in yoga exercise for at least 30 minutes, 4 times a week for next 2 months.
   Strongly disagree: __1__:__2_:__3__:__4__:__5__:__6_:__7_: Strongly agree

3. I am determined to engage yoga exercise for at least 30 minutes, 4 times a week for next 2 months.
   Strongly disagree: __1__:__2_:__3__:__4__:__5__:__6_:__7_: Strongly agree

SOCIAL SUPPORT AND EXERCISE SURVEY

Participant ID: ________________ **Pre ____ Post ____ Follow up ____**

Below is a list of things people might do or say to someone who is trying to exercise regularly. If you are not trying to exercise, then some of the questions may not apply to you, but please read and give an answer to every question.

Please rate each question twice. Under family, rate how often anyone living in your household has said or done what is described during the last three months. Under friends, rate how often your friends, acquaintances, or coworkers have said or done what is described during the last three months.

Please write one number from the following rating scale in each space:

none	rarely	a few times	often	very often	does not apply
1	2	3	4	5	6

During the past three months, my family (or members of my household) or friends:

	Family	Friends
1. Exercised with me.		
2. Offered to exercise with me.		
3. Gave me helpful reminders to exercise ("Are you going to Exercise tonight").		
4. Gave me encouragement to stick with my exercise program.		
5. Changed their schedule so we could exercise together.		
6. Discussed exercise with me.		
7. Complained about the time I spend exercising.		
8. Criticized me or made fun of me for exercising.		
9. Gave me rewards for exercising (bought me something or gave. me something I like).		
10. Planned for exercise on recreational outings.		
11. Helped plan activities around my exercise.		
12. Asked me for ideas on how they can get more exercise.		
13. Talked about how much they like to exercise.		

Participant Satisfaction Survey

Yoga Training session

1. Please tell us how much you liked the following aspects of the "Yoga" program

	Like Very Much	Like Some-what	Neither Like or Dislike	Dislike Some what	Dislike Very Much	Don't Know
Organization of session	☐	☐	☐	☐	☐	☐
Length of each session	☐	☐	☐	☐	☐	☐
Start and end time of each session	☐	☐	☐	☐	☐	☐
Training location	☐	☐	☐	☐	☐	☐
Outreach information	☐	☐	☐	☐	☐	☐
Eligibility requirements	☐	☐	☐	☐	☐	☐
Parking availability	☐	☐	☐	☐	☐	☐
Other (please describe ....)	☐	☐	☐	☐	☐	☐

2. Please tell us what you thought about the training activities and trainer:

	Like Very Much	Like Some-what	Neither Like or Dislike	Dislike Some what	Dislike Very Much	Don't Know
A. Delivery of training						
Exercise classes	☐	☐	☐	☐	☐	☐
B. The trainer						
Cultural sensitivity	☐	☐	☐	☐	☐	☐
Knowledge of materials	☐	☐	☐	☐	☐	☐
Preparedness	☐	☐	☐	☐	☐	☐
Time used effectively	☐	☐	☐	☐	☐	☐

3. How much of the yoga training was:

	Some	All	None
New	☐	☐	☐
Review	☐	☐	☐
Not relevant	☐	☐	☐

4. What, if anything, would you add to the training?

____

____

5. What, if anything, would you eliminate from the training?

____

____

6. Did the training meet your expectations?
☐ Exceeded expectations
☐ Met expectations
☐ Sort of met expectations
☐ Did not meet expectations
☐ Don't Know

7. Any additional comments?

____

____

Relapse Prevention Training Information

8. Please tell us what you thought about the training activities:

	Like Very Much	Like Some-what	Neither Like or Dislike	Dislike Some what	Dislike Very Much	Don't Know
A. Delivery of training						
Emails	☐	☐	☐	☐	☐	☐
Phone calls	☐	☐	☐	☐	☐	☐

9. For each topic, please indicate if you have used the information provided and how useful the information on this topic has been:

	Very Useful	Some what Useful	Neither	Not Very Useful	Not at All Useful	No, Didn't Use
Learning about long term OA self-care	☐	☐	☐	☐	☐	☐
Managing an effective yoga routine	☐	☐	☐	☐	☐	☐
Improving goal-setting	☐	☐	☐	☐	☐	☐
Establishing social support	☐	☐	☐	☐	☐	☐
Improving exercise self-efficacy	☐	☐	☐	☐	☐	☐

10. Which topic in the training did you find most useful?

____

11. Which topic in the training did you find least useful?

____

12. Any additional comments?

____

____

Yoga Program Study, Spring 2015 Participant ID

Number____________

Yoga Practice Log

Week ____

The overall goal of the program is to practice yoga for at least 120 minutes a week (at least 30 minutes/day 4 times a week). You are encouraged to practice more than that if you are able. If you haven't reached that goal yet, it is time to set your weekly yoga practice goal! Write it down below. Make sure you fill out the table below every day.

My goal is to practice yoga ______ minutes/hours each day this week.

Day	Frequency	Minutes or Hours	Comments
1			
2			
3			
4			

APPENDIX – C

- **CS-PFP Testing Protocol**
- **CS-PFP Test Data Form**
- **NeuroCom Balance Master® Test Protocols**
- **Goniometer Testing Protocol**

CS-PFP 10 TESTING PROTOCOL

LOW EFFORT TASKS:

The first sets of tests completed were the low effort tests. They consist of weight carry, jacket and reach.

Weight carry specification includes:

- Counter height from the floor is 35 inches
- The distance from one counter to the other is 63 inches (the weight will be carried from one angle of the counter to the other equaling 71 inches)
- There was 60 pounds of weight available with several sizes of pots and pans available.

Jacket task: requires availability of 4 men's lightweight broad cloth jacket with zippers with raglan sleeves and no elastic cuff.

Reach test: requires an 8-foot wall mounted adjustable shelf (the centimeter scale is to be mounted so that 0 to 50 cm is from the floor, and 1 sponge (8.0 x 3.5 x 1 inches).

MEDIUM EFFORT TASKS:

The second sets of tests completed were the medium effort tests. They consist of floor sweep, laundry and picking scarves.

Floor sweep specifications include:

- A 5-foot x 4-foot tile floor
- 1 broom with synthetic fibers and split ends
- Short handle, home size dust pan
- 2 cup measuring cup
- 1 pound of kitty litter

Laundry specifications include:

- 6 article of clothing (sweat shirts and shorts, no large robes) weight approximately 4 pounds
- 3 (2 pounds sand bags)
- 1 (3 pound sand bag)
- Clothes basket (total weight of clothes + basket +weights = 16pounds)
- A top landing washing and front load dryer (left hinge door) and
- A counter (36 inches high) to the right of the dryer on which to sit the clothes basket

Picking up scarves test: require four scarves (21 inches x 21 inches each) by placing all the scarves in 2 x 2 arrangements approximately 1 inch apart.

HARD EFFORT TASKS:

The third sets of tests completed were the hard effort tests. They consist of floor up/down, grocery, stair climbing and endurance walk.

Floor up/down specifications include two chairs with the seat height off the floor equaling 17 inches.

Grocery specifications include:

- A total walking distance of 42.3 yards
- The distance from the grocery store to the steps equaling 16.3 yards
- The distance from the steps to the kitchen counter equaling 26 yards
- A standard door to open a go through
- The height of the kitchen counter equaling 35 inches
- Canned goods and grocery items of varied weight and volume totaling 60-80 pounds
- 4 cloth grocery carrying bags

Endurance walk specifications include a flat non-skid surface with each lap equaling 118 yards

CS-PFP 10 ITF** DATA SHEET (Cress et al., 1996)

Testing Site:________________ Study:________________ Test #________ Tester:________________ Date:________________

Subject ID:____________ Sex: M F Living Status: House Apt. Group Home Retirement Community SNF Other:____________

DOB:__________ Age:____________ Height:________________ cm Weight:________________ kg

Primary Diagnosis: CVD Arthritis COPD Orthopedic Diabetes N/A

Assistive Device: Cane Walker Rolling Walker 4-wheeled Walker Assistive Device Use Level: Low Med High (circle all that apply)

TASK	TIME	WEIGHT	CONVERSION	HEIGHT	LAPS (there/back from cone) Distance____	PARTIAL LAP	TOTAL M	COMMENTS (log anything unusual about each task or overall)
Weight Carry	FP004 sec	FP005 kg	lbs/2.2 =					
time: sec., weight: kg	(3.5 - 9)	(2.273-29.545)						
Jacket	FP010 sec							Sm Med Lg XL 2X 3X
seconds	(10 - 60)							
Scarves	FP006 sec							
seconds	(2.5 - 10)							
Reach				FP014 cm	plus (correction (cm) in lab) or ___ + ___			RIGHT LEFT
reach (cm) / height (cm)				(1.15 - 1.4 ratio)				
Floor Sweep	FP022 sec							
seconds	(15 - 75)							
Laundry 1	FP025 sec	4.1 kg						
seconds	(18 - 60)							
Laundry 2	FP028 sec	4.1 kg						
seconds	(12- 60)							
Floor Sit	FP042 sec							
seconds	(5 - 50)							
Groceries	FP044 sec	FP045 kg	lbs/2.2 =					
time: sec., weight: kg	(35 - 145)	(2.273-27.273)						
Walk					# of laps * lap distance	m	FP048 m	
meters							(152.4 - 701)	
Stair Climb	FP055 sec				#stairs	FP056		
seconds	(4.18 - 14.3)							
TOTAL PFP TIME								FP052
Overall PFP RPE	FP053							

Data entry:________________

(initial and Date)

Special Considerations: (if yes, ask if it is chronic or if today is different, log)

End of test: log anything unusual about any specific task or overall

CS-PFP10datasheet

NEUROCOM TEST PROTOCOL

SIT-TO-STAND (STS)

Description

The STS quantifies the patient's ability to rise from a seated to a standing position. Key components of this task include shifting the body's COG forward from an initial position over the seat to a location centered over the base of support (feet), followed by extension of the body to an erect standing position while maintaining the centered COG position. The measured parameters are weight transfer time, rising index (force exerted to rise), sway velocity during the rising phase, and left/right symmetry of the rising force.

STS Comprehensive Report

1. The COG trace for each trial is displayed on the left side of the report.
2. **Weight Transfer** is the time in seconds required to voluntarily shift COG forward beginning in the seated position and ending with full weight bearing on the feet.
3. **Rising Index** is the amount of force exerted by the legs during the rising phase. The force is expressed as a percentage of the patient's body weight.
4. **Cog Sway Velocity** documents control of the COG over the base of support during the rising phase and for 5 seconds thereafter. Sway is expressed in degrees per second.
5. **Left/Right Weight Symmetry** documents differences in the percentage of body weight borne by each leg during the active rising phase.
6. The shaded area on each graphic represents performance outside of the normative data range. Green bars indicate performance within the normal range; red bars indicate performance outside the normal range. A numerical value is given at the top of each bar.

Functional Implications

Rising from a seated to a standing position is influenced by a number of musculoskeletal, movement control, and balance factors. Accurate control of COG position is critical to controlling the rise movement, as well as to maintaining postural stability. If the COG is not moved sufficiently forward or if the COG is moved too far forward, the patient will either fall back into the chair or fall forward. During the task, lateral stability depends on symmetrical distribution of force between the two legs. Finally, the rising maneuver also depends on adequate lower extremity and trunk strength, and range of motion. The transfer process can be slowed by problems with range, strength and flexibility in the lower extremity or trunk. Movement or postural control impairments impact speed and COG position and control during the task. Functional consequences include the inability to rise from the seated position during performance of activities; rising from seats of variable heights; or a dependence on upper extremity assistance or the assistance of another person. Safety is a concern if instability occurs during or immediately following the rise, or while descending to sit.

TANDEM WALK (TW)

Description

The TW quantifies characteristics of gait as the patient walks heel to toe from one end of the forceplate to the other. Measured parameters are step width, speed, and endpoint sway velocity.

TW Comprehensive Report

1. The COG trace for each trial is shown on the left side of the report.
2. **Step Width** is the lateral distance in centimeters between the left and right feet on successive steps.
3. The **Speed** is the velocity in centimeters per second of the forward progression.
4. The **End Sway** is the velocity in degrees per second of the anterior/posterior component of COG sway for 5 seconds beginning when the patient terminates walking.
5. The shaded area on each graphic represents performance outside of the normative data range. Green bars indicate performance within the normal range; red bars indicate performance outside the normal range. A numerical value is given at the top of each bar.

Functional Implications

Tandem gait is a high demand activity requiring careful control of both COG movement (head, trunk, pelvis) and the successive re-establishment of a stable, narrow base of support. Compared to normal gait, the tandem walk test tends to be more specific to impairments affecting balance.

Patients with COG control problems often compensate by increasing their step width and broadening their base of support to make balancing easier. Slower gait speeds have been shown to correlate with frailty, functional loss, and fall risk in the elderly. Inability to walk quickly may be caused by strength or range of motion impairments, or movement disorders. Self-restriction in speed may be due to sensory loss, fear of falling, or avoidance. Excessive end sway can be a measure of muscular strength and volitional control.

STEP/QUICK TURN (SQT)

Description

The SQT quantifies turn performance characteristics as the patient takes two forward steps, quickly turns 180o and returns to the starting point. The measured parameters are the time to execute the turn and the sway velocity during the turn execution.

SQT Comprehensive Report

1. The COG trace for each trial is shown on the left side of the report.
2. **Turn Time** quantifies the number of seconds required for the individual to execute the 180-degree in-place turn. Time begins when forward progression is arrested and ends when forward progression in the opposite direction is initiated.
3. **Turn Sway** quantifies the postural stability of the individual during the turn time defined above. Turn sway is expressed as the average COG sway velocity in degrees/second.
4. The shaded area on each graphic represents performance outside of the normative data range. Green bars indicate performance within the normal range; red bars indicate performance outside the normal range. A numerical value is given at the top of each bar.

Functional Implications

Ability to quickly change direction of travel is a critical component of normal mobility. The task is sensitive to impairments of balance because the patient must maintain stability during the turn while the visual and vestibular inputs are being disturbed by rapid turning of the head and eyes. The functional consequences are an inability to perform activities requiring rapid turns, such as dancing or sports, and increased risk for falls during normal activities of daily living that require turning.

Goniometer measurement protocol

A traditional goniometer will be used to measure the flexibility (ROM) for the elbow, hip, and knee. This measurement will be taken for extension and flexion of the elbow, hip and knee. A traditional goniometer is a protractor with extending arms. To use a goniometer there are three steps that are needed to be followed.

- The fulcrum of the device will be aligned with the joint (elbow/ hip /knee) to be measured.
- Stationary arm of the device will be aligned with the limb being measured.
- Holding the arms of goniometer in place, the joint (elbow/ hip /knee) will be moved through its range of motion.

Finally, the degree between the endpoints will be measured, which represents the entire range of motion (ROM).

APPENDIX – D

- **Yoga Poses**

- **Relapse Prevention Intervention Weekly Emails**

- **Relapse Prevention Intervention Weekly Phone Dialogue**

- **Yoga Home Practice**

Type of yoga poses applied and its dosage

Types of Asana	Starting position and procedure	Dosage
Tadasana	Mountain pose; basic standing pose	Hold the pose for 30-60 sec
Uttitha Trikonasana	Standing extended triangle pose; stretch to the sides with arms and legs spread. Stretch the arm with the support of block	Hold for 30-60 sec
Virbhadrasana	Standing lunge pose, forward lunge with unaffected leg supported by block	Hold for 20-30 sec
Dandasana	Staff pose; seated on blanket with legs extended, arms stretched	Hold this pose for 1 minute
Supta Tadasana	Supine mountain pose; flex and extend legs at the knees while lying flat, head supported by towel/blanket	Hold this pose for 1 minute
Supta	Supine foot pose, Raising one leg at a time straight using belt, head supported on the towel/blanket	Hold this pose for 20 -30 sec

Padangustasana		
Urdhva Hastasana	Standing hand pose; raising hands over head	Hold this pose for 20- 30 sec
Ardha Uttanasana	Standing deliberate stretch pose, arms parallel to floor, touching wall and stretch arms and legs	Hold this pose for 20 -30 sec
Prasarita Padathanasana	Standing: Bending from the waist forward holding onto the seat of chair	Hold the pose for 30 sec
Baddha Konasana	Seated restrained angle pose: legs flexed at the knees, feet brought in close to the body assisted by the belt	Hold the pose for 30-60 sec
Urdhwa Prasarita Padasana	Supine stretch foot pose; raising both the legs from the floor and propping them with feet flat on the wall	Hold the pose for 30- 60 sec
Virasana	Warrior pose; seated on the blanket with knee flexed to the sides of the body: Buttocks on the bolster	Hold this pose for 30 sec
Swastikasana	Seated cross-legged pose: Seated on blanket with knees flexed in cross legged position	Hold this pose for 30- 60 sec
Savasana	Supine relaxation pose: Lying, head on the blanket. Practice with at least 5 minutes Return to it periodically through your posture session to relax body/mind	Hold this pose for 5 minutes

Weekly Emails

Week 1

Hello___________!

As part of the Relapse Prevention program you are participating in, you will be receiving weekly emails from me. I hope you will be able to use the tips I include each week. Thank you so much for your participation! Have a great week and don't forget to fill out your Yoga Practice Log this week!

Weekly Tip: It can be helpful to set goals about choosing to practice yoga instead of another activity (like watching TV). An example would be to set a goal of substituting yoga for your least favorite TV show. It may be helpful to set a specific time and place each day that you are able to practice.

When you are setting your Yoga Practice Goal this week, choose a specific goal that you feel confident that you can achieve but try to make an improvement from what you are doing now. The goal is to practice 120 minutes a week (30 minutes of yoga 4 times a week). If you have not reached that yet, choose a specific number that you can reasonably reach. If you have already reached the goal then make small increases by about 5-10%. Progress is the key, so make goals that will stretch you, but still be attainable.

Thanks!

Additional Information:

Best Yoga apps of the year- (For iPhone & Android)

- Daily yoga- Fitness On-the-Go (Both *Free*)

- 7 Minutes Yoga for Beginners (Both *Free*)

- Simply Yoga Free (Both *Free*)

- Yoga.com (iPhone $3.99, Android *Free*)

- iYoga+ (iPhone *Free*)

- Pocket Yoga (iPhone $3.99, Android $2.99)

Hope this will help you continue practicing yoga. Talk to you on (Thursday/Friday/Saturday)

Week 2

Hello_________!

I hope your week went well last week. Have a great week and don't forget to fill out your Yoga Practice Log this week!

Weekly Tip: When you set your Yoga Practice Goal this week, choose a small reward for yourself that you will do or get if you achieve your goal every day. The reward can be something that you go buy like that book you have been wanting to read or something that is free like a nice bubble bath.
Invite a friend or family member to practice yoga with you. It will give you somebody to talk to. Who knows, it may become a routine for both of you!

Thanks!

Additional Information:

1. Rachel White teaches at Yoga at Tiffany's in Norman…....yogaattiffanysnorman.com
   Sundays 9am-Hot All Levels
   Mondays 1:30pm- Flow Level one
   Tuesdays 1:30pm- Bolster All Levels and 4:15pm- All Levels Hot
   Wednesday 1:30pm- Flow Level One
   Thursdays 1:30pm- Gentle All Levels
   Fridays 6am- Hot All Levels on the month of June, and 4:15pm- Hot All Levels

   She is also teaching a free yoga in the park class on June 6th at Lions Park at 9:00am.
   She is available for private lessons at the studio or on location. Check back at website rachelwhiteyoga.com for other news or facebook (https://www.facebook.com/RachelWhiteYoga).

2. Sandy See teaches "Movement & Meditation" class on Tuesdays 7:00pm at Senior Citizen Center, Norman.
   Class offered by donation and proceeds will support local nonprofits.
   Contact- Sandy: 405-290-8758**;** seemeditation@cox.net

3. Yoga classes at Sam Noble Museum on Friday morning.
   For information check the link below:
   http://www.ou.edu/content/far/facilities-programs/yoga-and-tai-chi-sam-noble-museum.html

Hope this will help you continue practicing yoga. Talk to you on (Thursday/Friday/Saturday)

Week 3

Hello_______!

I hope your week went well last week. Have a great week and don't forget to fill out your Yoga Practice Log this week!

Weekly Tip: Hope rewarding yourself for achieving your goal has improved your confidence further. Keep on improving! You have passed the two week mark and are still doing GREAT! When the weeks get difficult and you don't think you can finish, look at your weeks past and remember your best week yet! Keep sticking with your practice just as you have been doing for the past 2 weeks! Keep moving no matter what!

Think ahead as this program nears its end. Schedule your practice into your day and set goals for when you have practiced 3, 5, or even 10 days in a row. Don't compare your practice to other people. Instead, compete with yourself. Do better this week than you did last week. Do better today than you did yesterday!

Thanks!

Additional Information:

Yoga home practice videos

http://yogawithadriene.com/yoga-beginners-40-minute-home-yoga-workout/

http://www.arthritis.org/living-with-arthritis/exercise/workouts/yoga/videos/cat-cow.php

Week 4

Hello_______!

I hope your week went well last week. Have a great week and don’t forget to fill out your Yoga Practice Log this week!

Weekly Tip: Although Yoga is considered a great form of exercise for people with arthritis due to its gentle and slow movement, any exercise program is difficult to begin and maintain. You are now starting your last week and you have accomplished something great. Even though you may or may not have achieved the goals you set in the beginning, you are still reading these emails which means you still care about your fitness journey. Again, I say, you have accomplished something great and I encourage you to continue your journey!

Thanks!

Additional Information:

Long term Osteoarthritis self-care (Documents Attached

Phone Dialogue

(Starting week 10 then every 2 weeks after that)

1. "How is the yoga practice going for you so far?"

2. "Do you have any struggles/successful strategies?"

3. –Briefly go over the concepts in the messages from the emails in the past 2 weeks.

4. –Motivational comment. For example: "You have done well so far… keep up the good work!"

Yoga Home Practice

All of you are amazing humans! I would encourage you to keep stretching, breathing and mediating. Buy two blocks and a strap, or use a belt or scarf. For meditation do the following:

Find a quiet, uncluttered room with a flat surface. You can also do yoga meditation outside, as long as it is not noisy and in direct sunlight.

Choose a time and place for a regular yoga meditation. Yoga meditation is best done regularly at the same time, so make sure you are choosing a time that will work well most days of the week.

Prepare the meditation space. Roll out your yoga mat and place blankets nearby. Focus on making it a calm space

Start your own yoga practice.

Arranging your body comfortably set an intention for your practice. Try to disconnect from your thoughts. Scan through your body and check in with how you're doing physically and then mentally/emotionally.

Breathe in and out of your nose. Stretch your body anyway you want.

Cat/cow your body and go into downward facing dog.

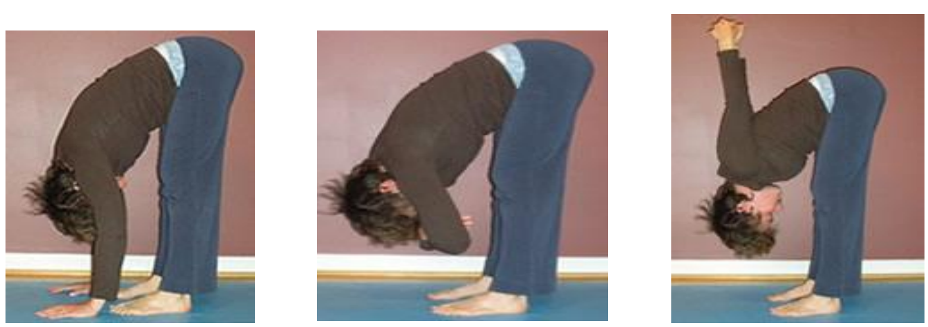
Cat/cow poses

Downward facing dog

Then shift to a plank and go to child's pose.

Child's poses

Then back to downward facing dog, and then forward fold your body.



Forward fold bends

Stretch your neck. Stretch your shoulders.

Go to Warrior 2 and Extended Side Angle Pose.

Warrior I

Warrior II

Warrior III

Extended Side Angle Pose

Practice your balance.


Balance Poses

Stretch your hips. Bend your back. Stretch your back.



Back bends

Sit on your booty and twist your torso.

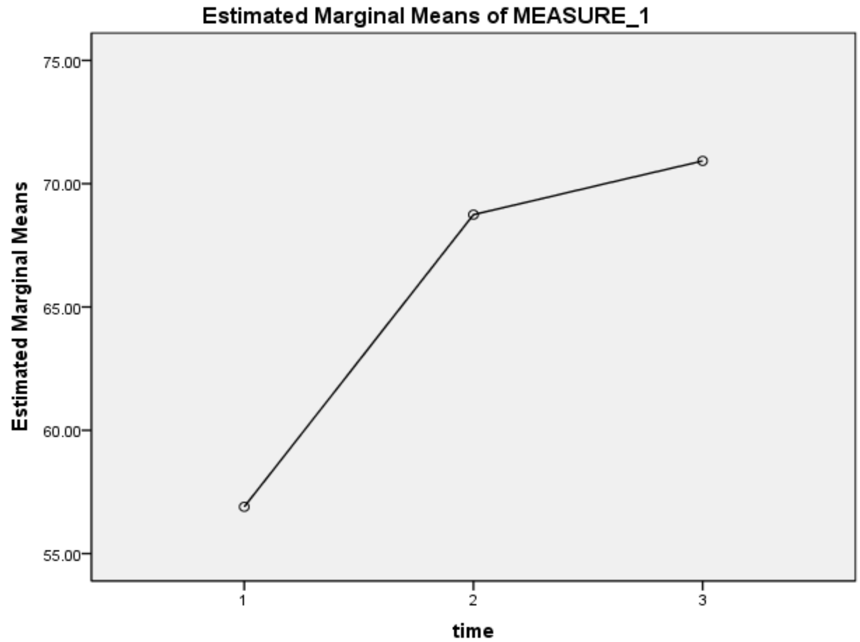
Lie down and twist your body on both sides.

At the end of your practice, place your body comfortably. And meditate.

APPENDIX – E

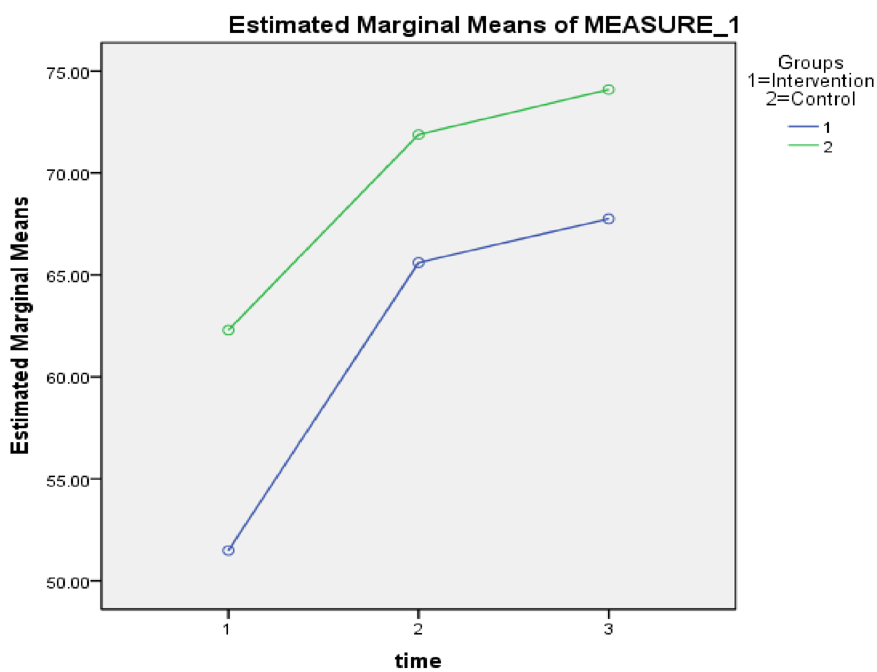
- **Figures 1-20: Plots for the overall time effect for all variables for total sample and group**
- **Figures 21-24: Correlation matrices that demonstrate the temporal stability in the rank ordering of variable scores over time**

Figure 1: Overall time effect for total functional performance (TFP) for the total sample



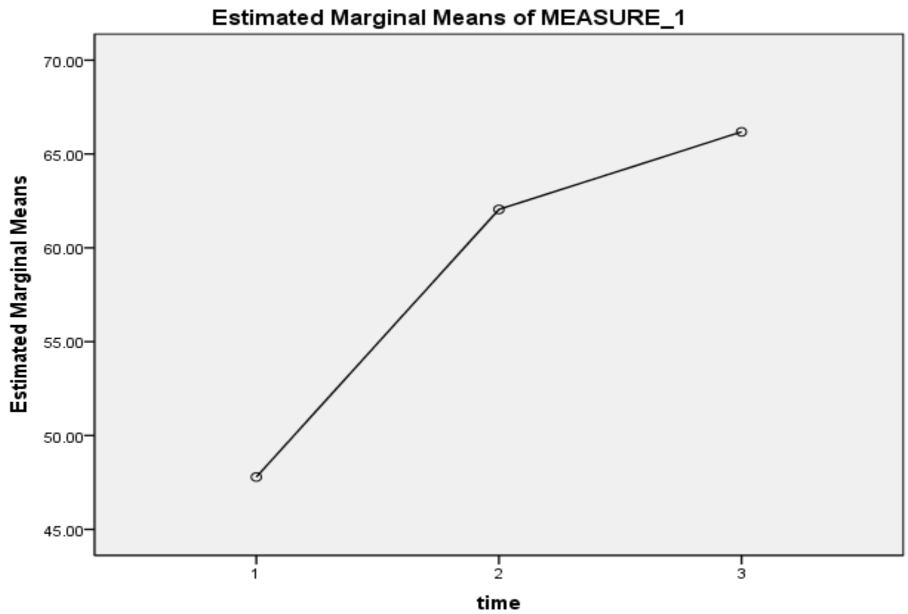
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 1a: Overall time effect for total functional performance (TFP) by group



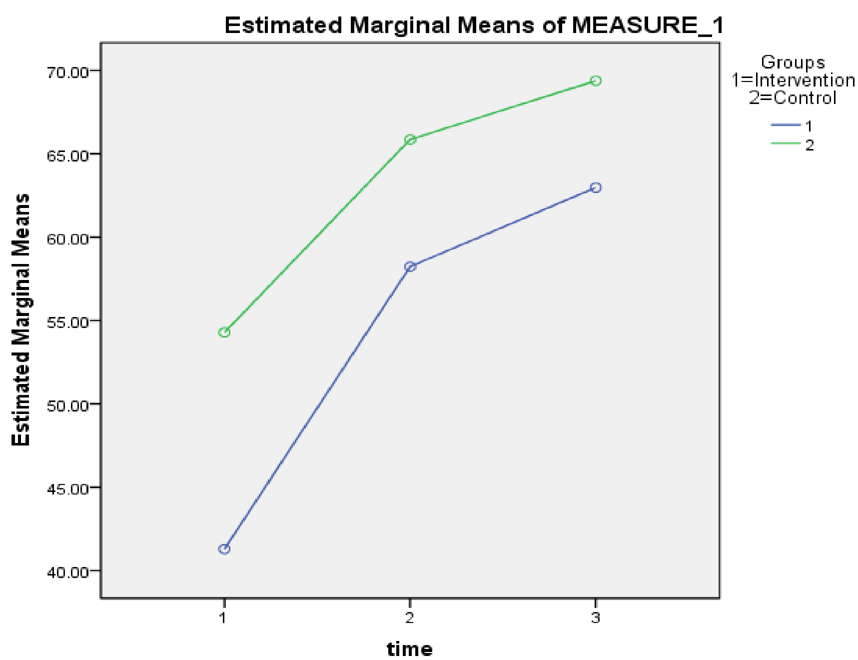
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 2: Overall time effect for lower body strength (LBS) for the total sample



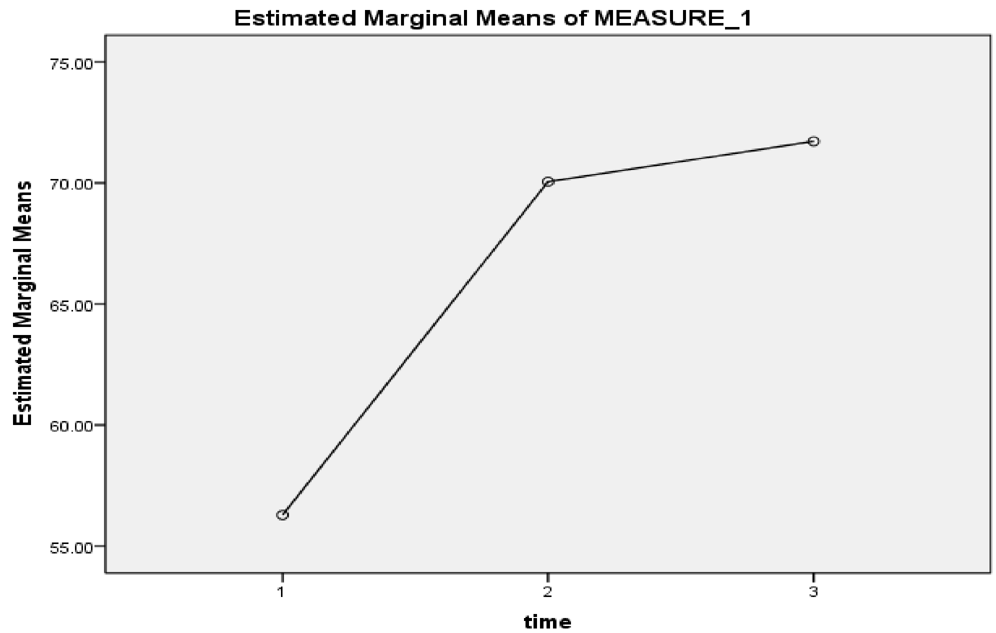
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 2a: Overall time effect for lower body strength (LBS) by groups



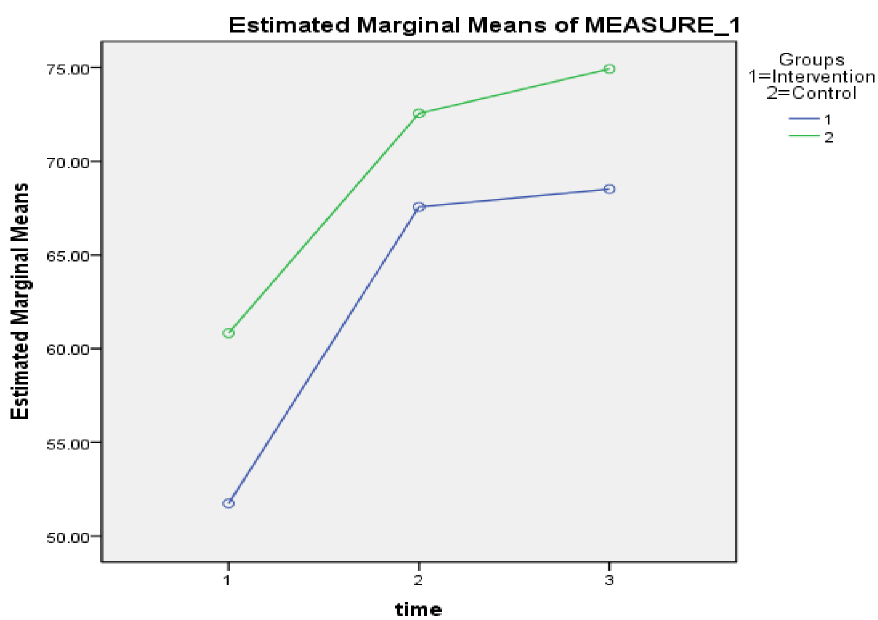
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 3: Overall time effect for balance and coordination (BAC) for the total sample



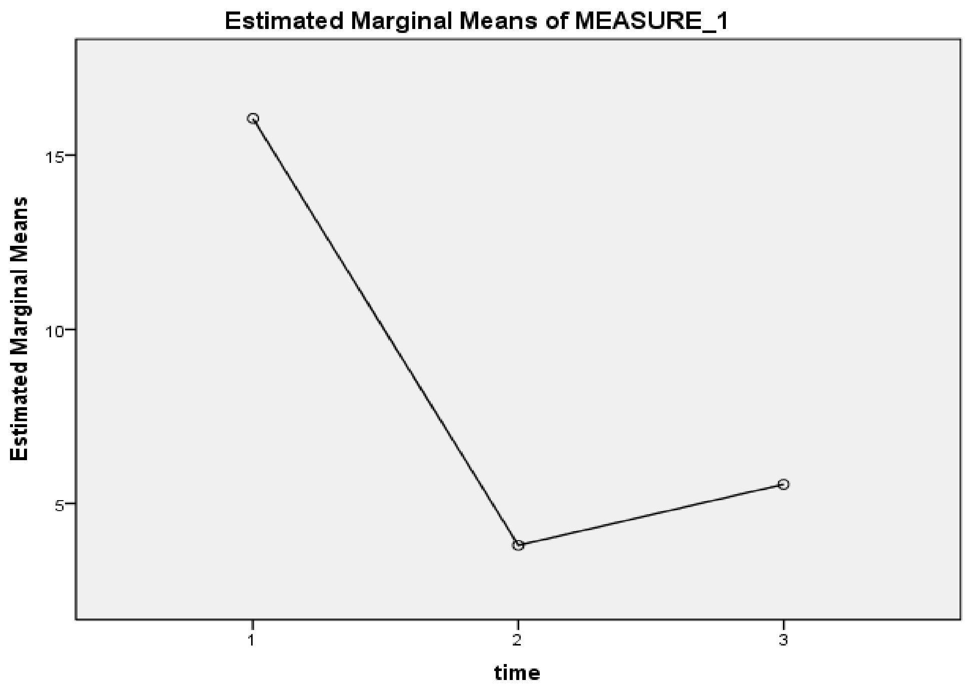
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 3a: Overall time effect for balance and coordination (BAC) by groups



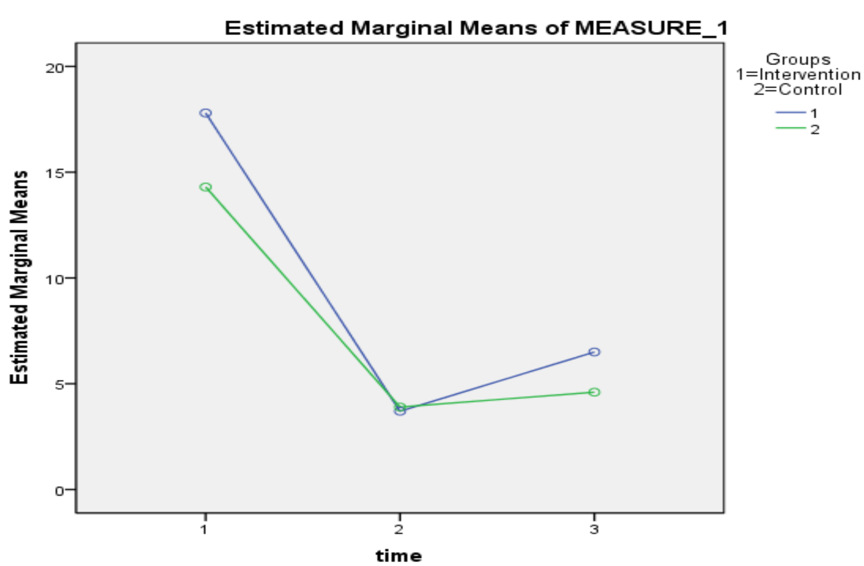
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 4: Overall time effect for physical function (PFWOMAC) for the total sample



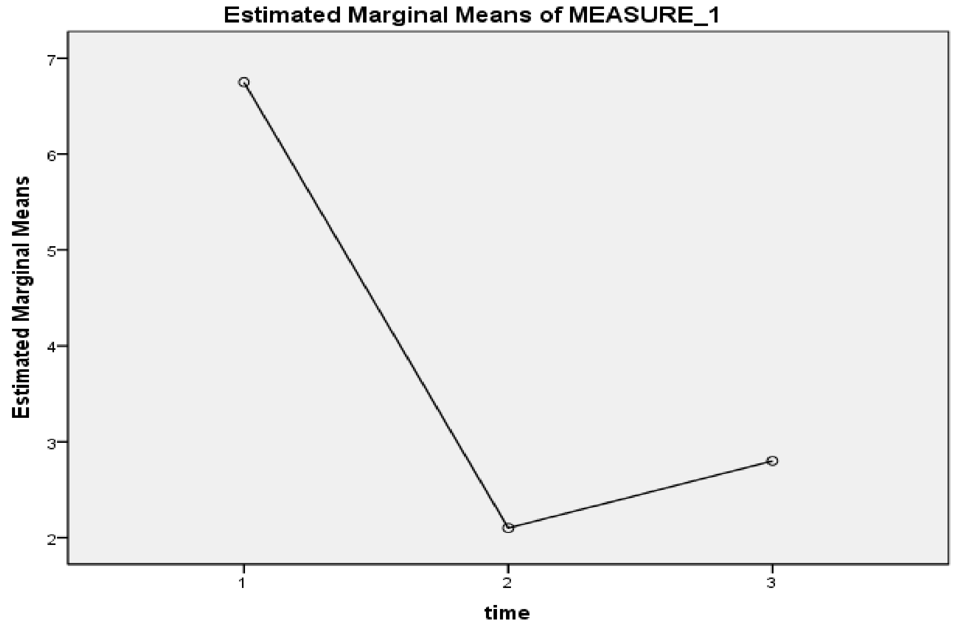
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 4a: Overall time effect for physical function (PFWOMAC) by groups



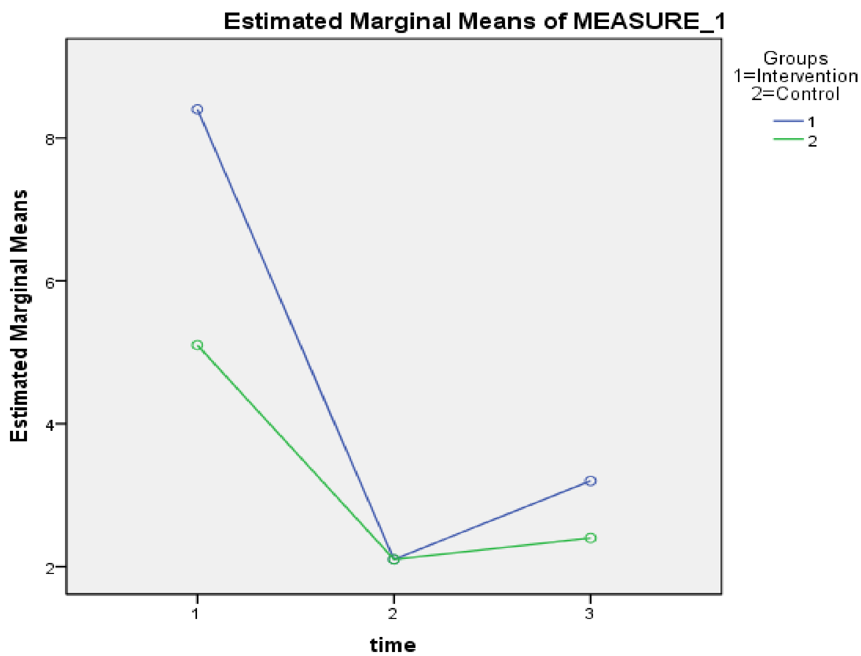
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 5: Overall time effect for pain (PWOMAC) for the total sample



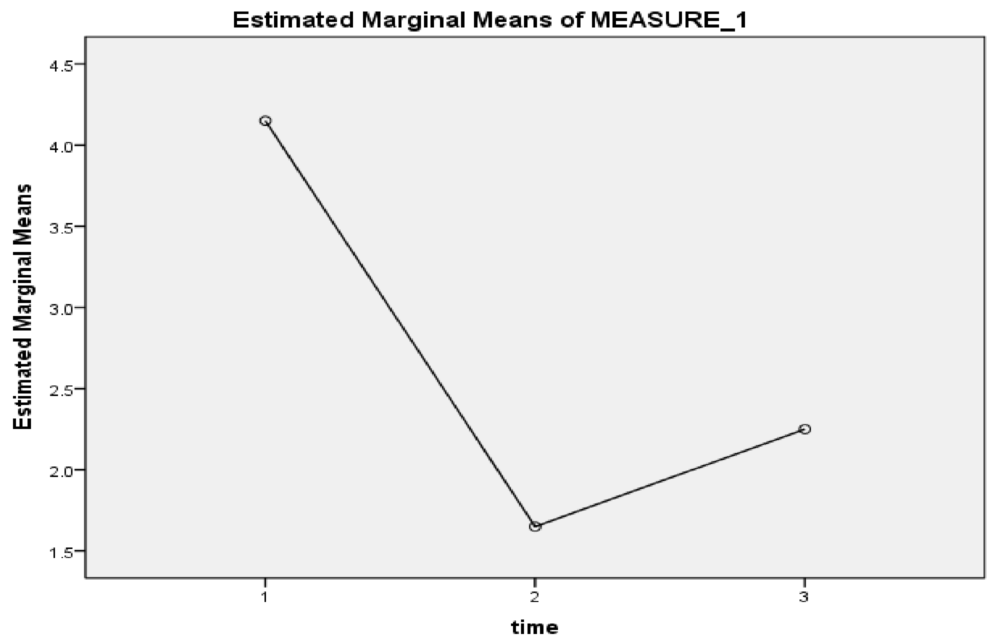
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 5a: Overall time effect for pain (PWOMAC) by groups



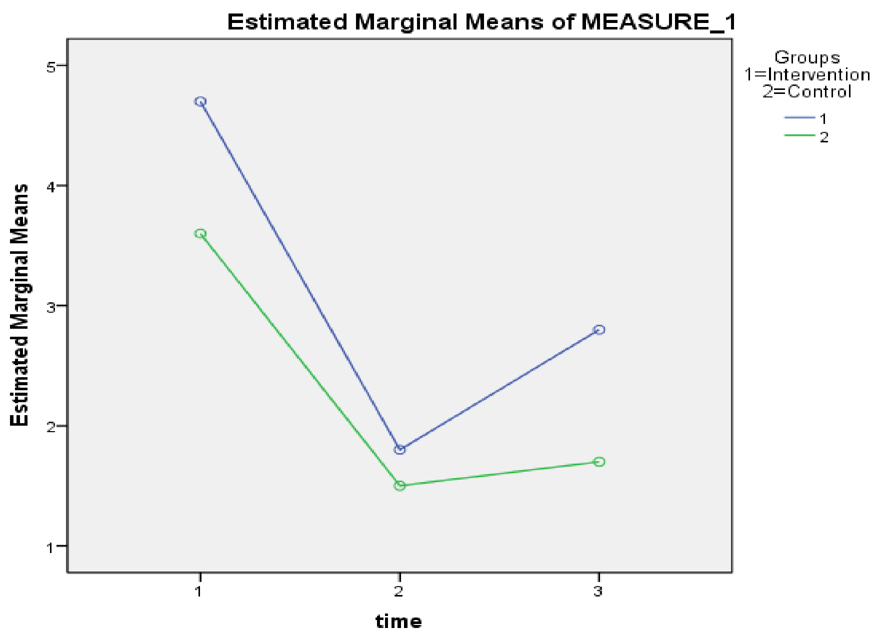
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 6: Overall time effect for stiffness (SWOMAC) for the total sample



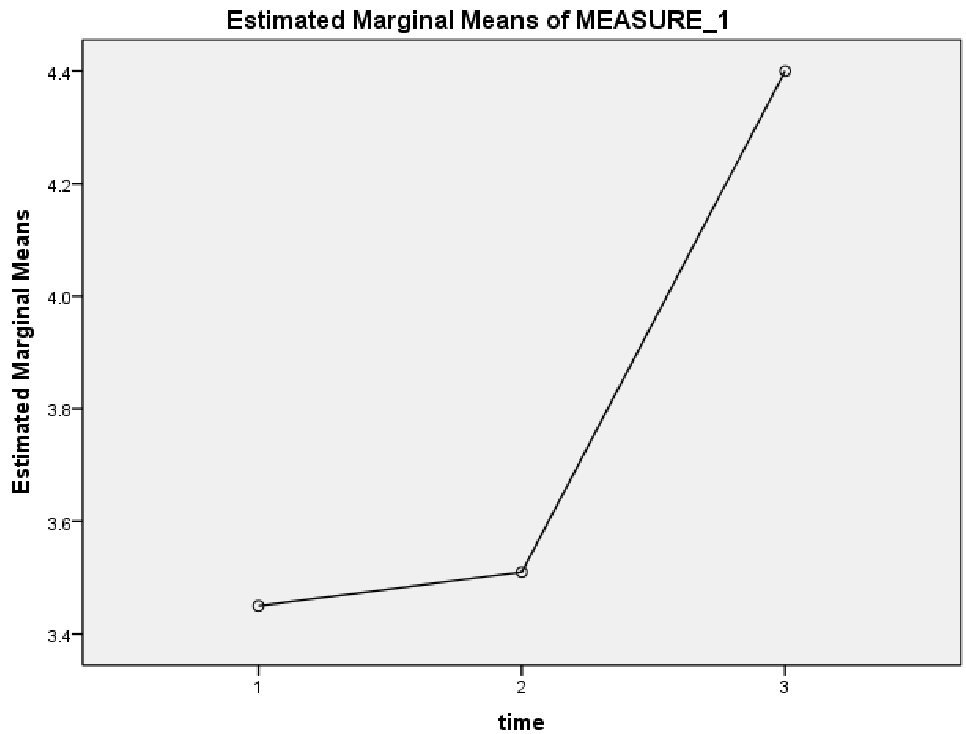
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 6a: Overall time effect for stiffness (SWOMAC) by groups



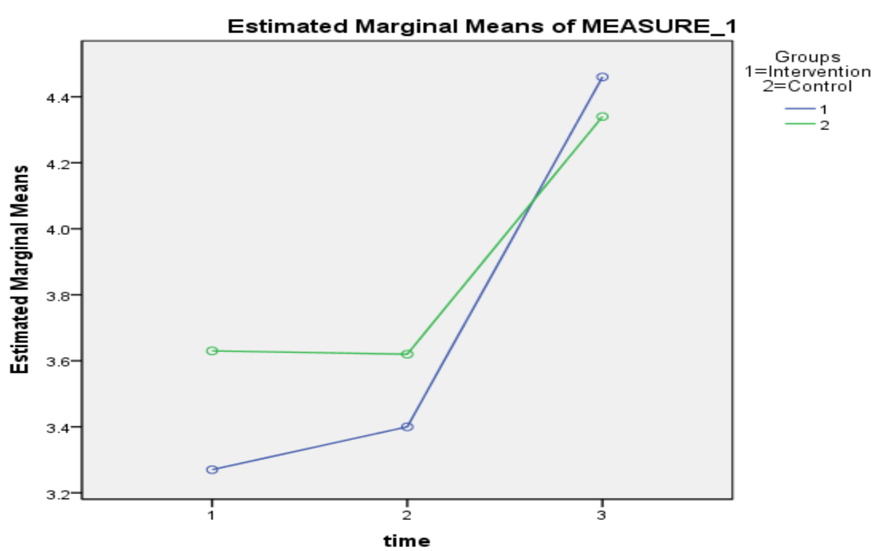
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 7: Overall time effect for Sit-to-Stand (STS) for the total sample



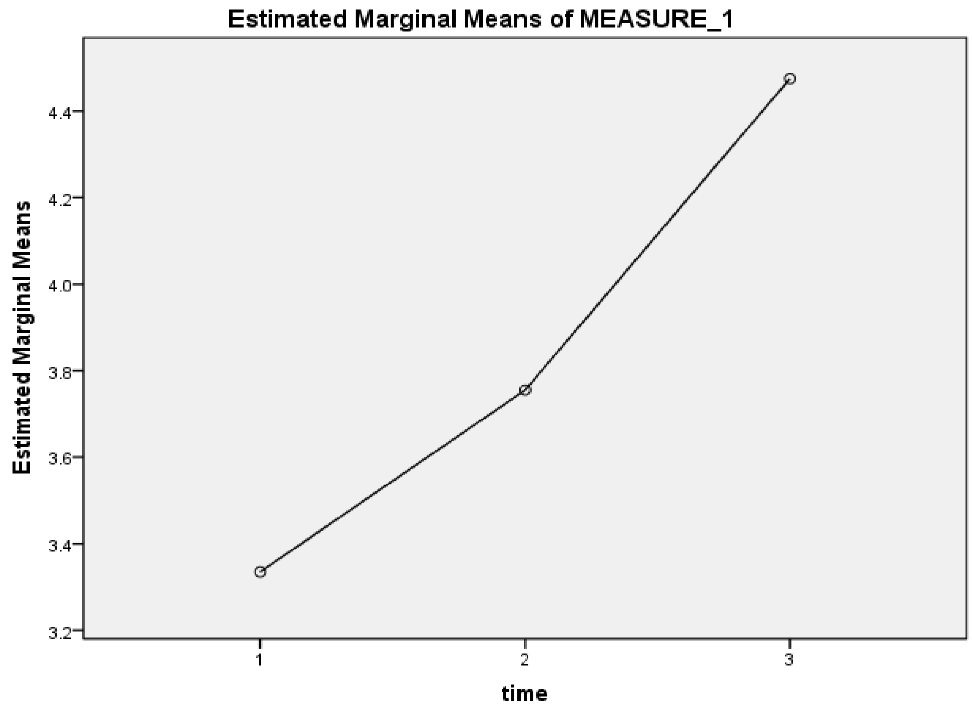
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 7a: Overall time effect for Sit-to-Stand (STS) by groups



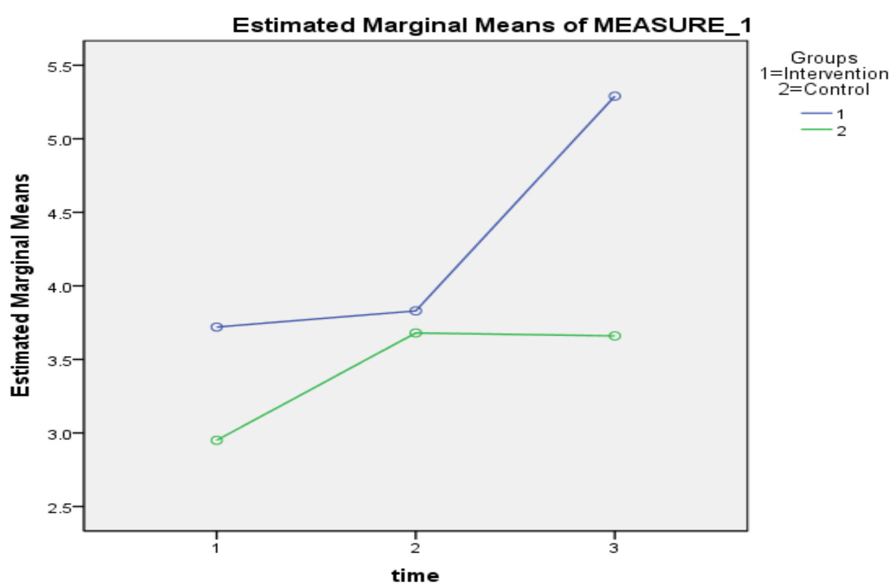
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 8: Overall time effect for Tandem Walk (TW) for the total sample



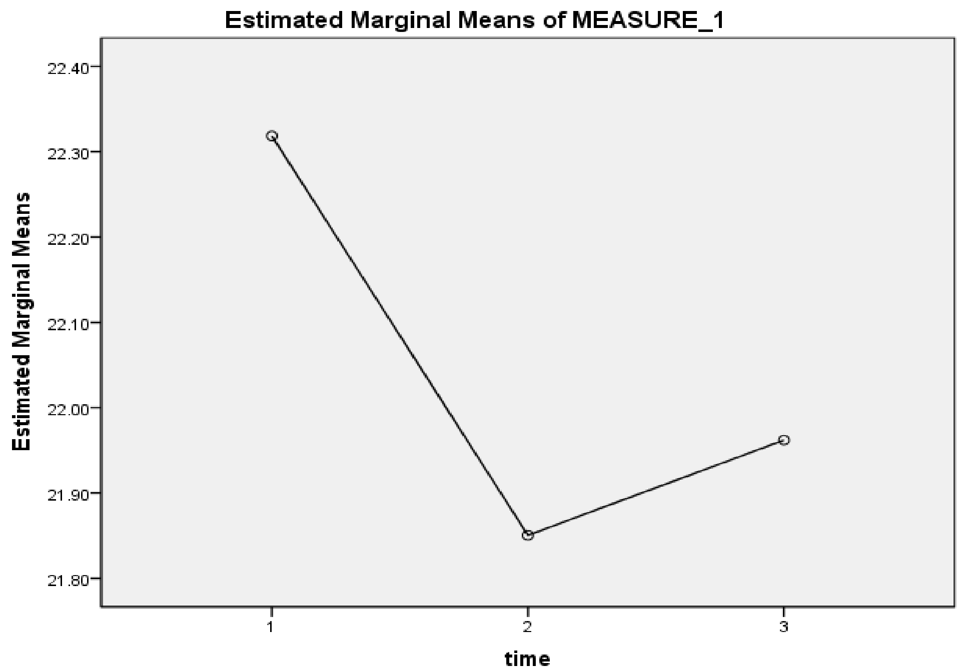
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 8a: Overall time effect for Tandem Walk (TW) by groups



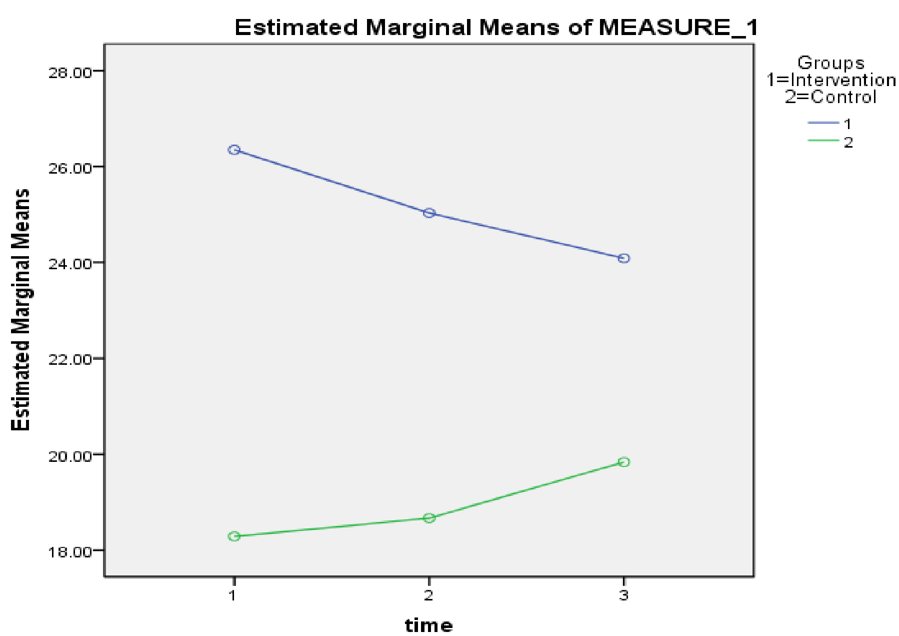
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 9: Overall time effect for Step-Quick Turn (SQT) for the total sample



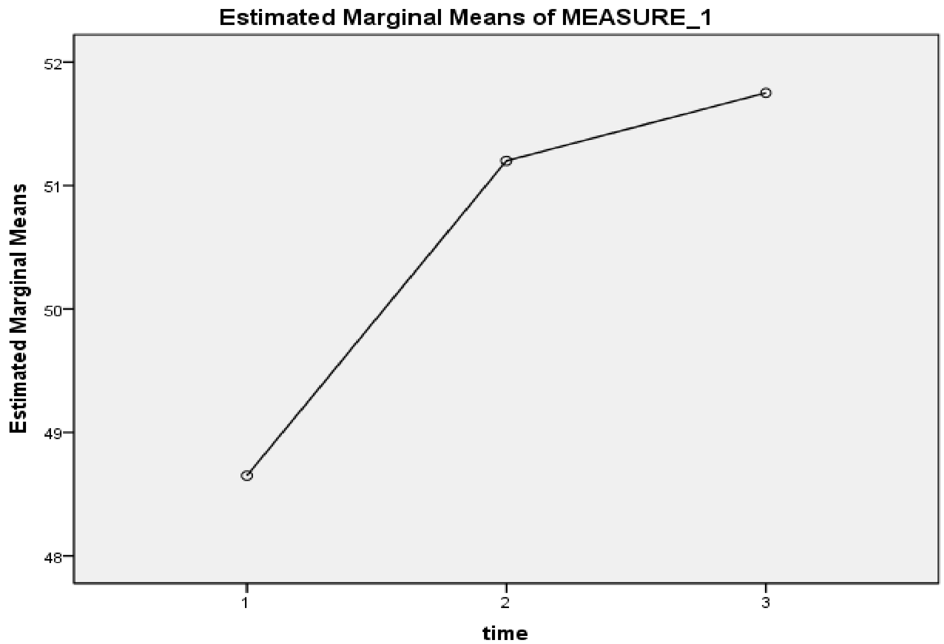
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 9a: Overall time effect for Step-Quick Turn (SQT) by groups



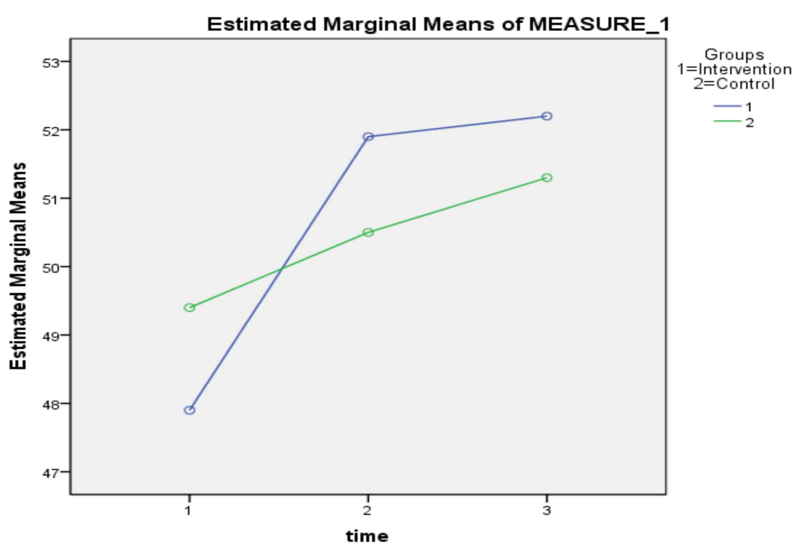
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 10: Overall time effect for Ankle Plantarflexion (APLANFLEX) for the total sample



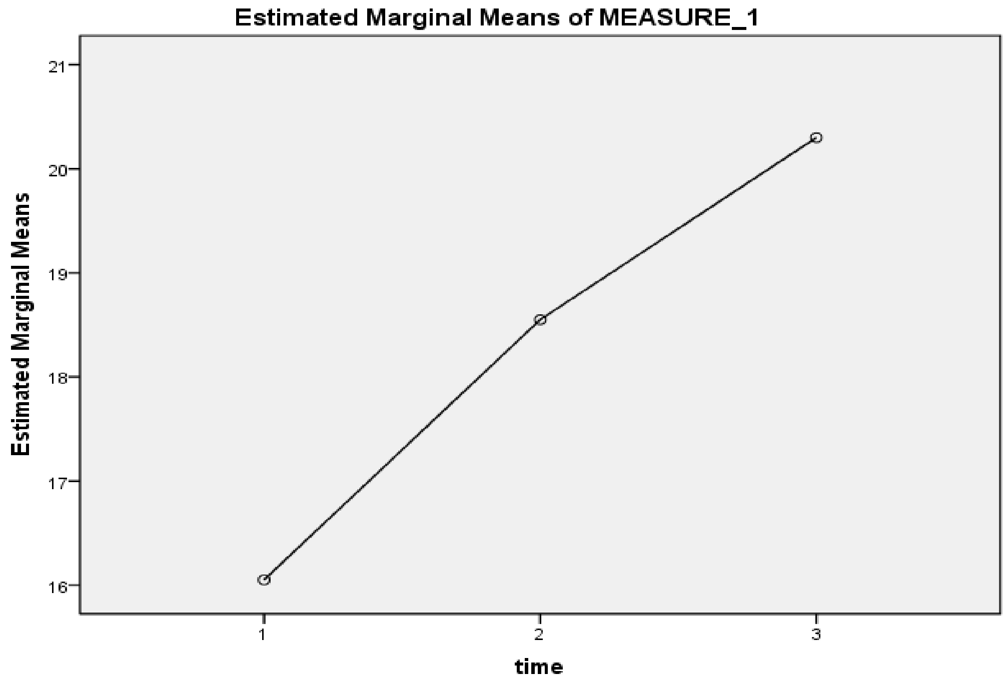
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 10a: Overall time effect for Ankle Plantarflexion (APLANFLEX) by groups



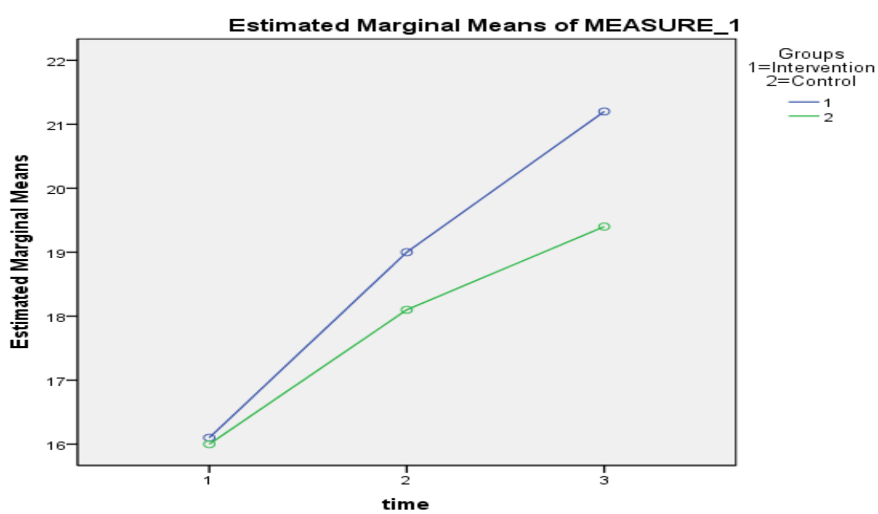
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 11: Overall time effect for Ankle dorsiflexion (ADORSIFLEX) for the total sample



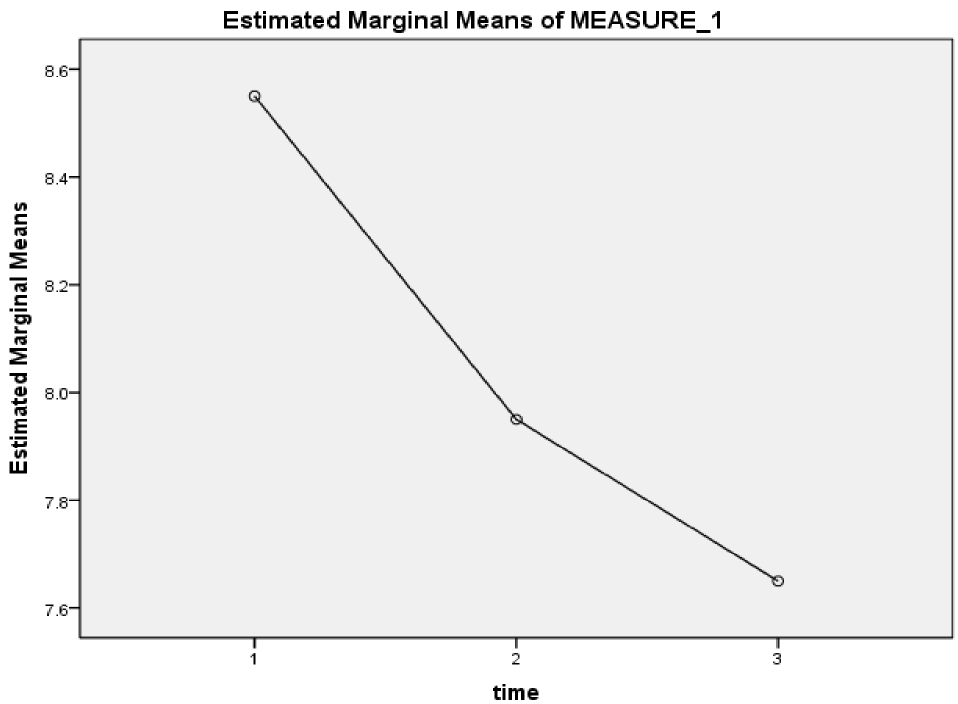
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 11a: Overall time effect for Ankle dorsiflexion (ADORSIFLEX) by groups



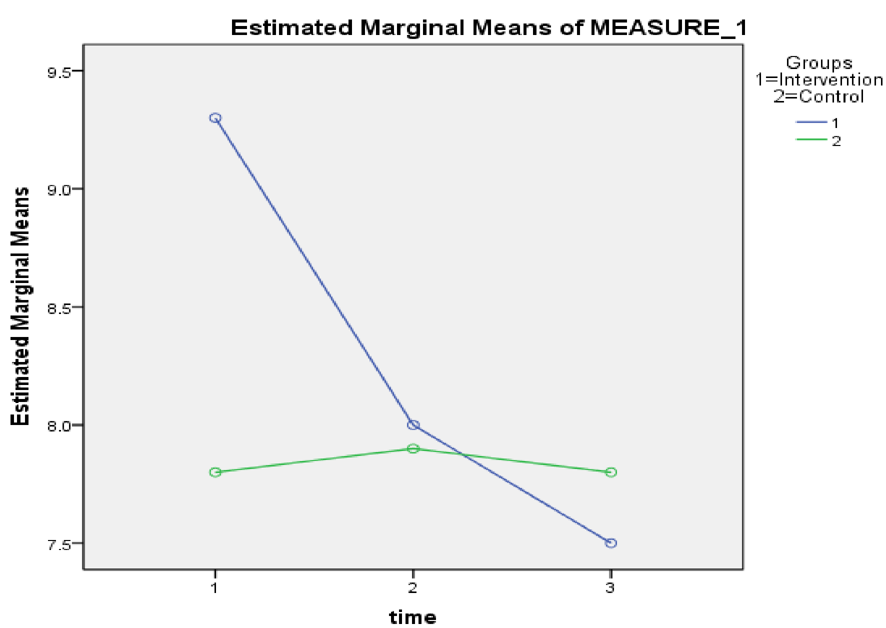
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 12: Overall time effect for Knee Extension (KEXT) for the total sample



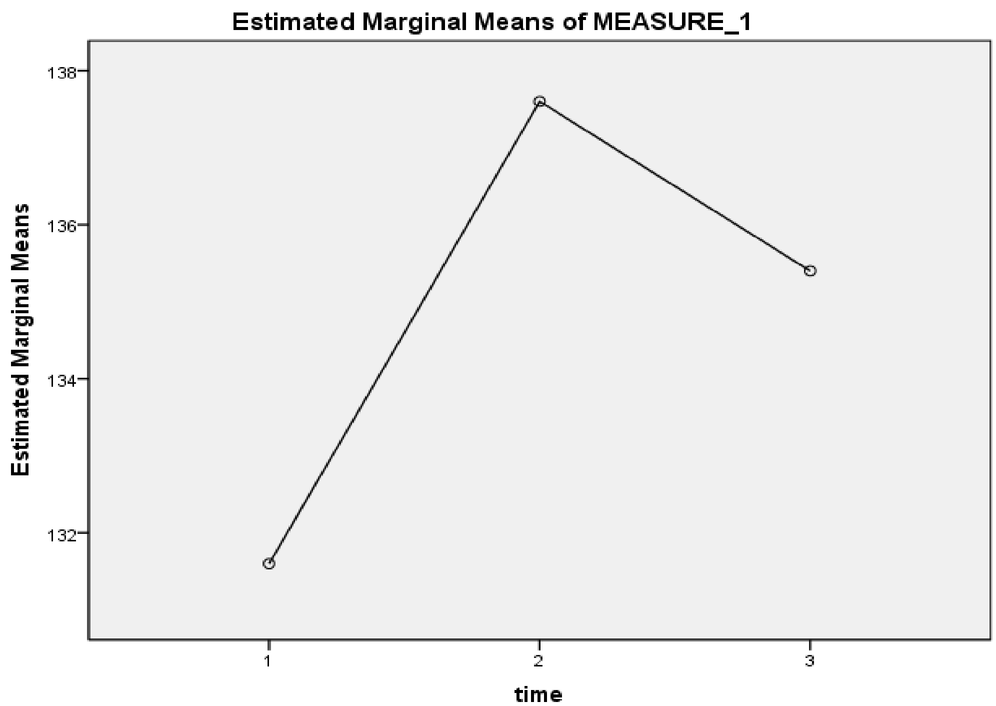
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 12a: Overall time effect for Knee Extension (KEXT) by groups



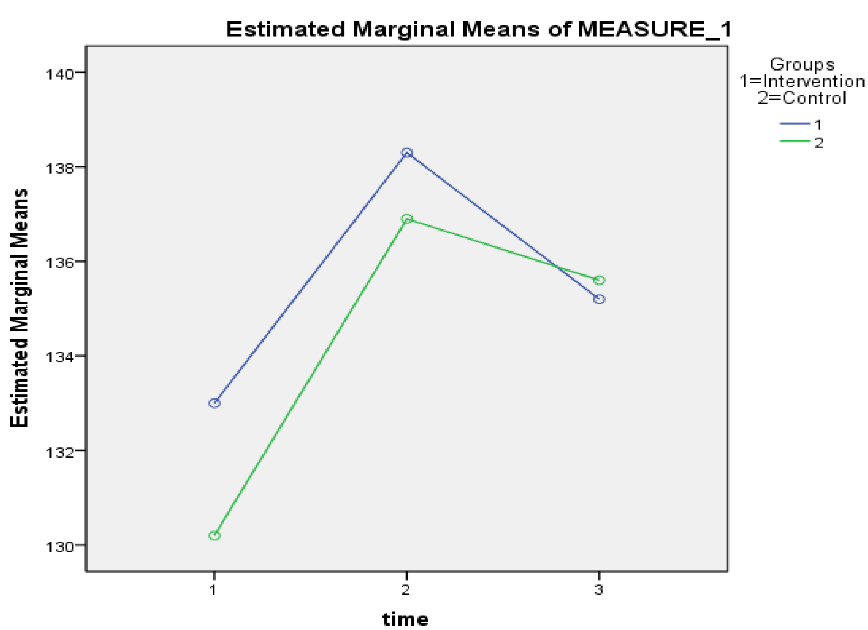
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 13: Overall time effect for Knee Flexion (KFLEX) for the total sample



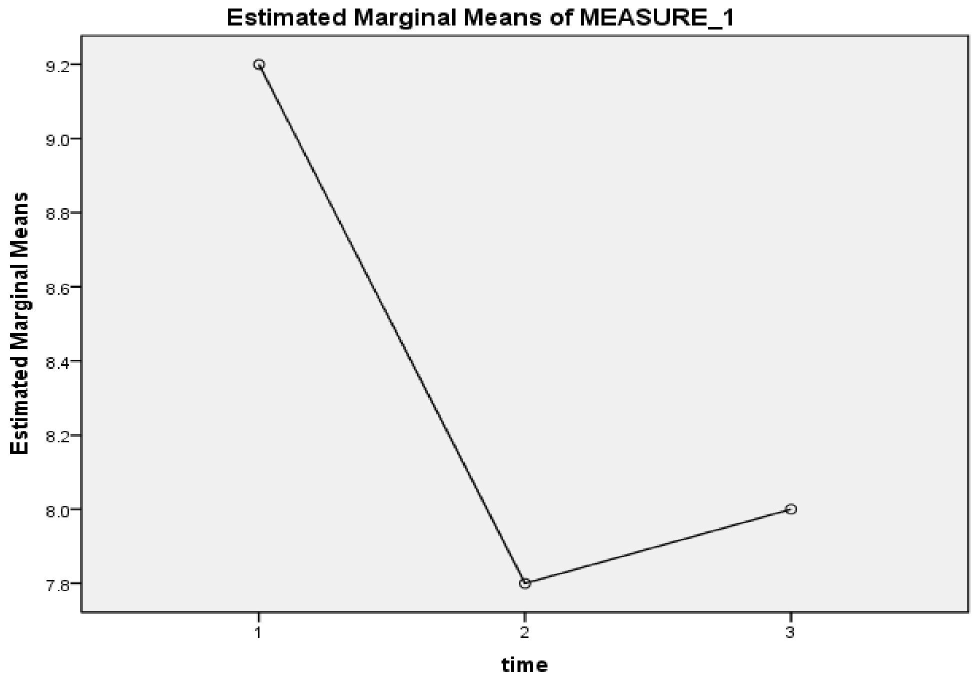
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 13a: Overall time effect for Knee Flexion (KFLEX) by groups



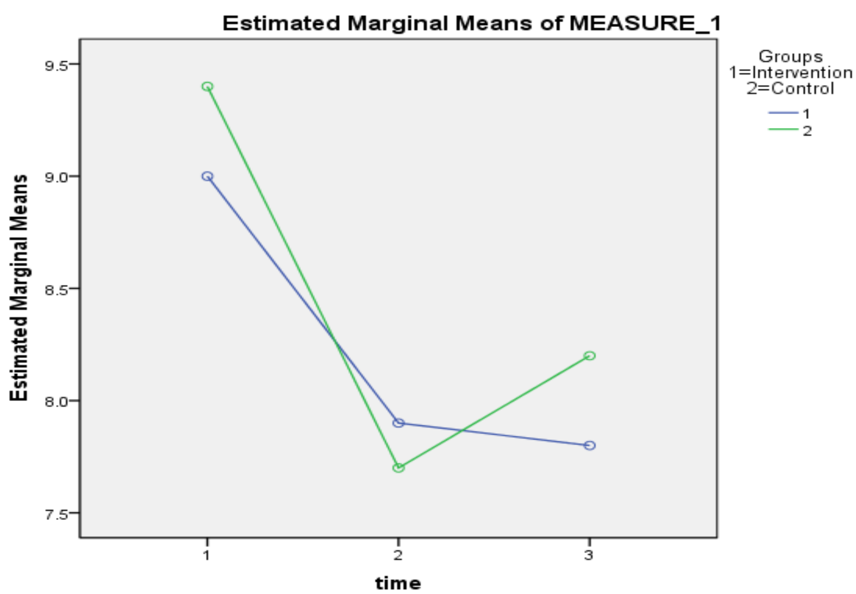
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 14: Overall time effect for Hip Extension (HEXT) for the total sample



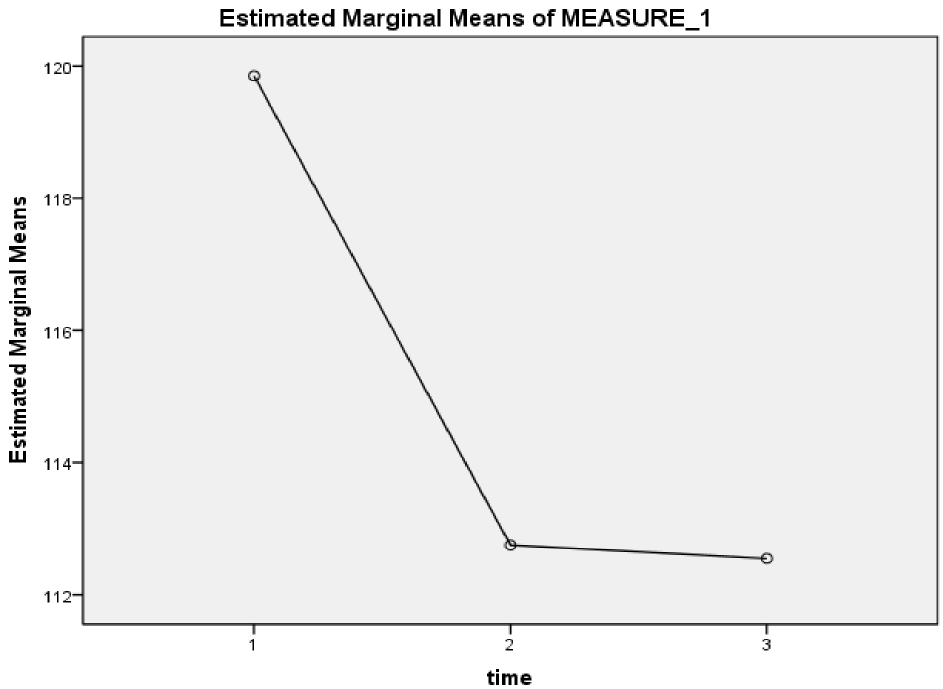
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 14a: Overall time effect for Hip Extension (HEXT) by groups



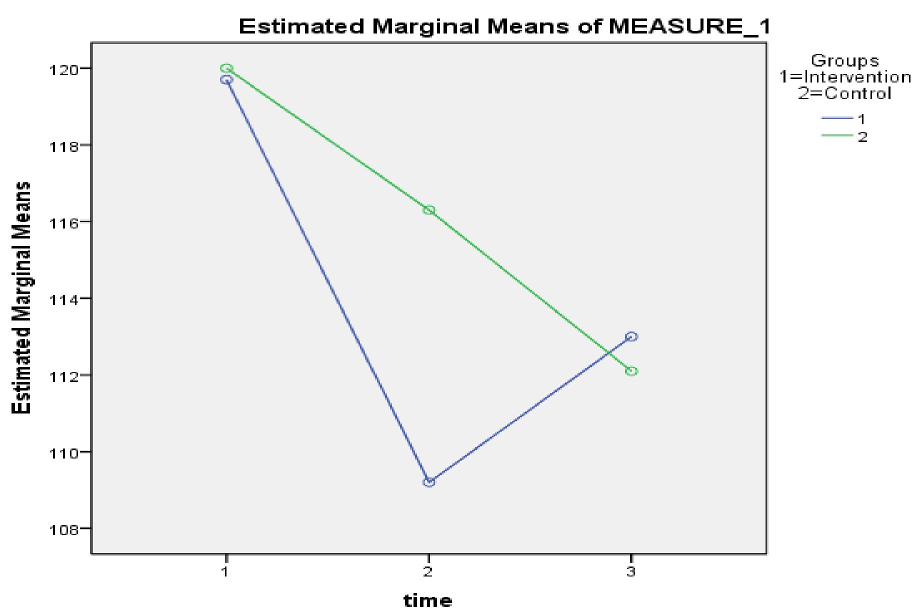
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 15: Overall time effect for Hip Flexion (HFLEX) for the total sample



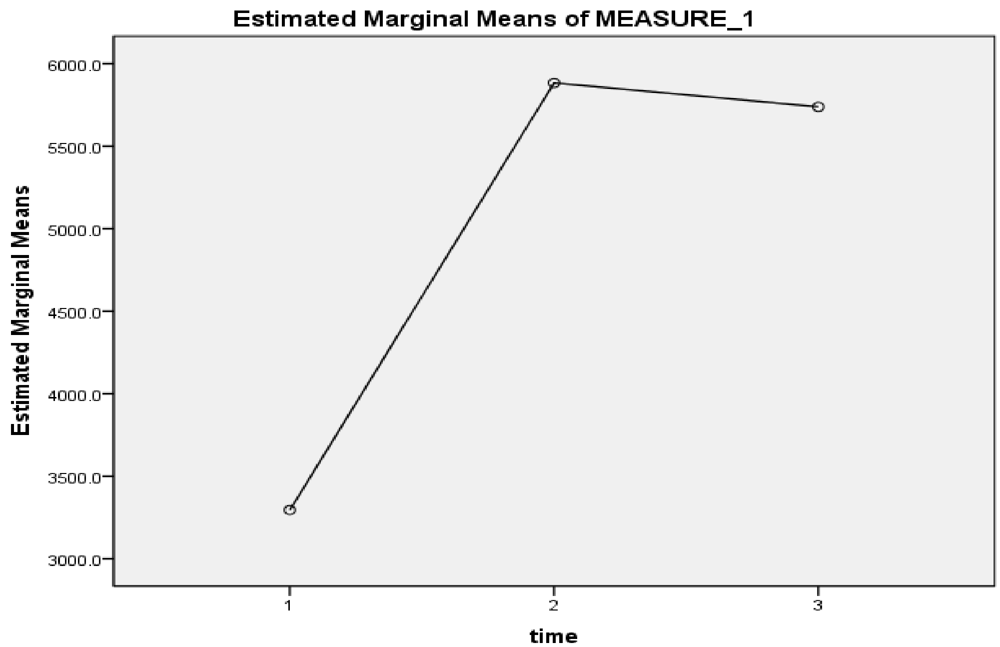
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 15a: Overall time effect for Hip Flexion (HFLEX) by groups



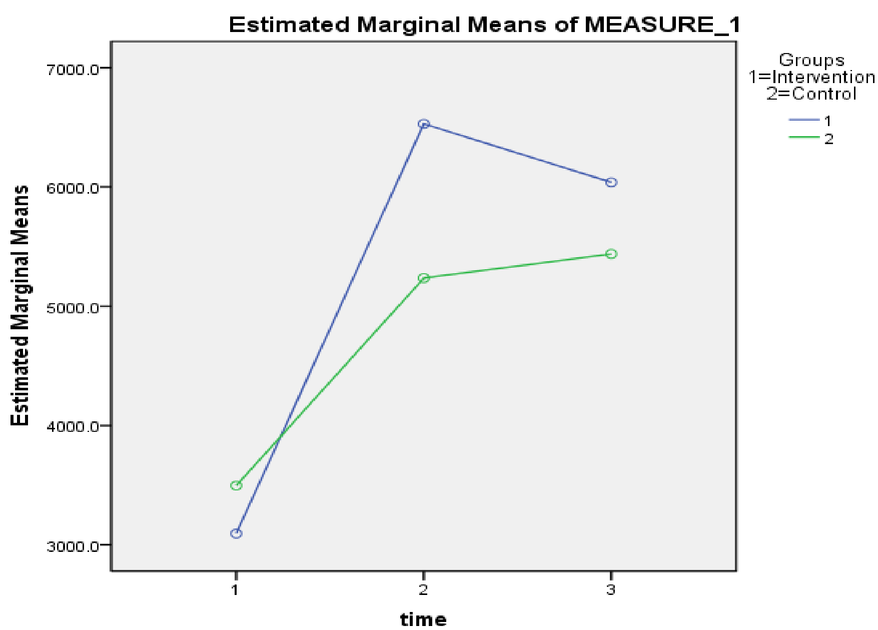
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 16: Overall time effect for Physical Activity (PATOT) for the total sample



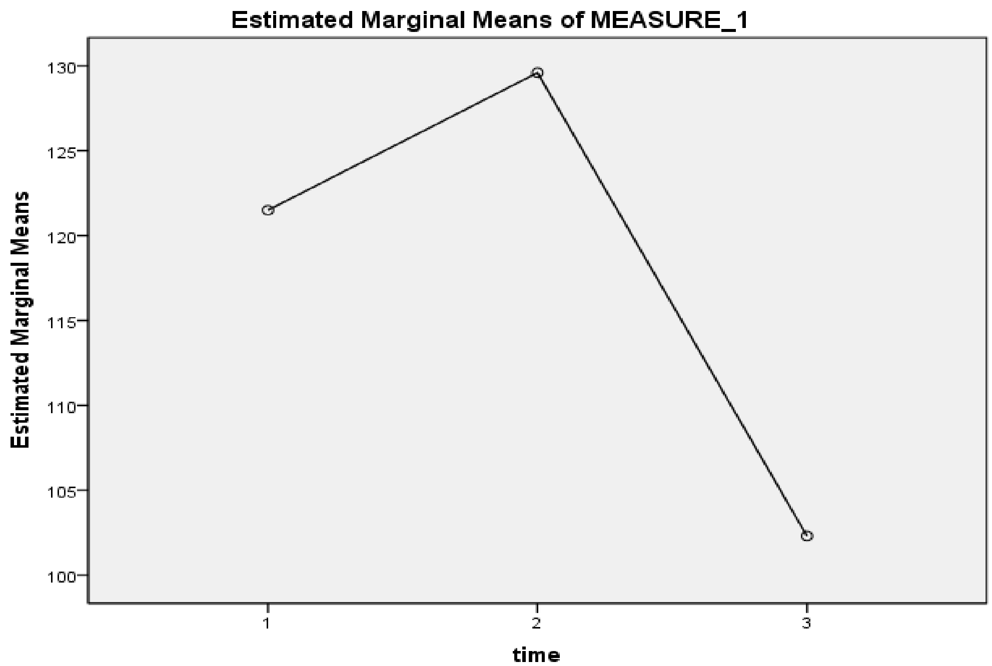
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 16a: Overall time effect for Physical Activity (PATOT) by groups



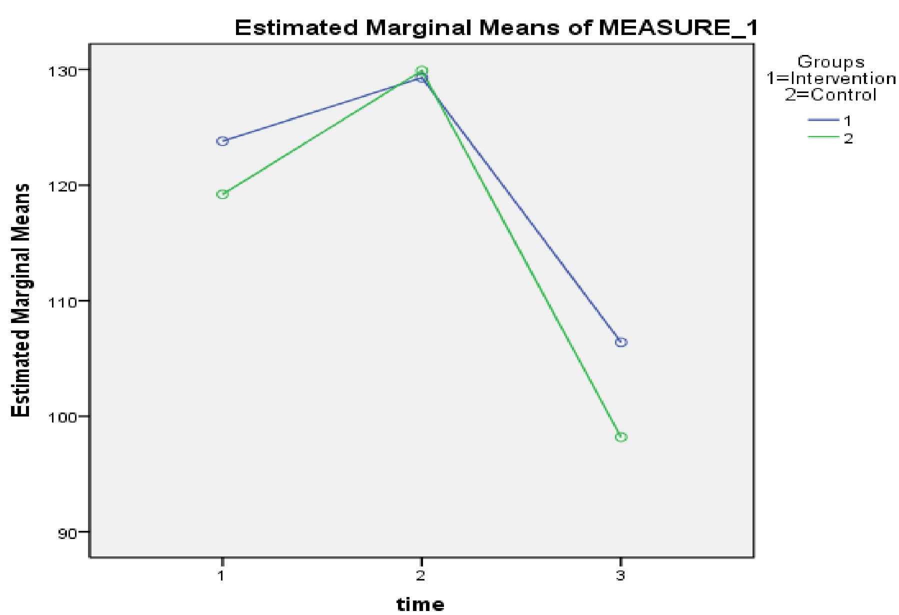
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 17: Overall time effect for Exercise Self-efficacy (ESE) for the total sample



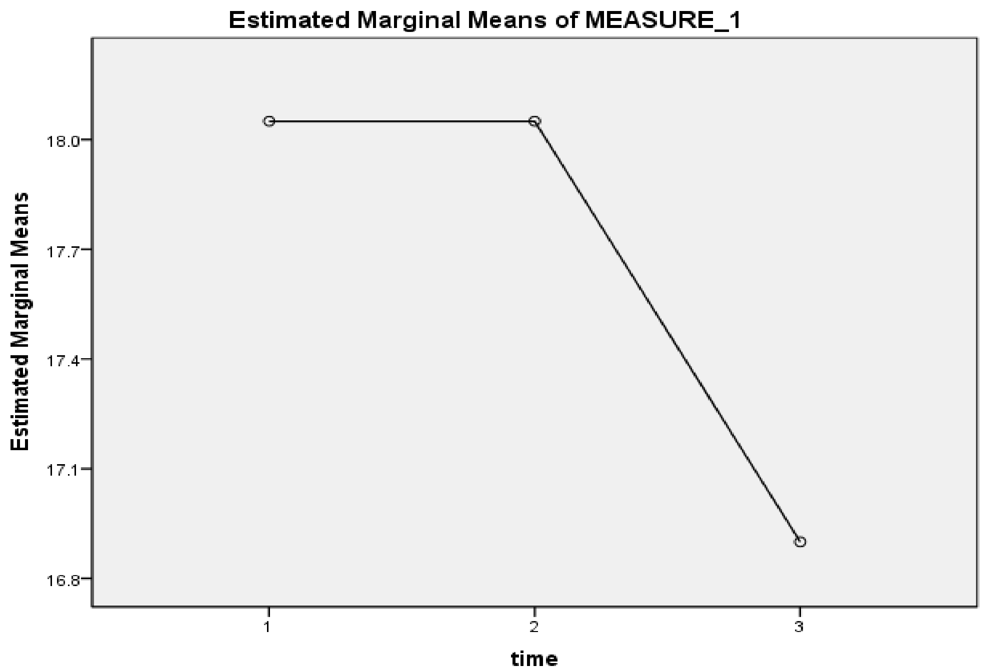
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 17a: Overall time effect for Exercise Self-efficacy (ESE) by groups



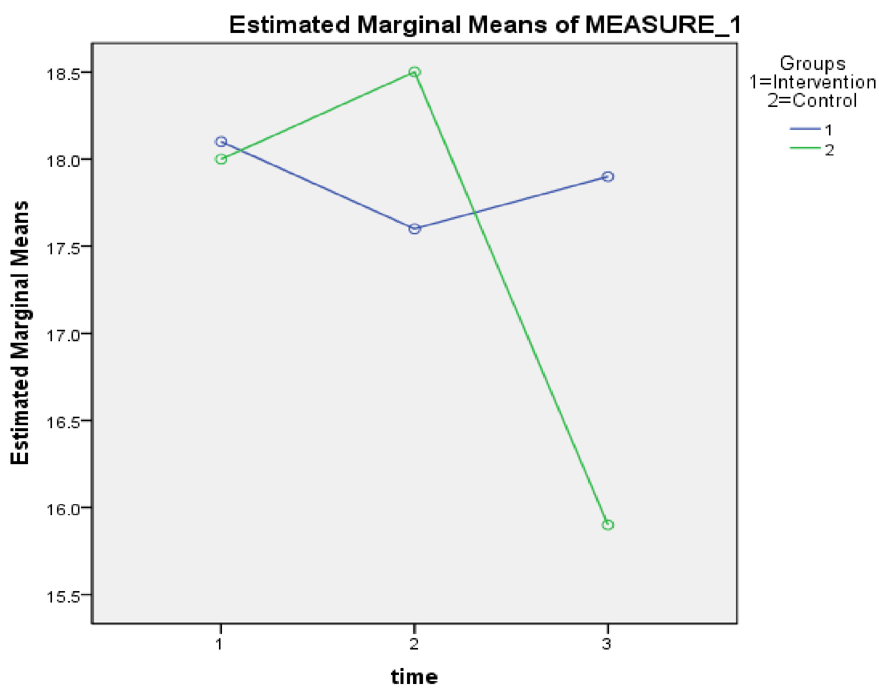
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 18: Overall time effect for Exercise Intention (EIS) for the total sample



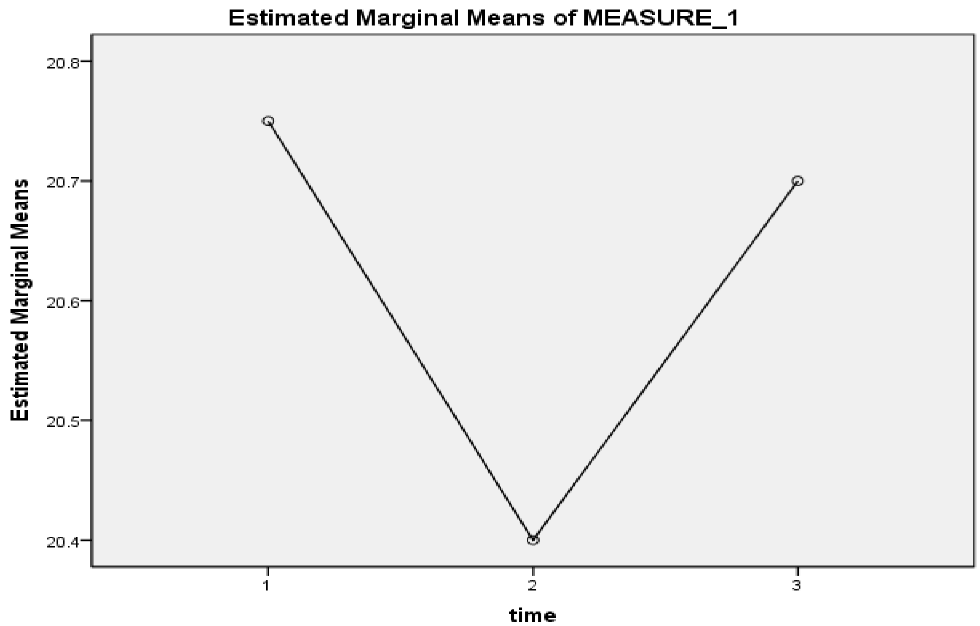
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 18a: Overall time effect for Exercise Intention (EIS)by groups



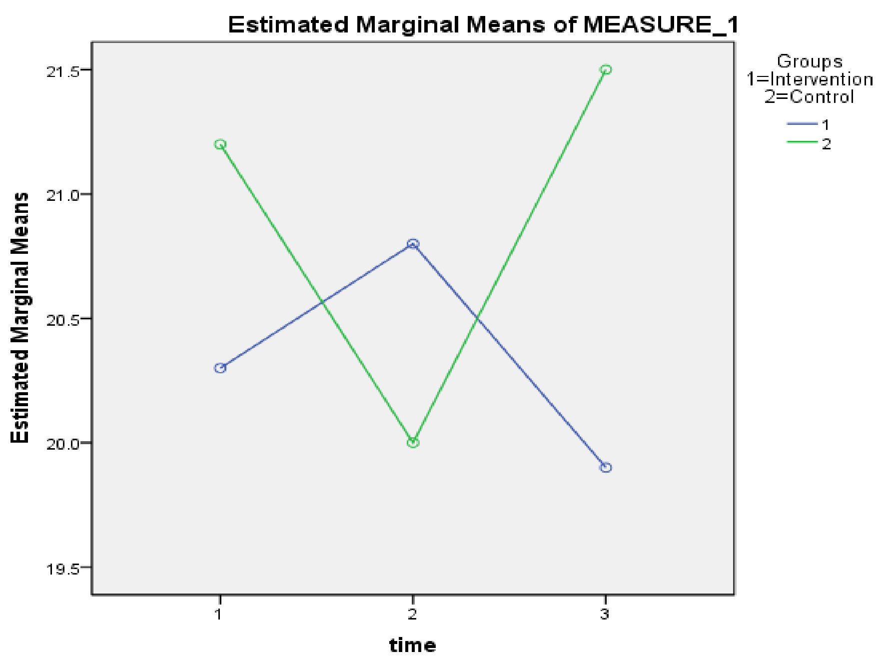
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 19: Overall time effect for Social Support for Exercise from Family (SSFAM) for the total sample



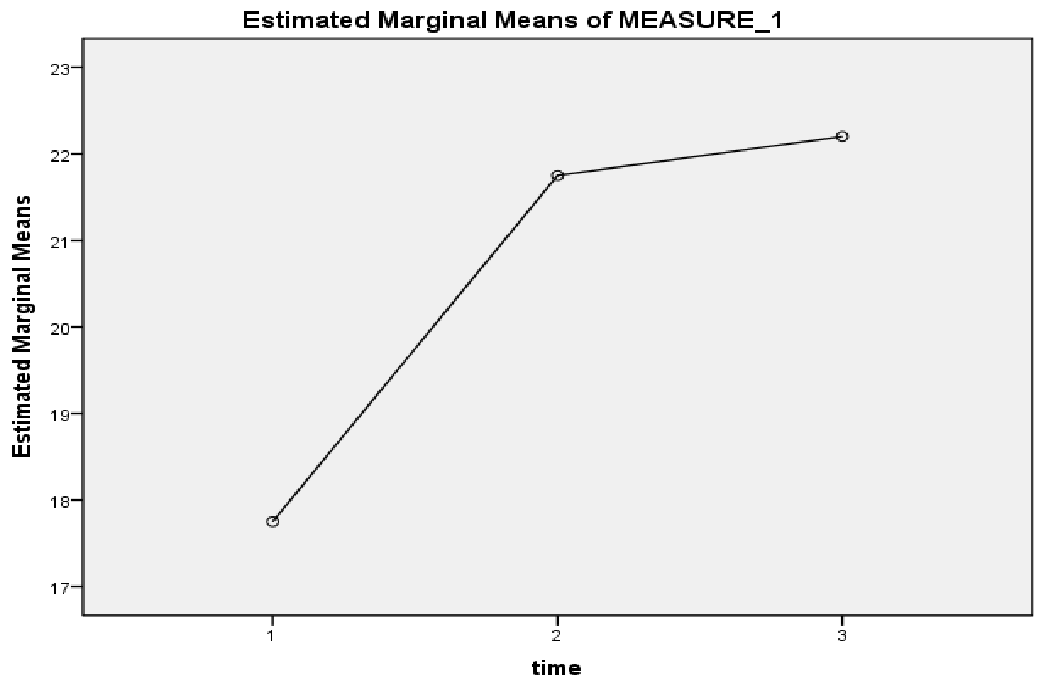
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 19a: Overall time effect for Social Support for Exercise from Family (SSFAM) by groups



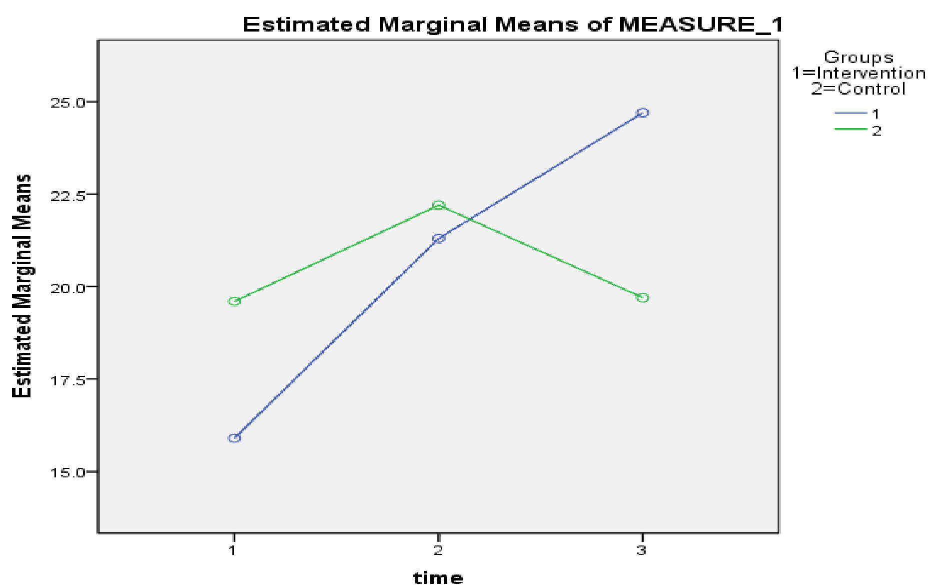
Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 20: Overall time effect for Social Support for Exercise from Friends (SSFRI) for the total sample



Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 20a: Overall time effect for Social Support for Exercise from Friends (SSFRI) by groups



Time: 1- pre-test; 2- post-test; 3- follow-up test

Figure 21: Correlation matrix for physical function, pain and stiffness variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. TFP pre	-	.704	.629															
2. TFP post	.704	-	.858															
3. TFP f-u	.629	.858	-															
4. LBS pre				-	.676	.579												
5. LBS post				.676	-	.80												
6. LBS f-u				.579	.80	-												
7. BAC pre							-	.643	.513									
8. BAC post							.643	-	.825									
9. BAC f-u							.513	.825	-									
10.PFWOMAC pre										-	.608	.525						
11.PFWOMAC post										.608	-	.817						
12.PFWOMAC f-u										.525	.817	-						
13.PWOMAC pre													-	.096	.606			
14.PWOMAC post													.096	-	.262			
15.PWOMAC f-u													.606	.262	-			
16.SWOMAC pre																-	.280	.492
17.SWOMAC post																.280	-	.528
18.SWOMAC f-u																.492	.528	-

Figure 22: Correlation matrix for balance variables

	1	2	3	4	5	6	7	8	9
1. STS pre	-	.937	.609						
2. STS post	.937	-	.694						
3. STS f-u	.609		-						
4. TW pre				-	.175	.068			
5. TW post				.175	-	.496			
6. TW f-u				.068	.496	-			
7. SQT pre							-	.714	.645
8. SQT post							.714	-	.509
9. SQT f-u							.645	.509	-

Figure 23: Correlation matrix for flexibility variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. APFLEX pre	-	.628	.276															
2. APFLEX post	.628	-	.510															
3. APFLEX f-u	.276	.510	-															
4. ADFLEX pre				-	.298	.374												
5. ADFLEX post				.298	-	.307												
6. ADFLEX f-u				.374	.307	-												
7. KEXT pre							-	.249	.213									
8. KEXT post							.249	-	.089									
9. KEXT f-u							.213	.089	-									
10.KFLEX pre										-	.902	.639						
11.KFLEX post										.902	-	.719						
12.KFLEX f-u										.639	.719	-						
13.HEXT pre													-	.039	.214			
14.HEXT post													.039	-	.075			
15.HEXT f-u													.214	.075	-			
16.HFLEX pre																-	.126	.250
17.HFLEX post																.126	-	.593
18.HFLEX f-u																.250	.593	-

Figure 24: Correlation matrix for physical activity and predictors of exercise variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. PATOT pre	-	.143	.458												
2. PATOT post	.143	-	.377												
3. PATOT f-u	.458	.377	-												
4. ESE pre				-	.608	.298									
5. ESE post				.608	-	.661									
6. ESE f-u				.298	.661	-									
7. EIS pre							-	.355	.299						
8. EIS post							.355	-	.386						
9. EIS f-u							.299	.386	-						
10.SSFAM pre										-	.769	.644			
11.SSFAM post										.769	-	.442			
12.SSFAM f-u										.644	.442	-			
13.SSFRI pre													-	.387	.444
14.SSFRI post													.387	-	.407
15.SSFRI f-u													.444	.407	-