THE EFFECT OF ILIOPSOAS EXERCISES ON LOW BACK PAIN, FUNCTION, AND RANGE OF MOTION

A THESIS

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BY

KATHRYN L. BARTON, B.S.

DENTON, TEXAS

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TEXAS WOMAN'S UNIVERSITY
DENTON, TEXAS

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To the Dean of the Graduate School:

I am submitting herewith a thesis written by Kathryn L. Barton entitled "The Effect of Iliopsoas Exercises on Low Back Pain, Function, and Range of Motion." I have examined this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Masters of Science with a major in Kinesiology.

David L. Nichols, Major Professor

We have read this thesis and recommend its acceptance:

Department Chair

Accepted:

Dean of the Graduate School

DEDICATION

In loving memory of my father, John H. Barton, whose encouragement, guidance, and love made me the person I am today. He will be forever loved and missed.

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ABSTRACT

KATHRYN L. BARTON

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The purpose of this study was to determine if 6 weeks of iliopsoas exercises would relieve low back pain and increase range of motion. Twenty-four men and women (25-65 years) with self-reported low back pain were randomly assigned to exercise either once a day (Group 1, n=7), twice a day (Group 2, n=7) or were in the control group (n=10). Surveys regarding pain and function were taken by all participants at baseline, 3 weeks, and 6 weeks. Measurements of lumbar and hip flexion were also obtained. A significant improvement ($p < .05$) in low back pain over 6-weeks was found in both exercise groups. A significant increase in lumbar flexion was found in exercise Group 2. No significant difference was found in function or hip flexion. In conclusion, exercising the iliopsoas results in decreased low back pain, but may not be a beneficial approach in improving function.

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CHAPTER I

INTRODUCTION AND PROBLEM

If you are over 30 years of age, stressed or have bad posture, then you may be among the many who suffer from low back pain. Low back pain is a common problem for much of the population. Although low back pain has been the focus of much research, there is an inadequate connection between investigative findings, clinical symptoms, and treatment strategies (Kader, Smith, & Wardlaw, 2000). There is more than one cause of low back pain, and no one knows for sure what treatments work best in alleviating the pain.

Low back pain can be caused by a variety of factors, and the cause can come from many different areas of the body. It does not often occur in one single episode. The causes are many faceted and may include years of bad posture while sitting, walking, lifting, and standing that cause muscles to become weak and tight (Kader et al., 2000). This means that back pain can come from damaged nerves (due to spinal stenosis, which is a narrowing of the spinal canal), disc bulge, poor alignment of the vertebrae and spasms of deep back, as well as, deep abdominal muscles (Domholdt, Friel, & Smith, 2005; Kader et al.). Pain felt in the low back may also radiate from areas like the middle or upper back or a hernia in the groin area (Kader et al.). Various symptoms such as burning, tingling, and leg weakness can occur. In the general population, physical characteristics associated with the development of low back pain include: decreased iliopsoas and hamstring muscle length, weakened abdominal and back extensor muscles, and decreased back extensor muscle endurance (Domholdt et al.). In addition, optimal musculoskeletal function requires that an adequate range of motion be maintained in all joints, particularly in the lower back and posterior thigh regions, as lack of flexibility (i.e., the ability to move a joint through its complete range of motion) in this region may be associated with an increased risk for the development of chronic low back pain (Balady et al., 2000).

Purpose

According to the National Institutes of Health (2008), low back pain is the number two reason that Americans see their physician, second only to colds and the flu. The general public can utilize self-care measures that will allow for alleviation of low back pain. Low back pain may be acute, lasting less than 1 month, or chronic, lasting longer than 3 months. While developing acute back pain more than once is common, long-term pain is not (National Institutes of Health). The National Institutes of Health has identified several types of people who may be at a greater risk for acquiring low back pain. These people are those who:

- Have bad posture,

- Are over age 30,
- Are pregnant,
- Smoke, do not exercise, or are overweight,
- Have arthritis or osteoporosis,
- Work in construction or another job requiring heavy lifting, frequent bending and twisting, or whole body vibration (e.g., driving a truck, operating a sandblaster, or using a jackhammer),
- Have a low pain threshold, and/or
- Feel stressed or depressed.

In addition to the above, athletes may be at risk for increased low back pain. The types of athletes at risk include participants of sports that require a large amount of kicking and hip movement, such as football, gymnastics, soccer, rowing (Arnold & Hosea, 2008) and cycling (Little & Mansoor, 2008). This might not only cause low back pain, but can also cause iliopsoas tendonitis and bursitis (Johnston, Lindsay, Wiley, & Wiseman, 1998). Iliopsoas tendinitis refers to inflammation of the iliopsoas muscle, which can also affect the bursa located underneath the tendon of iliopsoas muscle, resulting in bursitis and causing excruciating hip pain and low back pain (Johnston et al.). It has been proposed by Johnston et al. that acute or chronic occupational trauma and sports injuries have accounted for the majority of reported cases of iliopsoas bursitis. Other exercises, such as weight lifting and strength training, could cause such pain or syndromes due to the amount of bending and squatting involved (Johnston et al.). The purpose of this study was to find out if exercises that target the iliopsoas muscle would improve low back pain, while also determining if there was a difference if exercises are done once or twice a day.

Hypotheses

Should the focus of relieving back pain be on stretching and becoming more flexible? We have all heard at one time or another that flexible muscles are important in the prevention of injuries. Therefore, the purpose of this study was to determine if a combination of strengthening and stretching the iliopsoas would relieve low back pain, improve function, and increase flexibility during hip and lumbar flexion. My hypothesis was that completing an exercise program that targeted the iliopsoas muscle would be a beneficial approach to alleviating low back pain, improving function, and increasing the range of motion during hip and lumbar flexion. The premise is that these back and abdominal exercises for the iliopsoas muscle will stabilize the pelvis and ease the stiffness that shifts the pelvis, consequently resulting in pain.

The null hypotheses were: (a) there was no effect of exercise on the dependent variables of lumbar flexion and function of the low back; (b) there was no effect of time on the dependent variables of lumbar flexion and function of the low back; (c) there was no interaction effect of exercise and time on the dependent variables of lumbar flexion and function of the low back; and (d) there was no effect of exercise on the dependent variable of low back pain. To test these hypotheses, the significance level was set at .05.

Operational Definitions

Low back pain: a distressing sensation felt along the lower spine or in the musculature of the posterior thorax (Davis, 2001). For this study, low back pain was measured by simply asking the participant if he/she has low back pain. It will also be assessed using the visual analog pain scale (VAPS) [Lowe & Wewers, 1990] during 20 min of sitting, standing, and walking.

Function: the action performed by any structure (Davis, 2001). For this study, functional status of the iliopsoas muscle was measured using the Oswestry Disability Index (ODI) [Fairbank & Pynsent, 2000].

Range of motion: the distance through which a joint can move, measured in degrees of a circle (Davis, 2001). For this study, range of motion was measured using inclinometers to calculate forward flexion of the lumbar spine.

Assumptions and Limitations

Before proceeding, the investigator must presume that certain conditions are present. One condition assumed is that participants are capable of exercising and will be truthful about performing their exercises on a daily basis. Another assumption is that the instruments for measuring data, such as the VAPS, self-reported function survey (ODI), other diagnostic tests, and testers, are valid and reliable. Finally, it must be assumed that the participants understand the directions and will follow instructions.

Along with assumptions, there are also limitations. One limitation is there could be differences by the participants in the interpretation of the questions on the pain scale and the self-reported function questionnaires. Another limitation is differences in the way the participants correctly perform the exercises. While the exercises chosen for this study target the iliopsoas muscle, there is a possibility that other muscles will be affected by the exercises, which is a limitation of this study. Lastly, the participants' truthfulness in responding to the questionnaires is also a limitation of this study.

Significance

Low back pain is a common occurrence, with no one cause or treatment. Backache is not an illness in itself but a symptom; its development means something has gone wrong somewhere, although it may not be clear what (Goldmann & Horowitz, 2000). This purpose of this study is to establish if exercising the iliopsoas muscle would result in a significant decrease in low back pain, a significant increase in function, as measured by ODI scores, and a significant increase in lumbar and hip range of motion.

CHAPTER II

LITERATURE REVIEW

Low back pain is a common problem associated with unstable trunk muscles. The literature regarding low back pain is inconsistent about the connection of the iliopsoas to low back pain. Common daily movements such as trunk rotation, bending and lifting have been associated with acquiring low back pain (Andersson, Grundstrom, & Thorstennson, 2002). However, the involvement of deep trunk muscles (i.e., the iliopsoas) in such movements has not been studied thoroughly. The use of flexibility and proprioceptive neuromuscular facilitation exercises have been studied to examine if these will contribute to freedom from low back pain (Ames & Konczak, 2005; Domholdt et al., 2005; Kuukkanen & Malkia, 2000). Throughout the literature a universal theme arises. The cross sectional area of the iliopsoas (and other deep abdominal muscles) appears to have a connection to whether or not one will suffer from low back pain (Barker, Jackson, & Shamley, 2004; Dangaria & Naesh, 1998). In addition, there are also rare ailments that have effects on the psoas muscle and contribute to low back pain (Chalaupka, 2006). These issues will be examined to determine if a more complete connection exists between low back pain and the iliopsoas muscle.

Anatomy

Before comprehending the association between low back pain and the iliopsoas muscle, the anatomy must be understood. The iliopsoas muscle is a group of deep abdominal muscles. The iliopsoas is comprised of the psoas major, psoas minor and the iliacus (refer to Figure A1 in Appendix A; Tank, 2005).

All three muscles function as hip flexors. This action is primarily to lift the upper leg towards the body when the body is fixed or to pull the body toward the leg when the leg is fixed (Davis, 2001; Martini, 2001). The psoas major is a contributor of spinal rotation, or turning the trunk left or right (Tank, 2005). According to Martini, these muscles also perform the flexion movement at lumbar intervertebral joints, or the space between two adjacent vertebrae, allowing one to bend forward. When in the standing position, the psoas muscles and abdominals act as antagonists (the psoas muscles move the pubis backward while the abdominals pull the pubis forward) allowing for proper alignment of the spine and hips (Martini).

The psoas major originates from the anterior surfaces and transverse processes of vertebrae T_{12}-L_5 (Martini, 2001). Its tendon joins with the iliacus to insert into the lesser trochanter of the femur (Martini). The psoas major is innervated by branches L_2-L_3 of the lumbar plexus (Tank, 2005). The psoas minor is a long, slender muscle placed in front of the psoas major muscle, and is only present in about 60% of individuals (Tank). If the psoas minor is absent, it is often because of the general variation from person to person. Not having this small muscle does not impede life in any way (Martini; Tank). It arises from the sides of the bodies of T_{12} and L_1, including the intervertebral disc between them (Martini). The psoas minor tendon inserts into the pectineal line on the pubis, the illiopectineal eminence (union of ilium and pubis) and the iliac fascia (Martini). It is innervated by the L_2-L_3 branches of the lumbar plexus (Martini; Tank). Finally, the iliacus originates in the iliac fossa of the ilium and inserts, with its tendon fused with the psoas major, into the femur distal to the lesser trochanter (refer to Figure A2 in Appendix A; Tank). Distal refers to the furthest point from the trunk or midline of the body (Davis, 2001). The iliacus is innervated by the femoral (L_2-L_3) nerve (Martini). For ease of interpretation, the branches of the lumbar plexus, seen in Figure A3 in Appendix A (Martini), exit through the intervertebral foramen of the vertebrae, seen in Figure A4 in Appendix A (Martini). The anatomy is important to understand in order to recognize the relationship of the iliopsoas muscle and low back pain as well as low back function.

Kuukkanen & Malkia (2000) believe that having a flexible core (including the iliopsoas), contributes to relief of back pain. Gold (2004) suggests, instead of simply strengthening a specific muscle, the emphasis must be on awareness, control, balancing, and coordination of the involved muscles. In other words, when the iliopsoas muscles achieve their proper length and responsiveness, they stabilize the lumbar spine, giving the feeling of better support and strength, and cause the spine and abdomen to fall back, giving the appearance of strong abdominal muscles and the feeling of a strong core (Kuukkanen & Malkia). Gold further explains:

> Doing exercises, such as crunches, strengthen the abdominal muscles while at the same time overpowering the psoas muscles, placing them at too high of a level of tension, subsequently causing back pain. High abdominal muscle tone from abdominal crunches interferes with the ability to stand fully erect, as the contracted abdominal muscles drag the front of the ribs down. Numerous consequences follow: (a) breathing is impaired, (b) compression of abdominal contents results, impeding circulation, (c) deprived of the pumping effect of motion on fluid circulation, the lumbar plexus, which is embedded in the psoas, becomes less functional (slowed circulation slows tissue nutrition and removal of metabolic waste; nerve plexus metabolism slows; chronic constipation often results), and (d) displacement of the centers of gravity of the body's segments from a vertical arrangement (standing or sitting) deprives them of support; gravity then drags them down and further in the direction of displacement; muscular involvement (at the back of the body) then becomes necessary to counteract what is, in effect, a movement toward collapse. This muscular effort (a) taxes the body's vital resources, (b) introduces strain in

> the involved musculature (i.e., the extensors of the back), and (c) sets the stage for back pain and back injury. (p. 5)

While most of the literature points to stretching the iliopsoas, there is not enough clinical evidence to support a theory that strengthening the iliopsoas would or would not contribute to the relief of low back pain. As stated by Jaakkola, Kujala, Oksanen, Salminen, & Taimela (1992), optimal extensibility (length) of the iliopsoas is needed to prevent low back pain. However, one study reported that administering proprioceptive neuromuscular facilitation exercises of the psoas muscle to a chiropractic patient presenting with low back pain was effective in relief of symptoms (Ames & Konczak, 2005). Proprioceptive neuromuscular facilitation is a more advanced form of flexibility training that involves both the stretching and contraction of the muscle group being targeted. It is an excellent way to target specific muscle groups, increase flexibility, and improve muscular strength.

Body Movements and Low Back Pain

Frequent daily trunk twisting and decreased maximal strength during trunk rotation has been associated with low back pain and sciatic pain (Dufresne, Kumar, & van Schoort, 1995; Ferguson & Marras, 1997). Andersson et al. (2002) conducted a study to observe activation levels of deep trunk muscles in various unresisted and resisted trunk rotations. Researchers included six healthy men and four healthy women with a mean age ($\pm$SD) of 24 $\pm$ 2 years and 23 $\pm$ 2 years, respectively. They reported that while sitting, the highest involvement of the iliopsoas was on the ipsilateral (same) side during maximal trunk rotation with shoulder resistance. Interestingly, during unresisted maximal twisting of the trunk while sitting, the psoas major was active bilaterally, while the iliacus was only active ipsilaterally.

Traditional conservative therapies are intended to strengthen the muscles of the trunk using a judicious regimen of physical exercises (Claes et al., 1998). With this thought in mind, Claes et al. looked at the co-activation of the psoas and multifidi muscles on 18 cadaver specimens. They wanted to determine the consequences of a stimulation of muscle forces that cause flexion-extension, lateral bending and axial/trunk movements on the loads imposed on the functional spinal units (i.e., the psoas and multifidi). The researchers found that the co-activation of those muscles was accompanied by a 20% decrease in the range of motion of the trunk during lateral bending and axial movements. This decrease in range of motion translates to a significant increase in stability of the spine (Claes et al.). On the contrary, co-activation of the psoas and multifidi during flexion-extension caused an increase in percent range of motion, translating to a decrease in spinal stability. This is an important finding. Therapists and chiropractors should use this information when determining the appropriate exercise program for patients.

An issue with the two aforementioned studies, Anderson et al. (2002) and Claes et al. (1998) is that they only looked at a small sample of healthy subjects and a small sample of deceased subjects. It would be worthy of noting the consequences of the activation of these muscles in those who suffer from low back pain. Another drawback is that the sample size is too small to determine what the effects would be on different age groups and people of different heights, weights and physical conditions.

Cross Sectional Area of Muscle and Low Back Pain

A fascinating aspect of low back pain is the difference in the cross sectional area seen in the iliopsoas in people who suffer from low back pain compared to those who do not. In recent years, numerous data regarding the size and properties of muscles in patients with low back pain have been published (Emlik, Kamaz, Kiresi, Levendoglu, & Oguz, 2007). There are two main findings in the degeneration of muscles: a decrease in the size of the muscle (i.e., decrease in cross sectional area or atrophy) and an increase in the amount of fatty deposits within the muscle (Cambier, Cuyper, Danneels, Vanderstraeten, & Witvrouw, 2000). Nonuse of the muscles due to low back pain causes atrophy, both in flexor and extensor muscles (Cambier et al.; Emlik et al.). Barker et al. (2004) compared the cross sectional area of the psoas between the symptomatic and asymptomatic sides. The results yielded a significant difference in the cross sectional area between sides with a positive correlation between the percentage decrease in the cross sectional area of the psoas on the affected side and the rating of pain, reported nerve compression, and the duration of symptoms. These results are consistent with other studies of this nature. For example, Dangaria and Naesh (1998), as well as, Emlik et al. observed a significant reduction in the cross sectional area of the psoas major at the level and the site of the disc herniation with a positive correlation between that finding and the duration of symptoms. The evidence of atrophy of the psoas suggests that future studies be for selective exercise training of the psoas, which is less commonly used in clinical practice (Barker et al.).

Diseases of the Iliopsoas Muscle Associated with Low Back Pain

There are diseases of the iliopsoas which can cause low back pain. Although they are rare and abnormal, they are worth noting. Schwannomas are rare benign tumors, consisting only of Schwann cells, which occur either singly or in association with neurofibromatosis (Breatnach, Coughlan, Downey, & Foley-Nolan, 1989). Neurofibromatosis is a genetic disorder of the nervous system which causes tumors to form on the nerves anywhere in the body at any time (Davis, 2001). Patients who have these types of tumors in the psoas present with chronic low back pain, pain with resisted ipsilateral hip flexion, tenderness over the paravertebral area, and a limitation in lateral trunk flexion to the opposite side of the lesion. In the case study by Breatnach et al., the patient had severe low back pain and no conventional treatment worked. After obtaining a computed tomography (CT) scan, doctors found a large Schwannoma in the psoas muscle. After surgical removal, the patient was asymptomatic. Another case study presented by Chalupka (2006), illustrated that disease of the psoas was causing a patient to have chronic low back pain, gait disturbances, and repetitive falls. In this case magnetic resonance imaging (MRI) showed an abscess, known as primary pyomytosis (a bacterial infection in the skeletal muscle), in the psoas. Again once the infection was cured, the low back pain and other symptoms disappeared. If a healthcare provider finds that conservative treatment and therapy is not working to cure low back pain, the psoas muscle should be looked at for diseases.

Evaluation and Treatment of Low Back Pain

Low back pain should be appropriately evaluated to find the best course of treatment for the individual patient. There is good evidence for the effectiveness of acetaminophen, nonsteroidal anti-inflammatory drugs, skeletal muscle relaxants, heat therapy, physical therapy, advice to stay active, and spinal manipulative therapy (Kinkade, 2007). Patient medical history and physical examination should be the first evaluative processes that occur when seeing a doctor for low back pain. Physicians should look for certain symptoms (i.e., progressive neurological deficits, bowel or bladder dysfunction and bilateral leg weakness) that would require immediate imaging or laboratory tests (Kinkade). Screening tests include the straight leg and crossed straight leg raises, as well as testing strength and reflexes in the legs. According to Deyo (1986), 95% of patients who have a herniated disc (i.e., the spinal disc pushes out of its normal boundary, compressing spinal nerves that supply the lower extremities), also have sciatica (i.e., pain radiating down the back and sides of the legs beyond the knee). Therefore, if a patient has sciatica, it is very likely that they have a herniated disc which needs immediate attention. Most cases of low back pain resolve with conservative therapy and imaging is not required; however, if the pain does not stop within that time frame, a computed tomography scan or magnetic resonance image may be appropriate (Kinkade).

Conservative therapy includes medication, physical therapy, acupuncture, massage, exercise, and bed rest. Treatment methods for low back pain are as follows:

Medication

Anti-inflammatory Drugs

Acetaminophen and non-steroidal anti-inflammatory drugs have been proven effective in the relief of low back pain. Deyo, Koes, Scholten, & van Tulder (2006) noted significant improvement in pain control when using nonsteroidal anti-inflammatory drugs versus a placebo. They also found about the same amount of pain control when using acetaminophen; in other words, the two drugs are equally effective.

Opioids, Muscle Relaxants, and Corticosteroids

Other medications that may be used are opioids, muscle relaxants, and corticosteroids. Several studies have shown no significant advantage of opioid use in symptom relief when compared with acetaminophen or nonsteroidal anti-inflammatory drugs (Deyo et al., 2006; Kinkade, 2007). Muscle relaxants are helpful in the treatment of low back pain. Patients receiving a muscle relaxant had significant improvements in symptoms compared to those who received the placebo (Browning, Jackson, & O'Malley, 2001). While no studies support the use of oral steroids in patients with acute low back pain, epidural injections may be useful in patients with radicular symptoms (i.e., pain that radiates along the dermatome of a nerve) that do not respond to 2 to 6 weeks of conservative therapy (Kinkade).

Acupuncture, Physical Therapy, and Massage

With regard to acupuncture and massage, there are few and conflicting reports concerning the effectiveness. One group of researchers reported no evidence to support the benefit of acupuncture to alleviate low back pain or improve function (Berman, Ernst, Forys, Manheimer, & White, 2005). Another study consisting of patients with low back pain and sciatica found acupuncture to be helpful (Cherkin et al., 2005).

Physical therapy includes a multi-faceted approach to recovery. It can include such treatments as exercise, use of modalities (hot/cold pack, interferential stimulation, traction, massage and ultrasound) and patient education. While patient education appears to be helpful (Mannion & Moffett, 2005), traction and other modalities seem to have only short-term effects (Kinkade, 2007). Cold therapy for treatment of low back pain does not seem to have a positive effect on relief, whereas heat therapy has been found to increase function and decrease pain (Cameron, Esterman, French, Reggars, & Walker, 2006). A study that compared three different approaches to treatment found physical therapy in addition to a home exercise program was most effective regarding pain, aerobic capacity, disability, and psychological disturbance (Atay, Dogan, Kurtais, & Tur, 2008).

Exercise as Treatment for Low Back Pain

Exercise versus Bed Rest

In the many studies regarding lower back pain, there seem to be conflicting results when considering exercise versus bed rest. According to one study by Hagen, Hilde, Jamtvedt, & Winnem (2004), bed rest provides no benefit to patients who have low back pain. The researchers reviewed 1963 patient files to determine the effects of advice (to rest in bed versus to stay active) on pain, functional status, recovery time, and return to work. The study included males and females, aged 16-80 years old, who had low back pain for up to 4 weeks or exacerbations of chronic pain lasting less than 4 weeks. Regarding pain, the

Hagen et al. review found a "consistent and significant difference in favor of staying active" (p. 7).

There is strong evidence that exercise versus bed rest results in less time missed from work, improved functional status, and less pain (Aro et al., 1995; Hagen et al. 2004). And yet, Kinkade (2007) reports while staying active is effective in relieving low back pain, specific back exercise for patients with low back pain are not helpful. Another study yielded similar results, where it was observed that structured exercise therapy produced no benefit to the relief of low back pain (Hayden, Koes, Malmivaara, & van Tulder, 2005).

Types of Exercise

There are many studies that support exercise as a treatment for low back pain. However, the lingering question of what exercises or combination of exercises will relieve low back pain still plagues researchers.

Aerobics, aquatics, and flexibility training. Chatzitheodorou, Kabitsis, Malliou, & Mougios (2007) suggest that regular high intensity aerobic exercise alleviated pain, disability and psychological strain with regard to low back pain. A common argument amongst healthcare professionals is that flexibility exercises are an adequate treatment for low back pain. A study completed by Kuukkanen & Malkia (2000) looked at the effects of a 3-month therapeutic exercise program on flexibility in subjects with low back pain. The study consisted of 86 adult participants (39 males and 47 females; age not reported) who had low back pain, but did not have sciatica or previous back surgeries. The exercise program was progressive in nature and consisted of strength, endurance, and flexibility exercises. The results yielded minimal and no significant changes in iliopsoas flexibility and found no correlation between flexibility and the ODI or back pain intensity scores. The ODI is a questionnaire that assesses how low back pain affects activities of daily living. Although the participants' low back pain improved throughout the study, the improvements were decreased again after several weeks of no exercise. This implies that if one keeps exercising, low back pain will continue to decrease and possibly not return.

In a 2009 study, researchers compared aquatic exercise versus land based exercise and its effects on lumbar flexion and low back pain, based on VAPS scores during rest and movement, and function, as measured by ODI scores (Dundar, Evcik, Kavuncu, Solak, & Yigit). Dundar et al. had participants complete either a water aerobics program supervised by a physiotherapist or an individual land based exercise program. Both groups performed aerobics, stretching, and strengthening workouts and for 60 min, 5 times per week for 4 weeks. Significant improvements in lumbar flexion and VAPS scores were found in both groups. In addition, results were not significant between groups. The investigators did find, however, that the aquatic group had significant improvements in function, whereas the land based exercise group did not.

Flexibility is defined as the absolute range of motion in a joint or series of joints and muscles that is attainable (Davis, 2001), and is therefore directly related to the length of a muscle. This means that the tighter (i.e., shorter) a muscle is, the less flexible it will be, and vice versa. A common suggestion is that flexibility (i.e., longer muscles) is a key factor in having less pain overall (Aro et al., 1995). However, some studies have contradicted this theory by finding that those who suffer from low back pain actually have longer hip flexors (hamstring and iliopsoas muscles) than those without low back pain (Arabloo, Nourbakhsh, & Salavanti, 2006; Domholdt et al., 2005). Domholdt et al. found significant differences in functional limitations, iliopsoas length, back extensor strength and back extensor endurance between those with and without low back pain. Although the low back pain subjects in the Arabloo et al. study had longer iliopsoas muscles, they also had weaker abdominal muscles. It is fair to say that a combination of both impairments can lead to chronic low back pain. The only problem with the testing of the iliopsoas muscle length is that the investigators only used one test. It would be more effective to test muscle length two or even three different ways and average the scores.

Conventional treatment combined with exercise. Ames & Konczak (2005) did a case study on a 35-year-old male with low back pain. The participant was given a home exercise program, consisting of flexibility and proprioceptive neuromuscular facilitation exercises, and also received chiropractic treatment on the iliopsoas muscle. Significant improvements in his low back pain were obtained within 3 weeks. Although it was a case study, it suggests that conventional therapy, such as physical and chiropractic therapy, in addition to an exercise program is a good approach to seeing significant changes in iliopsoas function with subsequent improvements in low back pain. Legier (2005) completed a case study on a 43-year-old female suffering from low back pain with decreases in iliopsoas muscle function. The study consisted of a home exercise program and chiropractic treatment, comparable to the Ames and Konczak study. The study also yielded similar results to the Ames and Konczak study. Incorporation of active patient participation seems to be a significant factor in the resolution of the patient's low back pain (Legier). Active patient participation, such as taking the initiative to exercise, is important in the success of relieving low back pain.

In a recent study, researchers discovered that exercise combined with physical therapist assistance leads to significant improvements in VAPS scores in people with chronic low back pain (Dufour, Lundsgaard, Oefeldt, Stender, Thamsborg, 2010). Group 1 completed 12 weeks of exercise consisting of aerobics and back strengthening exercises done in the supine position. This group exercised for 5 hr per week on their own and 1 hr per week with a therapist. Group 2 completed 12 weeks of exercise consisting of body and leg lifting exercises in the prone position, as well as, dynamic contraction exercises of painful low back muscles. This group exercised for 4 hr per week on their own and 2 hr per week with a therapist. After the 12-week treatment, both groups showed significant improvements in low back pain, as measured by the VAPS. There was no significance between the groups. These improvements were maintained at the 6 and 12-month follow-ups but not at the 24-month follow-up.

In conclusion, low back pain is a common problem associated with problems of the iliopsoas muscle. Common daily movements strain muscles in the body which contribute to low back pain. The use of flexibility and proprioceptive neuromuscular facilitation exercises may be a good way to contribute to freedom from low back pain. The cross sectional area of the iliopsoas (and other deep abdominal muscles) appears to have a connection to whether or not one will suffer from low back pain. It was determined that nonuse of the muscles due to low back pain or hip pain contributes to the decrease in cross sectional area. Therefore, exercise should be one factor in helping patients get relief from low back pain. The rare ailments discussed above should be taken into account when treatment (i.e., physical therapy or exercise) for low back pain is not working. Since there is not a solid connection between low back pain and the iliopsoas, the objective of this study will be to determine whether exercising the iliopsoas will be an effective approach in relieving low back pain.

CHAPTER III

METHODS

Participants

This study consisted of 30 volunteers who by self-report suffered from low back pain. Participants were randomly assigned to one of three groups: (a) exercise once per day (Exercise Group 1), (b) exercise twice per day (Exercise Group 2), or (c) Control Group. Each participant signed an informed consent (Appendix F) and approval from the Institutional Review Board (IRB) [Appendix E] was obtained prior to beginning the study.

Inclusion Criteria

Participants were included in the study if they were over the age of 18 years old. They also had to have low back pain and a body mass index (BMI) of less than 30 kg/m^2. In addition, participants had to have two of the following: a positive Thomas Test, decreased lumbar flexion (see Table 1 below [Magee, 1992]), excessive lordosis (i.e., a forward curvature of the spine at the lumbar level), at least a moderate disability as indicated by his/her score on the ODI (see Table 2 below for disability categories [Fairbank & Pynsent, 2000]), or an increase of at least one point on a 10 point scale when completing the VAPS during 20 min of sitting, standing or walking.

Table 1. Lumbar Flexion Normal Limits (Magee, 1992).	
Position	**Measurement**
Decreased Lumbar Flexion	0 to 44°
Normal Lumbar Flexion	45 to 55°
Maximum Lumbar Flexion	65 to 90°

Table 2. Oswestry Disability Index Raw Score Chart (Fairbank & Pynsent, 2000).	
Raw Score	**Disability Category**
0-4	No Disability
5-14	Mild Disability
15-24	Moderate Disability
25-34	Severe Disability
34+	Complete Disability

Exclusion Criteria

Participants were excluded from the study if they were pregnant, had osteoporosis, or were seeking treatment for low back pain from a physician, chiropractor, or physical therapist. In addition, if the participant was on disability or had a workman's compensation claim with their company, they were excluded from the study. Lastly, each participant filled out a PAR-Q & You form. If it was determined that the participant needed to consult their physician before beginning exercise, the participant was excluded from the study.

Testing and Equipment

Subjective Measurements

The participants were asked at the beginning, middle, and at the end of the study if they had low back pain, to which they responded with either a yes or no. Participants also completed the ODI as well as the VAPS. The ODI is a questionnaire that assesses how low back pain affects activities of daily living (i.e., functional status). Some studies have found a significant correlation between low back pain and functional scores as measured by the ODI (Domholdt et al., 2005; Emlik et al., 2007). The index is valid and reliable (Fairbank & Pynsent, 2000). Raw scores on the ODI were calculated based on the responses to each individual question. For each of the 10 questions, each response had a value: A=0, B=1, C=2, D=3, E=4, F=5. The values for each question were added together to get the total or raw score. See Table 2 above for a correlation between raw score and disability (Fairbank & Pynsent, 2000). A VAPS allows the participants to give a representation of their pain over time during certain tasks. For this study, the participants will track their pain level during 20 min each of sitting, standing, and walking. The VAPS is valid and reliable (Huskisson & Scott, 1976; Lowe & Wewers, 1990). The VAPS score if determined by the difference in pain level before and after 20 min each of sitting, standing, and walking. For example, if the participant had a starting value of 2 (annoying) and an ending value of 6 (dreadful), their score would be 4. In addition, if the participant had a starting value of 4 (uncomfortable) and walked for 20 min and felt better with a score of 2 (annoying), their score would be -2. See Appendix B for both ODI and VAPS assessments.

Objective Measurements

Each participant completed a PAR-Q & You form. This is a good questionnaire to determine whether one is ready to start exercising and whether they should consult their doctor first. Since the primary movements of the iliopsoas are hip flexion and lumbar flexion, the participants were tested to determine the ranges of these motions. The best test to determine iliopsoas tightness is the Thomas Test to assess hip flexion contracture (Andersson & Cocchiarella, 2001). If hip flexion contracture occurs (i.e., a shortening of the hip muscles), then the Thomas Test is considered positive and indicates limited hip motion and a shortened iliopsoas muscle (Evans, 1994). Figure B1 in Appendix B (Magee, 1992) displays a negative and positive Thomas Test. Using the guide set forth by Magee, the Thomas Test procedure was completed as followed:

a) The participant laid supine on the examining table.
b) The investigator checked for excessive lordosis, which is indicative of tight hip flexors.
c) The investigator flexed one of the participant's hips by bringing the knee to the chest to flatten out the lumbar spine.
d) The participant held the flexed hip against the chest.

e) If the test was negative (i.e., no flexion contracture), the hip that was being tested (i.e., straight leg) would have remained on the examining table.

f) If a contracture was present, the participant's straight leg would have risen off the table. This was a positive Thomas Test.

g) To ensure the test was positive, the participant's straight leg was pushed onto the table. This caused an increased lordosis, again indicating a positive Thomas Test, or tight iliopsoas muscle.

Measuring lumbar flexion range of motion will indicate flexibility (i.e., ability to move a joint through its complete range of motion) of the iliopsoas muscle. Lumbar flexion was tested using the two-inclinometer technique and procedure by Andersson & Cocchiarella (2001). An inclinometer is an instrument used to measure angles; which the use of, according to Andersson & Cocchiarella, is the preferred method of obtaining accurate and reproducible measurements for the spine. The inclinometer technique has been shown to be a reliable and valid method for measurement of lumbar range of motion, one that makes it possible to measure and differentiate movements of the hip from those of the lumbar spine (Ensink, Frese, Hildebrandt, Saur, & Seeger, 1996). While the test itself is valid and reliable, there can still be sources of error. The largest contributor to test accuracy is investigator/device interface error (the investigator's use of the device and procedural error [Gabin, 2009]). The most significant factor in eliminating measurement error is in the training of and practice with the device by the investigators (Cholmakjian, Esler, Marciano, Murphy, & Rondinelli, 1992).

Therefore, for this study, the investigator did a test for accuracy of measuring lumbar flexion. This was accomplished by measuring lumbar flexion in six random people utilizing the same technique used in the study. Each of them was measured five times, with a 30 s rest between measurements. From this data, the investigators precision error was calculated to be 8.21%. This is consistent with other studies that measured reliability of using inclinometers to measure lumbar spine flexion. The investigator's precision error in those studies ranged from 4.3-16.4% (Mellin, 1986; Mowat, Portek, Pearcy, & Reader, 1983; Erickson, Merritt, Mclean, & Oxford, 1986; Kippers, Ng, Parnianpour, Richardson, 2001).

The procedure used and adapted from Andersson & Cocchiarella (2001), as seen in Figure B2 in Appendix B, was as follows:

a) The individual stood with legs straight and weight balanced on both feet, with hands on hips for support.
b) With the spine in neutral position, the inclinometer was set to 0°.
c) The first inclinometer was placed at the T_{12} spinous process and the second inclinometer was placed at the S_1 vertebrae.
d) The individual was instructed to flex the trunk (i.e., bend forward) as far as possible.

e) Lumbar degree of flexion was calculated by subtracting the S_1 inclinometer value from the T_{12} inclinometer value.

f) This was repeated three times and the values were averaged to calculate the lumbar flexion angle.

Procedure

This was a 6-week study and every participant in the control group and exercise groups completed the subjective and objective measurements defined above three times during the study: at baseline, at 3-weeks, and at 6-weeks. People who did not meet the inclusion criteria when the first measurements were taken were excluded from the study.

The participants in the exercise groups completed exercises specific to the iliopsoas muscle. Each participant in the exercise groups kept a daily log of exercises that allowed the researcher to track the exercises completed. Each participant was contacted on a weekly basis to make sure they were staying consistent with the exercises. Each of the exercises, adapted from Klein & Sobel (1994) and Liebenson (2007), were completed by the participants in the exercise groups either once or twice per day. Participants performed 2 sets of 10 repetitions of each exercise with a 1 min rest between sets. Complete descriptions and instructions for completion of the exercises are provided in Appendix C. The exercises included in this study were:

a) Kneeling hip stretch – This exercise provides a deep stretch of the psoas.

b) Recumbent hip stretch – This exercise utilizes gravity to provide a gentle stretch to the front of the hip.

c) Standing hip stretch – This is an upright hip stretch which will ensure that good flexibility during sports, recreation, and daily activities is maintained.

d) Spinal rotation – This simply stretches the iliopsoas.

e) Pelvic tilt – This is the most basic exercise to strengthen the iliopsoas. It will help to flatten the abdomen and the curve in the lower back.

f) Lean-backs – This exercise strengthens the deep abdominal muscles.

All participants were given a low back pain fact sheet at the beginning of the study. This fact sheet was obtained from NIH (2008) and contains information regarding causes and treatment of low back pain. It also contains information on organizations through which the participant can get additional information about low back pain. See a copy of this fact sheet in Appendix D.

Design and Analysis

Data were analyzed using SPSS. Descriptive statistics for all dependent variables were computed using SPSS. Two factors were identified, so a two-way analysis of variance (ANOVA) [treatment x time] was used to compare the population means for the dependent variables of function (i.e., ODI scores) and lumbar flexion. Certain assumptions were met such that data within the population were normally distributed and samples were representative of the population. The total variance was separated into the main effects and interaction effects. Simple effects analyses with Bonferroni adjustments were used as a follow-up for any significant interactions. The nonparametric test, Cochran's Q, was used to compare each group's changes in low back pain over time. Cochran's Q was also used to detect any significant differences in the Thomas test and excessive lordosis test over time for each group. Significance level was set at .05 to test the hypotheses.

CHAPTER IV

RESULTS

The purpose of this study was to compare the differences amongst three groups to determine if exercising the iliopsoas would relieve low back pain, improve function, and increase range of motion during hip and lumbar flexion. Another factor of this study was to determine if exercising once a day versus twice a day makes a bigger difference in the variables mentioned above. Since low back pain was assessed as a nominal variable, Cochran's Q was used to establish any significant differences over time. A two-way repeated measures ANOVA was used to compare the changes in lumbar flexion and ODI scores among the groups over time.

Description of Participants

A total of 30 people who suffered from self-reported low back pain were recruited for this study. Twenty-four people completed the full 6-weeks. Four dropped out for the reasoning that the exercises were too hard and took too long to complete. One had to drop out after being injured falling off a horse. The remaining participant dropped out because the exercises caused increased low back pain. For those participants who finished the study, there was 100% compliance to the exercise protocol and all of them tolerated the exercises well.

Among all participants (N=24: 17 females, 7 males) the mean (SD) for age, height, weight, and BMI were 48.67 (12.73) years, 170.92 (7.82) cm, 81.73 (10.78) kg, and 27.84 (2.39) kg/m^2, respectively. Table 3 shows mean anthropometric measurements of each group.

Table 3. Mean Values for Anthropometric Measurements of Each Group.

	Exercise Group 1 (N=7)	Exercise Group 2 (N=7)	Control Group (N=10)
Age (years)	51.8 (10.5)	47.4 (13.5)	47.5 (14.6)
Height (cm)	168.7 (7.4)	172.2 (9.9)	171.7 (7.1)
Weight (kg)	77.6 (12.9)	80.3 (9.7)	85.6 (9.2)
BMI (kg/m^2)	27.2 (3.2)	28.0 (2.6)	28.9 (1.1)

Values expressed as mean (± SD).

Low back pain information was obtained from the participants in two ways. First, the participants were asked if they suffered from low back pain, to which at the initial measurement session, 100% of the participants responded with a yes. By week 6 of the study, 57.1% of participants who exercised once per day, 28.6% of participants who exercised twice a day, and 80% of participants in the control group reported that they still had low back pain. Secondly, the participants completed the VAPS assessment. Changes in pain over time during sitting, standing, and walking can be seen in Table 4. Although changes in VAPS scores were not statistically analyzed, visual inspection of the data would suggest that by Week 6, the control group reported a greater increase in low back pain during 20 min of sitting, than at baseline. After 6-weeks of exercise, both exercise groups reported an increase in low back pain while sitting for 20 min. However, this increase in pain was lower than the baseline measurement. All groups had a lower average increase in low back pain from baseline to the end of the 6-weeks, while completing 20 min of standing and 20 min of walking.

Table 4. Mean Values for Changes in Low Back Pain Over Time Using the Visual Analog Pain Scale (VAPS).

	Exercise Group 1 (N=7)	Exercise Group 2 (N=7)	Control Group (N=10)
Sitting$_{(baseline)}$	1.4 (1.9)	2.3 (1.8)	2.2 (1.5)
Sitting$_{(3\text{-}week)}$	1.4 (1.4)	2.7 (1.3)	3.3 (2.2)
Sitting$_{(6\text{-}week)}$	1.1 (0.9)	2.1 (1.4)	2.5 (1.1)
Standing$_{(baseline)}$	2.3 (1.8)	3.0 (1.0)	3.9 (2.5)
Standing$_{(3\text{-}week)}$	2.6 (1.6)	2.0 (1.2)	3.5 (1.7)
Standing$_{(6\text{-}week)}$	1.8 (1.2)	1.4 (1.2)	2.7 (1.5)
Walking$_{(baseline)}$	2.8 (1.7)	1.6 (2.6)	3.0 (1.8)
Walking$_{(3\text{-}week)}$	2.4 (1.6)	1.0 (1.3)	3.3 (1.9)
Walking$_{(6\text{-}week)}$	2.1 (1.5)	0.6 (1.0)	2.5 (1.6)

Values expressed as mean (± SD).

Function of the iliopsoas muscle group was determined by participants' scores on the ODI survey. For the purpose of determining differences in an individual, the raw score of the ODI survey has to increase or decrease by five points to be clinically meaningful (Fairbank & Pynsent, 2000). Range of motion of the iliopsoas muscles were determined by executing three diagnostic tests: lumbar flexion, the Thomas test, and an excessive lordosis check of the lumbar spine. Table 5 represents ODI scores and lumbar flexion (degrees°) at baseline and after 6-weeks exercise intervention for each group.

Table 5. ODI Scores and Lumbar Flexion (°) Over Time.			
	Exercise Group 1 (N=7)	Exercise Group 2 (N=7)	Control Group (N=10)
ODI Scores$_{(Baseline)}$	14.1 (8.3)	18.4 (6.2)	18.6 (8.4)
ODI Scores$_{(3\text{-}week)}$	11.7 (7.9)	13.1 (7.9)	19 (8.8)
ODI Scores$_{(6\text{-}week)}$	10.7 (7.5)	9.9 (7.2)	17.2 (8.8)
Lumbar Flexion$_{(Baseline)}$	29.3 (7.8)	26.1 (6.1)	23.5 (8.2)
Lumbar Flexion$_{(3\text{-}week)}$	30.3 (7.8)	28.6 (6.3)	24 (7.5)
Lumbar Flexion$_{(6\text{-}week)}$	30.7 (7.4)	30.3 (4.7)	23.6 (7.7)
Values expressed as mean ($\pm$ SD).			

Participants scored either a positive or negative for the Thomas test and excessive lordosis. At baseline, 100% of the participants had a positive Thomas test. After 6-weeks of exercise, 100% of the participants in both exercise groups still had a positive Thomas test. Interestingly, 2 out of 10 participants in the control group had a negative Thomas test post intervention. Regarding excessive lordosis, the group that exercised once per day had 2 out of 7 participants test positive at baseline. By the end of the 6-week intervention, only 1 person in that group tested positive. The group that exercised twice per day had 4 out of 7 participants test positive at baseline. At 6-weeks, only 2 of the 7 tested positive. Concerning the control group, 4 out of 10 people had a positive excessive lordosis test at baseline compared to 3 out of 10 at week 6.

Test of Hypotheses

A two-way repeated measures ANOVA was used to determine if any significant differences in ODI scores (function) and lumbar flexion (range of motion) existed between treatments and over time. Cochran's Q was used to find significant differences in low back pain, the Thomas test and excessive lordosis test over time for each group. The findings were considered significant if $p < .05$. The results of the two-way repeated measures ANOVA for ODI scores and lumbar flexion can be seen in Tables 6 and 7, respectively.

Table 6. Two-Way Repeated Measures Analysis of Variance of ODI Scores.

Source	SS	df	Mean Square	F	P	Power
Group	238.959	2	199.479	2.429	.114	.432
Time	28.478	1.432	19.890	.921	.380	.172
Time*Group	130.781	2.864	45.671	2.115	.123	.473
Error	618.326	28.635	21.593	-	-	-

Values are expressed using the Greenhouse-Geisser measure.

Table 7. Two-Way Repeated Measures Analysis of Variance of Lumbar Flexion.

Source	SS	df	Mean Square	F	P	Power
Group	56.235	2	28.117	6.8	.006*	.873
Time	21.819	1.965	11.102	5.975	.006*	.850
Time*Group	38.528	3.930	9.802	5.276	.002*	.949
Error	73.031	39.304	1.858	-	-	-

Values are expressed using the Greenhouse-Geisser measure.
***The mean difference is significant at the .05 level.**

No significant differences were found in ODI scores over time. Figure 1 demonstrates the changes in ODI Scores over time. Exercise group 2 had a bigger decrease over time in ODI raw scores as compared to exercise group 1 and the control group. Although, no significant differences were observed between the groups, mean ODI scores for Exercise Group 2 decreased 8.5 points, which is considered clinically significant.

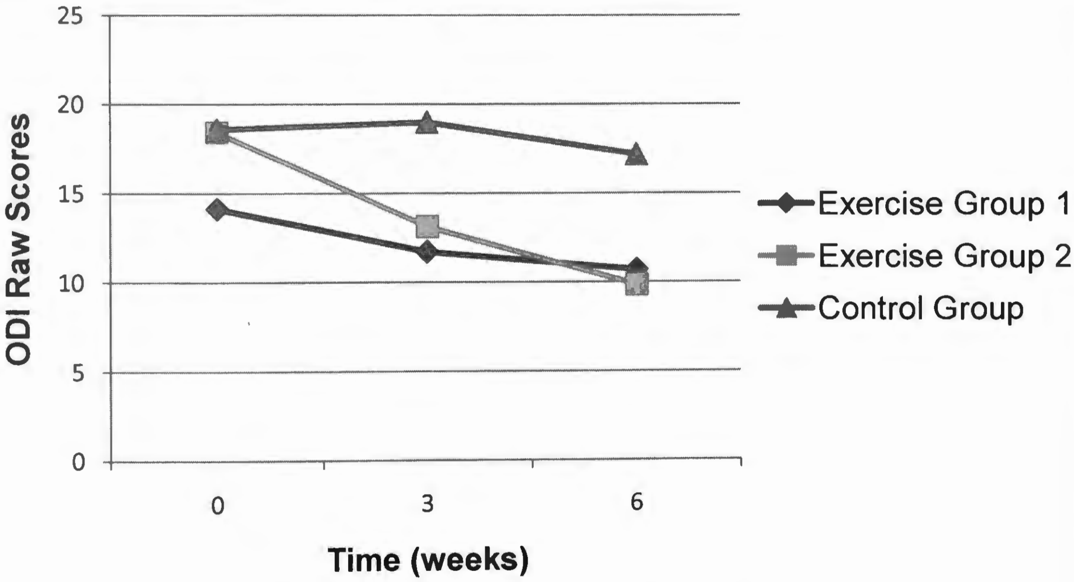

Figure 1: Changes in ODI scores over time

With respect to lumbar flexion, there was a significant interaction of group and time. Follow-up analysis, with a Bonferroni adjustment, indicated that a significant decrease in lumbar flexion occurred only in exercise group 2. The changes in exercise group 2 were significant between the initial measurement and the 3rd week measurement as well as between the initial measurement and the 6th week measurement. However, the changes were not significant in this group from the 3rd week to the 6th week. Exercise group 1 and the control group had no change in lumbar flexion over time. The interaction effect of lumbar flexion is seen in Figure 2.

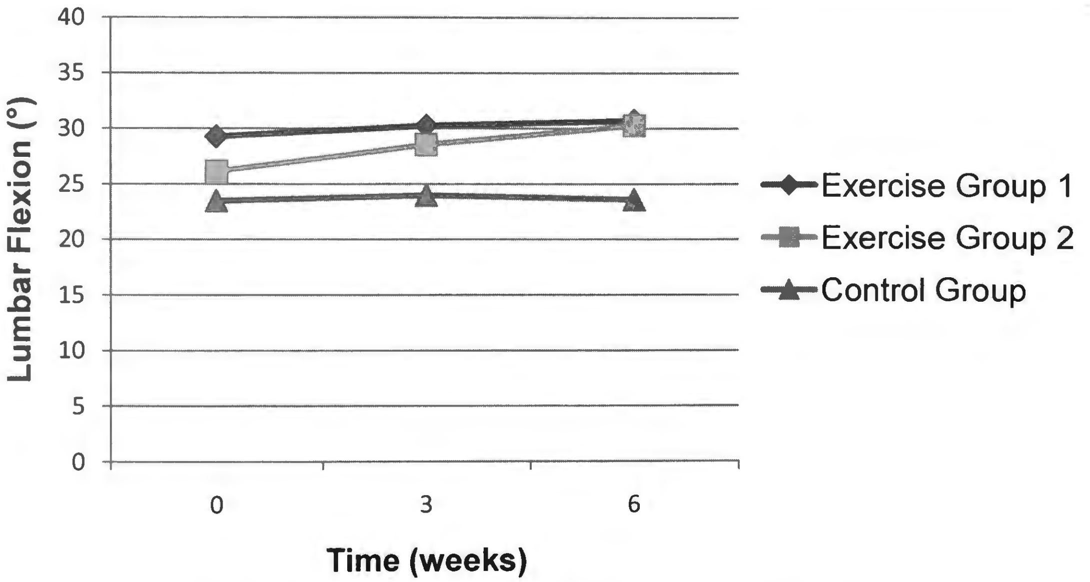

Figure 2: Changes in lumbar flexion over time

No results were shown to be significant after obtaining Cochran's Q statistics for both the Thomas test and excessive lordosis test. Cochran's Q with regard to low back pain is presented in Table 8 below. The change in low back pain response from baseline to 6-weeks was not significant for the control group. Significant improvements were observed in low back pain in both exercise groups. Follow up tests revealed that the significant change, for both exercise groups occurred only between baseline and 6-weeks.

Table 8. Cochran's Q for Low Back Pain Responses from Baseline to 6 Weeks.			
	Exercise Group 1 (N=7)	Exercise Group 2 (N=7)	Control Group (N=10)
Cochran's Q	6.0	7.6	4.0
df	2	2	2
P	.050*	.022*	.135
*The mean difference is significant at the .05 level.			

CHAPTER V

DISCUSSION

The purpose of this study was to determine if exercises specific to the iliopsoas muscle group have an effect on low back pain, function, and range of motion. In the following Chapter, a summary, discussion, and conclusions of this study, as well as, recommendations for further studies will be presented.

Summary

A total of 24 men and women with low back pain participated and completed this study. All participants were between the ages of 25-65 years. Anthropometric measurements were taken at baseline, at the 3rd week, and after the 6th week of the exercise treatment. Participants were instructed to maintain their current lifestyle, in regards to diet and exercise, during the intervention. Of those who completed the study, compliance to the exercise intervention was 100%.

The dependent variables, low back pain, function, and range of motion, were analyzed by two-way repeated measures ANOVA and the nonparametric test Cochran's Q. After analysis of the data ($p < .05$), the following decisions about the null hypotheses were made:

a) There was no effect of exercise on the dependent variables of lumbar flexion and function of the low back. Rejected

b) There was no effect of time on the dependent variables of lumbar flexion and function of the low back. Rejected

c) There was no interaction effect of exercise and time on the dependent variables of lumbar flexion and function of the low back. Rejected

d) There was no effect of exercise on the dependent variable of low back pain. Rejected

Discussion

The goal of this investigation was to determine if doing iliopsoas exercises for 6 weeks would result in decreased low back pain, increased range of motion, and improved function in people with low back pain. Another goal was to determine how double the amount exercise would influence these variables.

Exercising the iliopsoas for 6 weeks resulted in significant improvements in low back pain, especially when completing 2 sets of 10 repetitions twice per day of these 6 exercises. The finding of the present study is similar to the results by Hagen et al. (2004) and Aro et al. (1995) whereby significant improvements in low back pain were found when participants were active, whether it be structured exercise or ordinary activity, as opposed to being on bed rest. The present findings are also supported by the results of Chatzitheodorou et al. (2007) who concluded that following a regular high intensity aerobic exercise program alleviated low back pain. Case studies done by Ames & Konczak (2005) and Legier (2005) also presented evidence to support the notion that active participation in a home exercise program combined with conventional treatment was important in the successful relief of low back pain. Significant improvements in VAPS scores during movement have been seen in people with chronic low back pain when combining exercise and physical therapy for 4-6 hr per week over 12 weeks (Dufour et al., 2010). Dufour et al. reported that VAPS scores improved 20-30% from baseline to 12 weeks.

The results in the current study contradict the results by Kinkade (2007) and Hayden et al. (2005), in which a structured exercise program failed to produce relief in low back pain. Kuukkanen & Malkia (2000) discovered that participants, who completed a 3-month exercise program consisting of strength, endurance, and flexibility exercises, showed no significant changes in back pain intensity scores. The difference between the present study and Kuukkanen & Malkia may have been due to the amount of exercises. The most exercise done in the current study was 2 sets of 10 repetitions of 6 exercises, 2 times per day. The participants in Kuukkanen & Malkia completed 7 strength exercises at a rate of 3 to 4 sets of 15 to 20 repetitions at 60 to 80% of 10RM in addition to 7 endurance exercises at a rate of 3 to 4 sets of 15 to 20 repetitions at 30 to 40% of 10RM, 5 times a week. In 1995, Chavannes, Faas, Gubbels, & van Eijk studied the effect of exercises and back care on the course of acute, non-specific low back pain. Participants completed a 5-week course of exercise, had no treatment, or had a low-dose of ultrasound. At the 1 year follow-up, the change in degree of pain was not significant in any of the groups. One major difference between the current study and the above studies is the type of exercises performed. All of the above studies included exercises that targeted more muscle groups, whereas the current study tried to target only the iliopsoas group.

No significant differences were found with regard to function, as measured by ODI scores. This is consistent with Kuukkanen & Malkia (2000), in which, no correlation between lumbar range of motion and ODI scores were reported after participants finished a 3-month progressive exercise program. It is also consistent with the Chavannes (1995) study, where none of the groups displayed significant differences in disability scores after treatment for low back pain. Dundar et al. (2009) reported a significant improvement in function in an aquatic exercise group, but did not find significant improvements in those that were in the land based exercise group.

While Aro et al. (1995) and Hagen et al. (2004) both suggest that exercise results in improved functional status, this is inconsistent with the conclusions of the present study. Another study's results that are not in agreement with the results found here is the Ames & Konczak 2005 study, where significant changes in function, as measured by ODI scores, were found in those who participated in a home exercise program. Again the difference in the current study and the Ames & Konczak study is the amount of exercises carried out by the participants. While the exercises did target the psoas and iliotibial band muscles, the participants completed 2 PNF exercises at rate of 3 sets of 5 repetitions, 5 times per day.

With respect to lumbar flexion, the current study suggests that these 6 exercises have to be done at least twice a day, for a total of 4 sets of 10 repetitions in order to obtain significant improvements, as only Group 2 had a significant increase in lumbar flexion. This is consistent with participants that completed either a water aerobics program or a land based exercise program, in which, both groups displayed significant improvements in lumbar flexion after 4 weeks of treatment (Dundar et al., 2009). These results were maintained at the 12-week follow-up. In addition, results were not significant between groups.

Interestingly, after a 3-month therapeutic exercise program, Kuukkanen & Malkia (2000) reported no significant changes in lumbar flexion in 86 participants with low back pain. Another investigation into this topic was completed in 1987 by Evans, Gilbert, Hildebrand and Taylor. Researchers observed no statistically significant difference in lumbar flexion among any of the four treatment groups, which consisted of an exercise plus education group, an education plus bed rest group, a bed rest only group, and a control group. The exercises in the Evans et al. study were back flexion exercises only.

As in every study, there were strengths and limitations. A major strength was that there was 100% compliance to the exercise protocol, as indicated by the exercise logs of the participants. In addition, no participants indicated any change in current diet or exercise routines. This would substantiate that the results can be attributed to the exercise intervention. On the other hand, while the exercises chosen for this study targeted the iliopsoas muscle, there is a possibility that other muscles were affected by the exercises. This is a limitation of the study, specifically when inferring all improvements came from training the iliopsoas.

Furthermore, the investigators reliability in measuring outcome variables, specifically lumbar flexion, helps lend support to the effectiveness of the exercise treatment. The investigators precision error when measuring lumbar flexion was 8.21%, which as stated previously is consistent with other investigators using inclinometers to measure lumbar flexion. Significant differences were seen in lumbar flexion in exercise Group 2. The percentage change in lumbar flexion from baseline to after 6 weeks of exercise, in this group, was 15.84%. The percent change in lumbar flexion is greater than the investigator's precision error. This is evidence to support the notion that the significant change is a real change.

Although groups were randomly assigned, a potential limitation to the changes seen in lumbar flexion in exercise Group 2 as compared to Group 1 is that at baseline there was a slight, although non-significant difference in lumbar flexion between the two groups. When statistical adjustments were made so that the starting means were equal among all three groups, it was determined that the results were not different than when using unadjusted means.

Another limitation of the study was the small sample size. The observed power for detecting changes in low back pain function was only .47. With a larger sample size, results may have reached significance.

Conclusions

In conclusion, 6 weeks of exercise specific to the iliopsoas muscle results in significant improvements in low back pain and lumbar flexion. It does not, however, result in significant differences in function or hip flexion. Had a larger sample size been used or had the exercise intervention lasted longer, significant results may have been seen in those dependent variables.

Recommendations for Further Studies

1. Studies that include a greater sample size.
2. Studies that include a longer intervention period.
3. Studies that compare the effect of yoga versus Pilates versus high intensity aerobics on low back pain.
4. Studies that determine how long the improvements last after stopping the exercise program.

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APPENDIX A

Anatomical Representation of the Iliopsoas Muscle and Spine

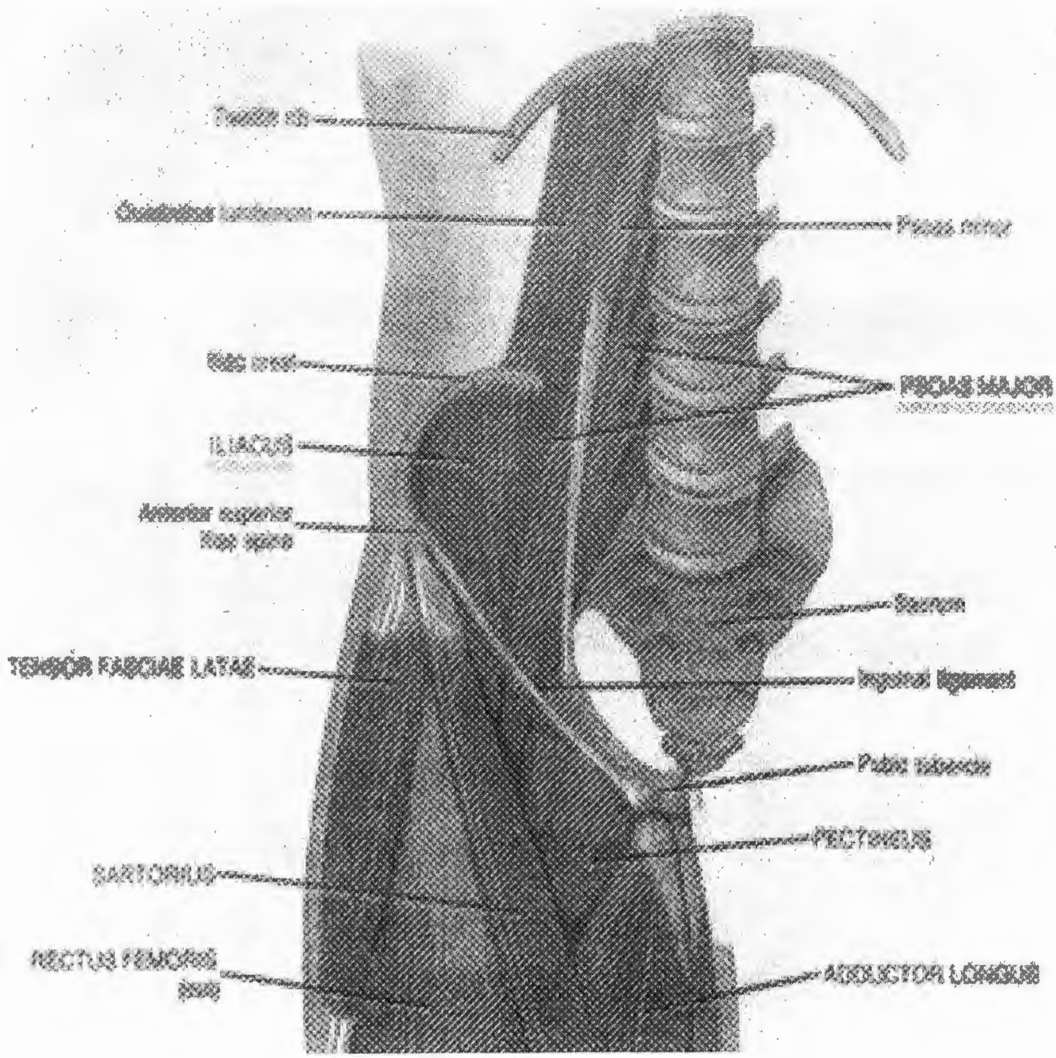


Figure A1. Anatomical representation of the parts of the iliopsoas muscle: psoas major, psoas minor, and iliacus (Tank, 2005).

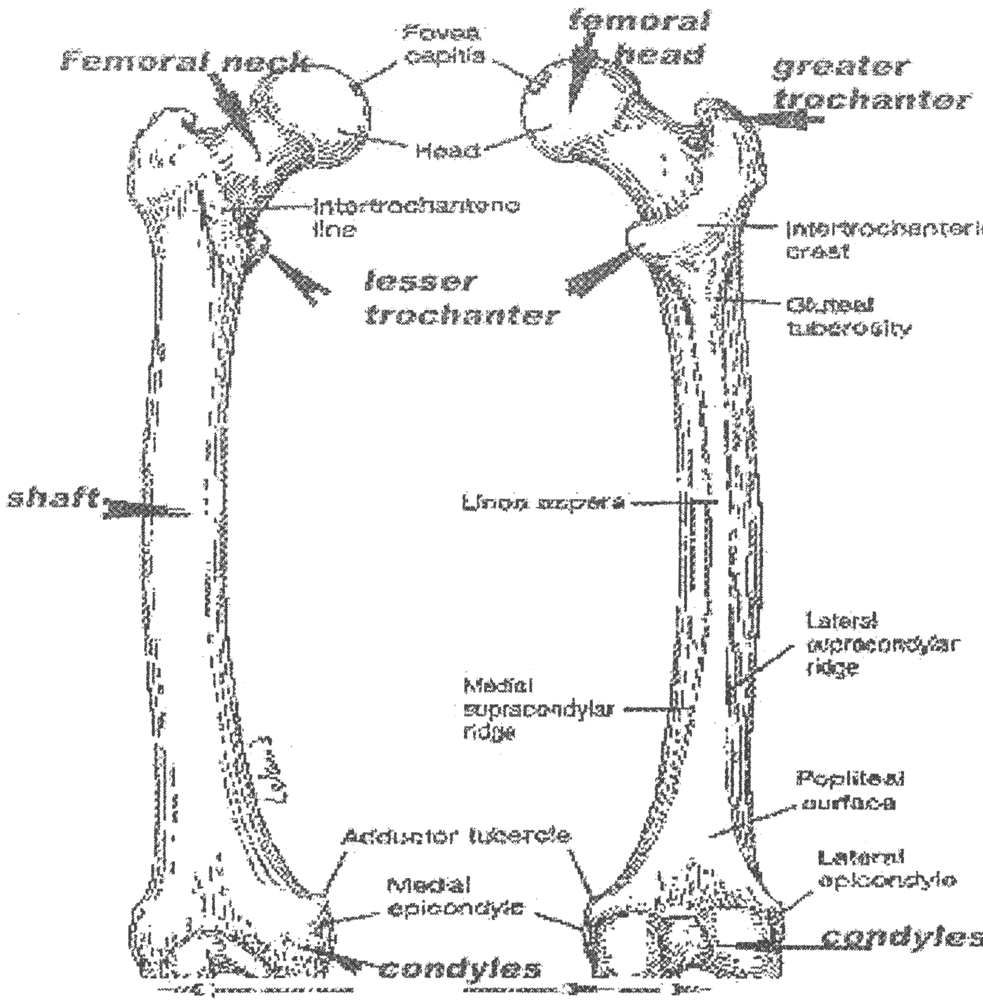


Figure A2. Anterior (left) and posterior (right) view of the femur. This demonstrates the insertion point (lesser trochanter of the femur) of the psoas major and iliacus (Tank, 2005).

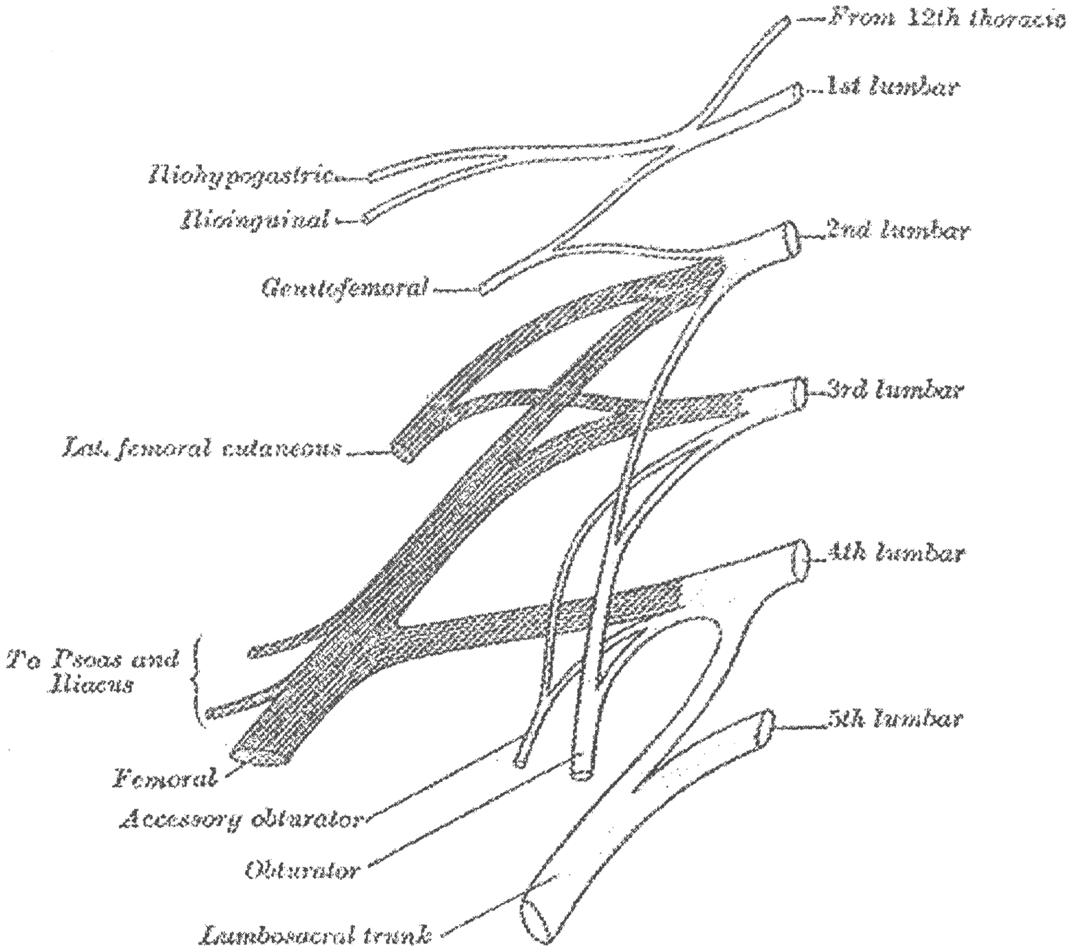


Figure A3. Branches of the lumbar plexus which innervate the iliopsoas. The 2nd, 3rd, and 4th lumbar branches give rise to the nerve supply of the iliopsoas muscles (Martini, 2001).

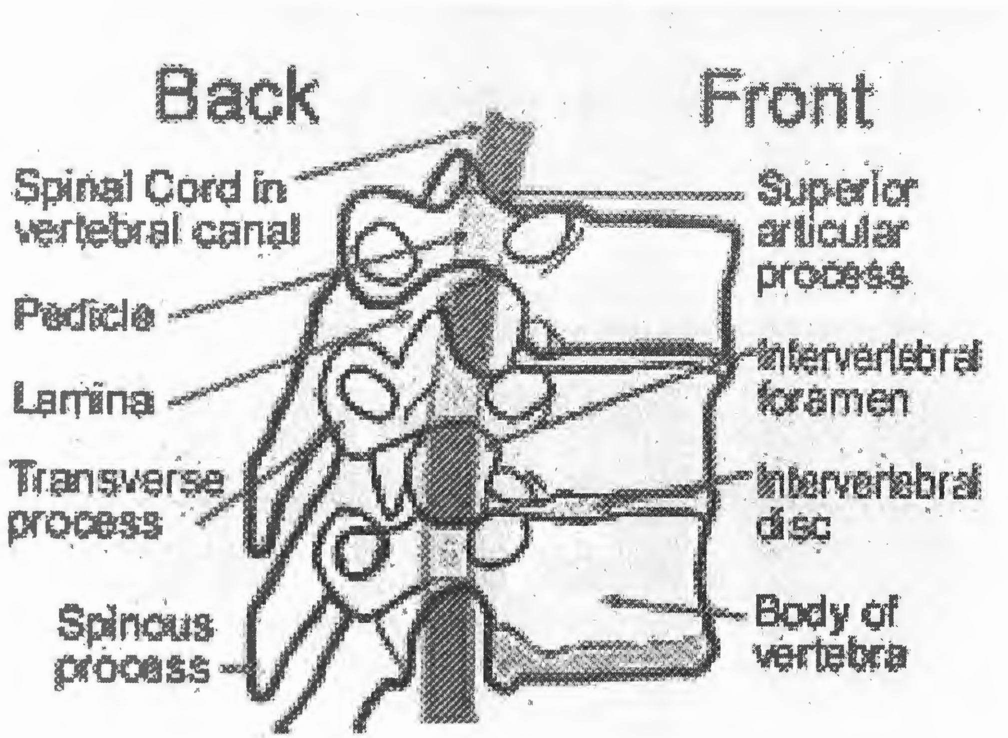


Figure A4. Side view of the spinal cord and vertebrae. The nerves exit the spinal cord via the intervertebral foramen (Martini, 2001).

APPENDIX B

Testing Procedures

Oswestry Disability Index

INSTRUCTIONS: This questionnaire has been designed to enable me to understand how your back pain has affected your ability to manage your everyday activities. Please answer each section by marking the ONE CHOICE that most applies to you. We realize you may feel that more than one statement may relate to you, but PLEASE JUST MARK THE ONE CHOICE WHICH MOST CLOSELY DESCRIBES YOUR PROBLEM RIGHT NOW.

Pain Intensity

A. The pain comes and goes and is very mild.
B. The pain is mild and does not vary much.
C. The pain comes and goes and is moderate.
D. The pain is moderate and does not vary much.
E. The pain comes and goes and is severe.
F. The pain is severe and does not vary much.

Personal Care (Washing, Dressing, Etc.)

A. I would not have to change my way of washing or dressing in order to avoid pain.
B. I do not normally change my way of washing or dressing even though it causes some pain.
C. Washing and dressing increases the pain, but I manage not to change my way of doing it.

D. Washing and dressing increases the pain and I find it necessary to change my way of doing it.
E. Because of the pain, I am unable to do some washing and dressing without help.
F. Because of the pain, I am unable to do any washing or dressing without help.

Lifting

A. I can lift heavy weights without extra pain.
B. I can lift heavy weights, but it causes extra pain.
C. Pain prevents me from lifting heavy weights off the floor.
D. Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, e.g., on a table.
E. Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned.
F. I can only lift very light weights at the most.

Walking

A. Pain does not prevent me from walking any distance.
B. Pain prevents me from walking more than one mile.
C. Pain prevents me from walking more than one-half mile.
D. Pain prevents me from walking more than one-quarter mile.
E. I can only walk while using a cane or on crutches.

F. I am in bed most of the time and have to crawl to the toilet.

Sitting

A. I can sit in any chair as long as I like without pain.

B. I can only sit in my favorite chair as long as I like.

C. Pain prevents me from sitting more than one hour.

D. Pain prevents me from sitting more than one-half hour.

E. Pain prevents me from sitting more than ten minutes.

F. Pain prevents me from sitting at all.

Standing

A. I can stand as long as I want without pain.

B. I have some pain while standing, but it does not increase with time.

C. I cannot stand for longer than one hour without increasing pain.

D. I cannot stand for longer than one-half hour without increasing pain.

E. I cannot stand for longer than ten minutes without increasing pain.

F. I avoid standing because it increases the pain straight away.

Sleeping

A. I get no pain in bed.

B. I get pain in bed, but it does not prevent me from sleeping well.

C. Because of pain, my normal night's sleep is reduced by less than one-quarter.

D. Because of pain, my normal night's sleep is reduced by less than one-half.

E. Because of pain, my normal night's sleep is reduced by less than three-quarters.

F. Pain prevents me from sleeping at all.

Social Life

A. My social life is normal and gives me no pain.

B. My social life is normal, but increases the degree of my pain.

C. Pain has no significant effect on my social life apart from limiting my more energetic interests ,e.g., dancing, etc.

D. Pain has restricted my social life and I do not go out very often.

E. Pain has restricted my social life to my home.

F. I have hardly any social life because of the pain.

Traveling

A. I get no pain while traveling.

B. I get some pain while traveling, but none of my usual forms of travel make it any worse.

C. I get extra pain while traveling, but it does not compel me to seek alternative forms of travel.

D. I get extra pain while traveling which compels me to seek alternative forms of travel.

E. Pain restricts all forms of travel.

F. Pain prevents all forms of travel except that done lying down.

Changing Degree of Pain

A. My pain is rapidly getting better.

B. My pain fluctuates, but overall is definitely getting better.

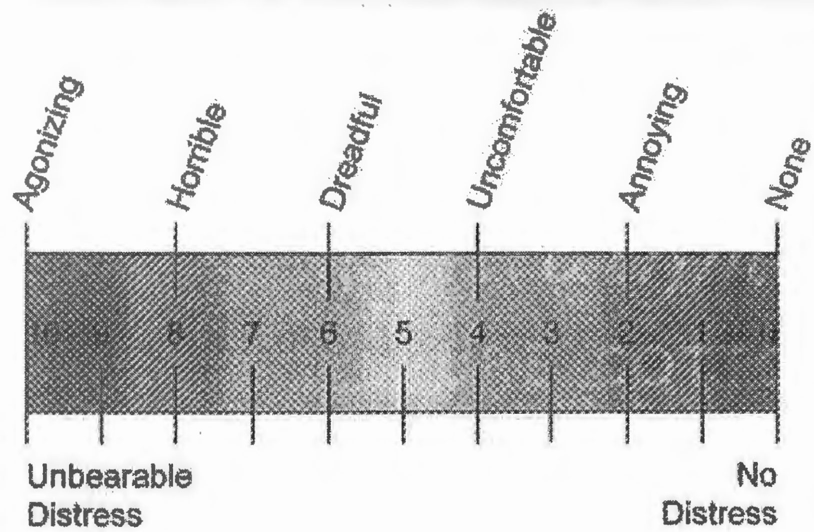
C. My pain seems to be getting better, but improvement is slow at present.

D. My pain is neither getting better nor worse.

E. My pain is gradually worsening.

F. My pain is rapidly worsening.

Visual Analog Pain Scale



Task ______________________________

Date ______________ *Start* ________ *End* ________

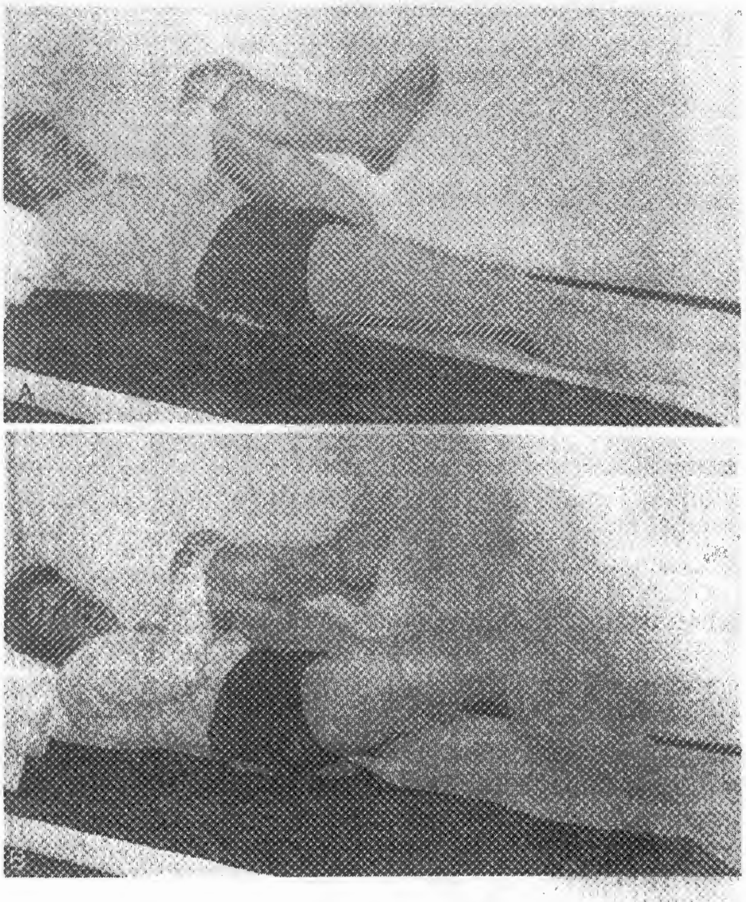
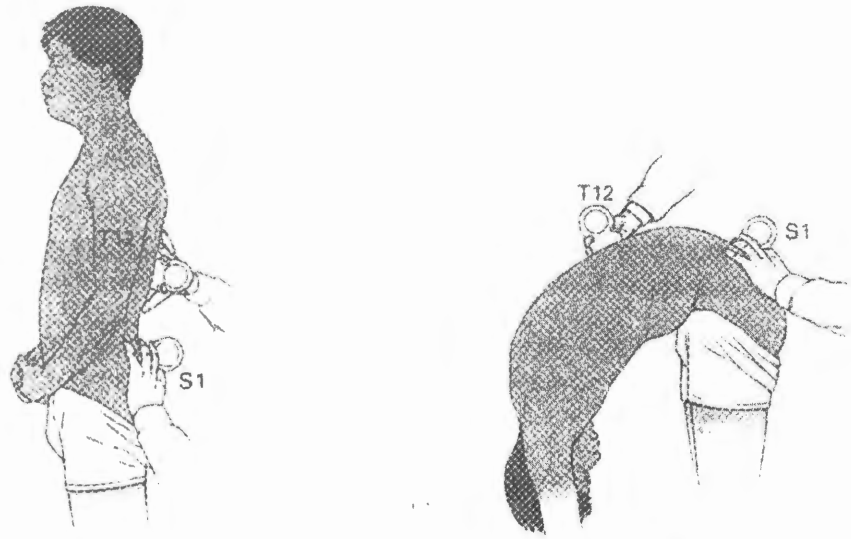


Figure B1. (a) Negative Thomas Test, (b) Positive Thomas Test. This test is used to measure iliopsoas muscle contracture (Magee, 1992).



a. b.

Figure B2. (a) Neutral Position, (b) Lumbar Flexion. Two-inclinometer technique to measure lumbar flexion (Andersson & Cocchiarella, 2001).

APPENDIX C

Exercise Routine

Exercise Routine

For each exercise, follow these basic steps:

Make sure your back is straight with your abs tight.

Slowly get into the stretch so you can isolate the stretch to the target muscle.

Maintain normal breathing and stay relaxed.

Hold the final stretch for three breaths or 10 seconds.

Repeat the procedure 10 times on each side of your body.

Perform 2 sets of 10. Make sure to rest at least 1 min between sets.

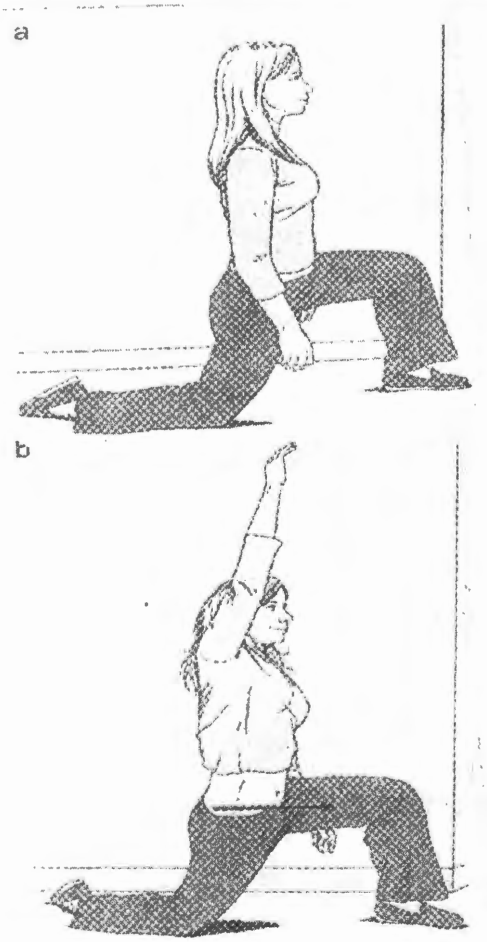


Figure 1 Kneeling hip stretch: (a) start position and (b) stretch position.

Kneeling Hip Stretch

Purpose: provides a deep stretch of the psoas.

Procedure:

- Do this stretch next to the wall
- Kneel on one knee on the side you wish to stretch (knee furthest from wall)
- For the opposite leg, make sure your foot is under and slightly in front of your knee
- Squeeze your buttocks so that your pelvis tilts backwards (i.e., your butt tucked under) until you feel a light pull in

the front of your thigh

- Gently push your thigh forward until you feel the stretch lightly increase
- Raise your arm on the side you are stretching and bend your trunk away from that hip

Recumbent Hip Stretch

Purpose: this stretch utilizes gravity to provide a gentle stretch to the front of the hip.

Procedure:

- Lie on your back on the side of your bed
- Hang one leg off the side of the bed and let it hang towards the floor and hug the other knee to your chest
- If your foot touches the floor, hug the opposite knee tighter until the foot comes up off the floor
- Raise your knee and thigh up about 1 in and hold for three breaths
- Then let the leg drop as far as it will towards the floor (without touching the floor)

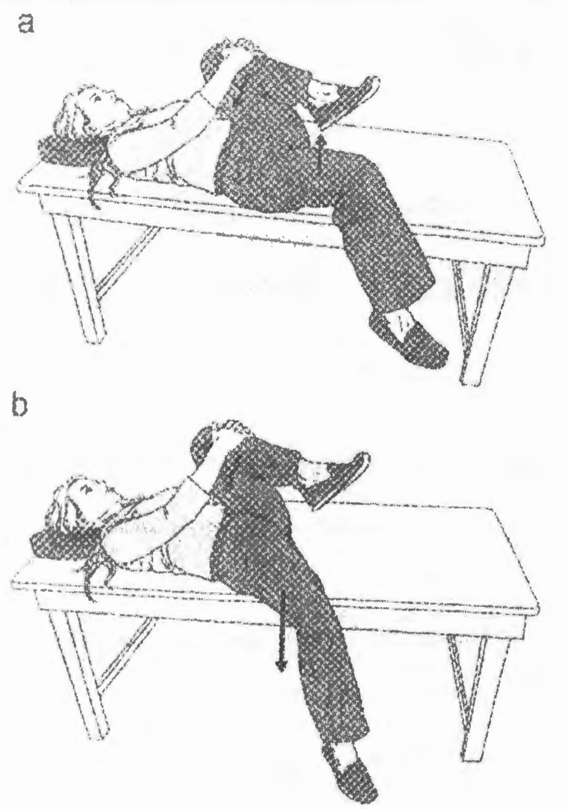


Figure 2 Recumbent hip stretch: (a) start position and (b) stretch position.

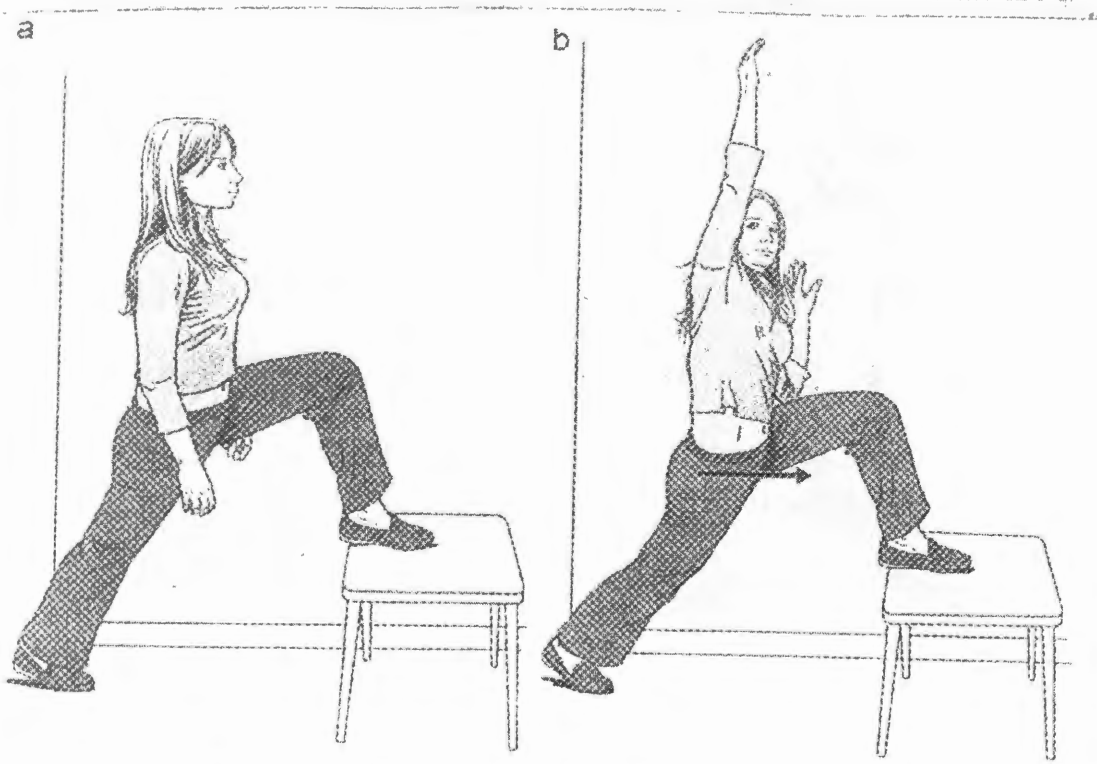


Figure 3 Standing hip stretch: (a) start position and (b) stretch position.

Standing Hip Stretch

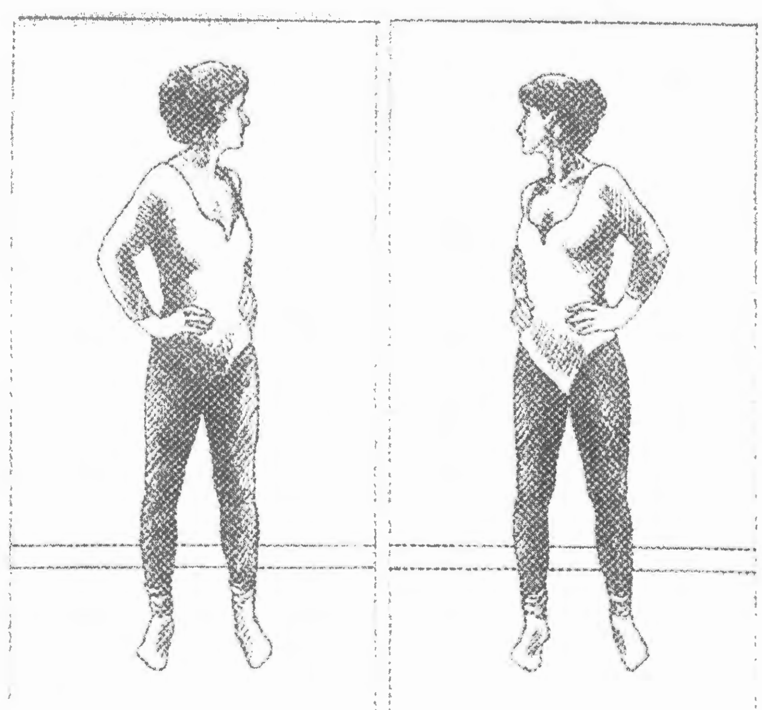
Purpose: upright hip stretches will ensure that you maintain good flexibility during sports, recreation, and daily activities.

Procedure:

- Place a chair near the wall
- Stand with the foot closest to the wall on the chair, with your foot slightly in front of your knee
- Move the foot on the floor slightly backwards to open the front of your hip and stand on the ball of your foot

- Squeeze your buttocks so that your pelvis tilts backwards until you feel a light pull in the front of your thigh
- Push off the floor slightly from the ball of your back foot until you feel the front of the hip stretching
- Raise your arm on the side you are stretching and bend your trunk away from that hip (towards the wall)
- Turn your torso slightly towards the side you are stretching

Spinal Rotation



Purpose: to stretch the iliopsoas.

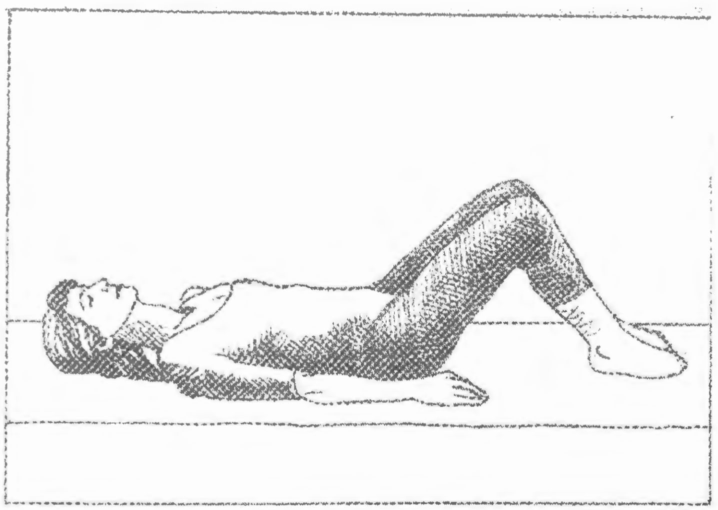
Procedure:

- Stand up straight while keeping the hips, knees and feet steady
- Twist the upper half of the body around to the left, as though you are trying to see behind you
- Return to the front

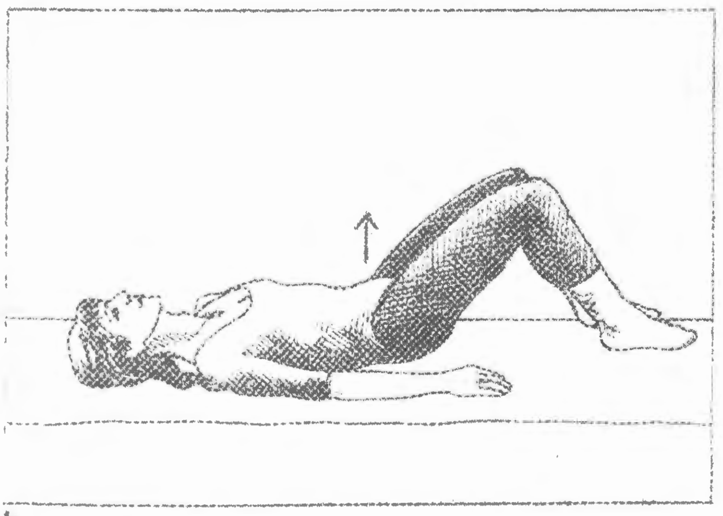
- Repeat motion to the right

Pelvic tilt.

Purpose: most basic exercise to strengthen the iliopsoas. It will help to flatten your abdomen and the curve in your lower back.



a



b

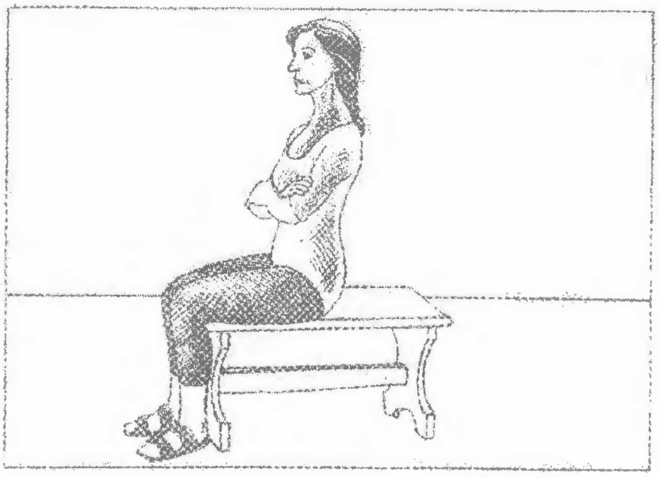
Procedure:

- (a) Lie on your back with your knees bent, both feet flat on the floor, and arms at your side
- (b) Exhale as you tighten your buttocks and pull in your abdominal muscles, so your back flattens to floor (Imagine that you are pulling your bellybutton up and in)
- Relax and inhale as you return to starting position

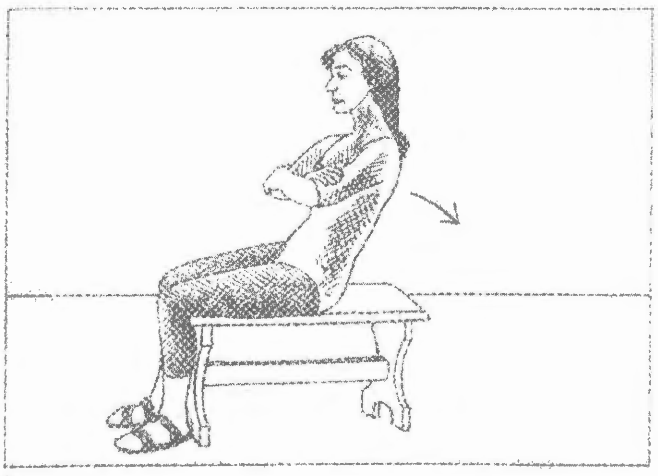
Lean-backs.

Purpose: Strengthen the abdominals.

Procedure:



a



b

- Sit on a bench that allows you to lean back.
- (a) Fold arms across the chest
- (b) While you exhale, contract your abdominals to lean back your body several inches
- After holding the position for three breaths, return to a straight sitting posture
- Inhale and relax

APPENDIX D

Low Back Pain Fact Sheet

Low Back Pain Fact Sheet

If you have lower back pain, you are not alone. Nearly everyone at some point has back pain that interferes with work, routine daily activities, or recreation. Back pain is the second most common neurological ailment in the United States — only headache is more common. Fortunately, most occurrences of low back pain go away within a few days. Others take much longer to resolve or lead to more serious conditions.

Acute or short-term low back pain generally lasts from a few days to a few weeks. Most acute back pain is mechanical in nature — the result of trauma to the lower back or a disorder such as arthritis. Pain from trauma may be caused by a sports injury, work around the house or in the garden, or a sudden jolt such as a car accident or other stress on spinal bones and tissues. Symptoms may range from muscle ache to shooting or stabbing pain, limited flexibility and/or range of motion, or an inability to stand straight. Occasionally, pain felt in one part of the body may "radiate" from a disorder or injury elsewhere in the body. Some acute pain syndromes can become more serious if left untreated. *Chronic* back pain is measured by duration — pain that persists for more than 3 months is considered chronic. It is often progressive and the cause can be difficult to determine.

Causes of Low Back Pain

As people age, bone strength and muscle elasticity and tone tend to decrease. The discs begin to lose fluid and flexibility, which decreases their ability to cushion the vertebrae.

Pain can occur when, for example, someone lifts something too heavy or overstretches, causing a sprain, strain, or spasm in one of the muscles or ligaments in the back. If the spine becomes overly strained or compressed, a disc may rupture or bulge outward. This rupture may put pressure on one of the more than 50 nerves rooted to the spinal cord that control body movements and transmit signals from the body to the brain. When these nerve roots become compressed or irritated, back pain results.

Low back pain may reflect nerve or muscle irritation or bone lesions. Most low back pain follows injury or trauma to the back, but pain may also be caused by degenerative conditions such as arthritis or disc disease, osteoporosis or other bone diseases, viral infections, irritation to joints and discs, or congenital abnormalities in the spine. Obesity, smoking, weight gain during pregnancy, stress, poor physical condition, posture inappropriate for the activity being performed, and poor sleeping position also may contribute to low back pain. Additionally, scar tissue created when the injured back heals itself does not have the strength or flexibility of normal tissue. Buildup of scar tissue from repeated injuries eventually weakens the back and can lead to more serious injury. Occasionally, low back pain may indicate a more serious medical problem. Pain accompanied by fever or loss of bowel or bladder control, pain when coughing, and progressive weakness in the legs may indicate a pinched nerve or other serious condition. People with diabetes may have severe back pain or pain radiating down the leg related to neuropathy. People with these symptoms should contact a doctor immediately to help prevent permanent damage.

Nearly everyone has low back pain sometime. Men and women are equally affected. It occurs most often between ages 30 and 50, due in part to the aging process but also as a result of sedentary life styles with too little (sometimes punctuated by too much) exercise. The risk of experiencing low back pain from disc disease or spinal degeneration increases with age.

Ways to Treat Acute Low Back Pain

Most low back pain can be treated without surgery. Treatment involves using analgesics, reducing inflammation, restoring proper function and strength to the back, and preventing recurrence of the injury. Most patients with back pain recover without residual functional loss. Patients should contact a doctor if there is not a noticeable reduction in pain and inflammation after 72 hours of self-care.

Although *ice and heat* (the use of cold and hot compresses) have never been scientifically proven to quickly resolve low back injury, compresses may help reduce pain and inflammation and allow greater mobility for some individuals. As soon as possible following trauma, patients should apply a cold pack or a cold compress (such as a bag of ice or bag of frozen vegetables wrapped in a towel) to the tender spot several times a day for up to 20 minutes. After 2 to 3 days of cold treatment, they should then apply heat (such as a heating lamp or hot pad) for brief periods to relax muscles and increase blood flow. Warm baths may also help relax muscles. Patients should avoid sleeping on a heating pad, which can cause burns and lead to additional tissue damage.

Bed rest — 1–2 days at most. Studies have found that persons who continued their activities without bed rest following onset of low back pain appeared to have better back flexibility than those who rested in bed for a week. Other studies suggest that bed rest alone may make back pain worse and can lead to secondary complications such as depression, decreased muscle tone, and blood clots in the legs. Patients should resume activities as soon as possible. At night or during rest, patients should lie on one side, with a pillow between the knees (some doctors suggest resting on the back and putting a pillow beneath the knees).

Exercise may be the most effective way to speed recovery from low back pain and help strengthen back and abdominal muscles. Maintaining and building muscle strength is particularly important for persons with skeletal irregularities. Doctors and physical therapists can provide a list of gentle exercises that help keep muscles moving and speed the recovery process. A routine of back-healthy activities may include stretching exercises, swimming, walking, and movement therapy to improve coordination and develop proper posture and muscle balance. Yoga is another way to gently stretch muscles and ease pain. Any mild discomfort felt at the start of these exercises should disappear as muscles become stronger. But if pain is more than mild and lasts more than 15 minutes during exercise, patients should stop exercising and contact a doctor.

Medications are often used to treat acute and chronic low back pain. Effective pain relief may involve a combination of prescription drugs and over-the-counter remedies. Patients should always check with a doctor before taking drugs for pain relief. Certain medicines, even those sold over the counter, are unsafe during pregnancy, may conflict with other medications, may cause side effects including drowsiness, or may lead to liver damage.

- *Over-the-counter analgesics*, including nonsteroidal anti-inflammatory drugs (aspirin, naproxen, and ibuprofen), are taken orally to reduce stiffness, swelling, and inflammation and to ease mild to moderate low back pain. *Counter-irritants* applied topically to the skin as a cream or spray to stimulate the nerve endings in the skin to provide feelings of warmth or cold and dull the sense of pain. Topical analgesics can also reduce inflammation and stimulate blood flow. Many of these compounds contain salicylates, the same ingredient found in oral pain medications containing aspirin.
- *Opioids* such as codeine, oxycodone, hydrocodone, and morphine are often prescribed to manage severe acute and chronic back pain but should be used only for a short period of time and under a physician's

supervision. Side effects can include drowsiness, decreased reaction time, impaired judgment, and potential for addiction. Many specialists are convinced that chronic use of these drugs is detrimental to the back pain patient, adding to depression and even increasing pain.

Quick Tips to a Healthier Back

Following any period of prolonged inactivity, begin a program of regular low-impact exercises. Speed walking, swimming, or stationary bike riding 30 minutes a day can increase muscle strength and flexibility. Yoga can also help stretch and strengthen muscles and improve posture. Ask your physician or orthopedist for a list of low-impact exercises appropriate for your age and designed to strengthen lower back and abdominal muscles.

- Always stretch before exercise or other strenuous physical activity.
- Don't slouch when standing or sitting. When standing, keep your weight balanced on your feet. Your back supports weight most easily when curvature is reduced.
- At home or work, make sure your work surface is at a comfortable height for you.
- Sit in a chair with good lumbar support and proper position and height for the task. Keep your shoulders back. Switch sitting positions often and periodically walk around the office or gently stretch muscles to relieve tension. A pillow or rolled-up towel placed behind the small of your back

can provide some lumbar support. If you must sit for a long period of time, rest your feet on a low stool or a stack of books.

- Wear comfortable, low-heeled shoes.
- Sleep on your side to reduce any curve in your spine. Always sleep on a firm surface.
- Ask for help when transferring an ill or injured family member from a reclining to a sitting position or when moving the patient from a chair to a bed.
- Don't try to lift objects too heavy for you. Lift with your knees, pull in your stomach muscles, and keep your head down and in line with your straight back. Keep the object close to your body. Do not twist when lifting.
- Maintain proper nutrition and diet to reduce and prevent excessive weight, especially weight around the waistline that taxes lower back muscles. A diet with sufficient daily intake of calcium, phosphorus, and vitamin D helps to promote new bone growth.
- If you smoke, quit. Smoking reduces blood flow to the lower spine and causes the spinal discs to degenerate.

Where Can I Get More Information?

For more information on neurological disorders or research programs funded by the National Institute of Neurological Disorders and Stroke, contact the Institute's Brain Resources and Information Network (BRAIN) at:

BRAIN
P.O. Box 5801
Bethesda, MD 20824
(800) 352-9424
http://www.ninds.nih.gov
Information also is available from the following organizations:

American Chronic Pain Association (ACPA) P.O. Box 850 Rocklin, CA 95677-0850 ACPA@pacbell.net http://www.theacpa.org Tel: 916-632-0922 800-533-3231 Fax: 916-652-8190	**American Pain Foundation** 201 North Charles Street Suite 710 Baltimore, MD 21201-4111 info@painfoundation.org http://www.painfoundation.org Tel: 888-615-PAIN (7246) Fax: 410-385-1832
National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse 1 AMS Circle Bethesda, MD 20892-3675 NIAMSinfo@mail.nih.gov http://www.niams.nih.gov Tel: 877-22-NIAMS (226-4267) 301-565-2966 (TTY) Fax: 301-718-6366	**American Association of Neurological Surgeons** 5550 Meadowbrook Drive Rolling Meadows, IL 60008-3852 info@aans.org http://www.aans.org Tel: 847-378-0500/888-566-AANS (2267) Fax: 847-378-0600
American Academy of Orthopaedic Surgeons/ American Association of Orthopaedic Surgeons 6300 North River Road Rosemont, IL 60018 hackett@aaos.org http://www.aaos.org Tel: 847-823-7186 Fax: 847-823-8125	**American Academy of Family Physicians** 11400 Tomahawk Creek Parkway Suite 440 Leawood, KS 66211-2672 fp@aafp.org http://www.aafp.org Tel: 913-906-6000/800-274-2237 Fax: 913-906-6095
American Academy of Physical Medicine & Rehabilitation 330 North Wabash Ave. Suite 2500 Chicago, IL 60611-7617	**American Academy of Neurological and Orthopaedic Surgeons** 10 Cascade Creek Lane Las Vegas, NV 89113

info@aapmr.org http://www.aapmr.org Tel: 312-464-9700 Fax: 312-464-0227	aanos@aanos.org http://www.aanos.org Tel: 702-388-7390 Fax: 702-871-4728

"Low Back Pain Fact Sheet," NINDS. Publication date July 2003. NIH Publication No. 03-5161

Prepared by: Office of Communications and Public Liaison

National Institute of Neurological Disorders and Stroke

National Institutes of Health

Bethesda, MD 20892

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APPENDIX E

IRB Approval Letter

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378 Fax 940-898-3416
e-mail: IRB@twu.edu

September 18, 2009

Ms. Kathryn Barton
3602 Blain Dr.
Rowlett, TX 75088

Dear Ms. Barton:

Re: The Effect of Iliopsoas Exercises on Low Back Pain, Function and Range of Motion

The above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and appears to meet our requirements for the protection of individuals' rights.

If applicable, agency approval letters must be submitted to the IRB upon receipt PRIOR to any data collection at that agency. A copy of the approved consent form with the IRB approval stamp and a copy of the annual/final report are enclosed. Please use the consent form with the most recent approval date stamp when obtaining consent from your participants. The signed consent forms and final report must be filed with the Institutional Review Board at the completion of the study.

This approval is valid one year from September 4, 2009. According to regulations from the Department of Health and Human Services, another review by the IRB is required if your project changes in any way, and the IRB must be notified immediately regarding any adverse events. If you have any questions, feel free to call the TWU Institutional Review Board.

Sincerely,

Kathy DeOrnellas, PhD

Dr. Kathy DeOrnellas, Chair
Institutional Review Board - Denton

enc.

cc. Dr. Charlotte Sanborn, Department of Kinesiology
Dr. David Nichols, Department of Kinesiology
Graduate School

APPENDIX F

Informed Consent

TEXAS WOMAN'S UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Title: The Effect of Iliopsoas Exercises on Low Back Pain, Function and Range of Motion

Investigator: Kathryn Barton, B.S...............kbarton@twu.edu......214/679-4614
Advisor: David Nichols, Ph.D.................dnichols@twu.edu......940/898-2522

Explanation of Purpose of the Research

You are being asked to participate in a research study for Ms. Barton's thesis at Texas Woman's University. The purpose of this research is to determine the impact of iliopsoas muscle (a deep abdominal muscle) exercises on low back pain and function. The aim of this study is to determine if exercising the iliopsoas muscle will improve the function of the iliopsoas muscle, which includes hip flexion (bringing your knee to your chest) and lumbar flexion (bending forward), and relieve low back pain.

Research Procedures

For this study, the investigator will obtain measurements from you to determine your range of motion during hip and lumbar flexion. You will be asked to complete three surveys regarding your readiness to begin exercise, your low back pain, and how this pain affects your daily activities. The setting for these measurements will be done at a private location agreed upon by you and the investigator. After the baseline measurements are completed, you will either be excluded because you do not have significant iliopsoas muscle deficiency, or you will be included in the study and you will be randomly assigned to one of three groups. The first participant included will be placed in Group 1, the second in Group 2, the third in the control group, the fourth in Group 1, and so on. Based on the group you are assigned to, you will be asked to commit to 0-30 minutes of exercise per day for six weeks. All participants will be asked to complete measurements at the end of the third week and at the end of sixth week of the study. The exercises include: kneeling hip stretch, recumbent hip stretch, standing hip stretch, spinal rotation, pelvic tilt, and lean backs. You will be asked to keep an exercise log, provided to you by the investigator. The maximum total time commitment for the study is between 5-27 hours over a six week period. Your time commitment will depend on the group to which you are randomly assigned. Time commitments for each group are: 16.5 hours over six weeks for Group 1, 27 hours over six weeks for Group 2, and 5 hours over six weeks for the control group.

Potential Risks

Potential risks related to your participation in the study include:

Fatigue -to avoid fatigue, you may increase rest time between exercises and reduce the number of sets. You may also withdraw from the study at any time.

Physical soreness - There will be no warm-up period. You will have to monitor your own soreness and if soreness worsens, you are encouraged to seek treatment from a physician. To relieve soreness, you may use ice or heat as necessary.

Emotional discomfort - You will be touched by the investigator during the measurement sessions, which may be embarrassing or uncomfortable. The investigator will give you a relaxed setting and talk you through the testing procedure. The investigator will answer any questions regarding the study, to help you feel more at ease. Please let the investigator know if you are experiencing any emotional discomfort.

Injury- One step to minimize risk of injury is to make sure the exercises are being done correctly. At the time of baseline measurements, the investigator will instruct you in proper technique for the exercises and you may contact the investigator at any time to go over the exercises so you can be sure you are doing them properly. If you continue to experience physical discomfort or your pain gets worse, you may discontinue the exercise and contact your doctor.

Loss of Confidentiality - Confidentiality will be protected to the extent that is allowed by law.

The screening and measurements will take place at a private location agreed upon by you and the investigator. A code name, rather than your real name, will be used on all questionnaires, measurement sheets, and exercise logs. Only the investigator and her advisor will have access to identifiable data and the forms previously mentioned. Hard copies of all data will be stored in a locked filing cabinet in the investigator's home office. The investigator will be the only one with a key to unlock the file cabinet. All data will be shredded within one year after completion of the study. It is anticipated that the results of this study will be published in the investigator's thesis as well as in other research publications. No names or other identifying information will be included in any publication. There is a potential risk of loss of confidentiality in all email, downloading and internet transactions. Only results of the study will be sent via email to my research advisor, *no identifiable data will be transferred over the internet.*

The researcher will try to prevent any problem that could happen because of this research. You should let the researcher know at once if there is a problem and she will help you. However, neither the Investigator nor Texas Woman's University provide medical services or financial assistance for injuries that might happen because you are taking part in this research.

Participation and Benefits

Your involvement in this research study is completely voluntary, and you may discontinue your participation in the study at any time without penalty. The benefit of this study includes possible relief of low back pain. At your request, a summary of results will be mailed to you upon completion of this study.*

Questions Regarding the Study

You will be given a copy of this signed and dated consent form to keep. If you have any questions about the research study you may ask the investigator or her advisor; their phone numbers and e-mail addresses are at the top of this form. If you have questions about your rights as a participant in the research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research and Sponsored Programs at 940-898-3378 or via e-mail at IRB@twu.edu.

***If you would like to receive a summary of the results of this study, please provide an address to which this summary should be sent:**

____

____

____

______________________________	_______________
Signature of Participant	Date

APPENDIX G

Raw Data

Group	Gender (1=m/2=f)	Age (yr)	Height (in)	Weight (lbs) wk0	Weight (lbs) wk3	Weight (lbs) wk6	BMI wk0	BMI wk3	BMI wk6
1	2	43	63	145	143	143	25.68	25.33	25.33
1	2	53	66	179	178	178	28.89	28.73	28.73
1	2	51	64	174	173	174	29.86	29.69	29.86
1	2	61	67	188	187	186	29.44	29.29	29.13
1	2	58	67	135	134	134	21.14	20.99	20.99
1	2	62	65.5	160	160	160	26.22	26.22	26.22
1	1	33	72	220	218	218	29.83	29.56	29.56
2	2	52	65.5	135	136	139	22.12	22.28	22.78
2	2	53	68	182	184	185	27.67	27.97	28.13
2	1	32	66	180	182	181	29.05	29.37	29.21
2	1	50	70	187	183	185	26.83	26.25	26.54
2	2	55	67	190	189	189	29.75	29.60	29.60
2	2	26	63	160	160	159	28.34	28.34	28.16
2	1	64	75	200	201	200	25.00	25.12	25.00
3	2	56	65	163	161	160	27.12	26.79	26.62
3	2	29	64	160	160	160	27.46	27.46	27.46
3	1	25	69	190	192	191	28.06	28.35	28.20
3	2	59	66	175	176	175	28.24	28.40	28.24
3	1	49	72	220	221	219	29.83	29.97	29.70
3	2	55	65	175	175	174	29.12	29.12	28.95
3	2	65	68	197	196	195	29.95	29.80	29.65
3	1	54	72	220	219	220	29.83	29.70	29.83
3	2	28	68	195	196	197	29.65	29.80	29.95
3	2	55	67	190	191	189	29.75	29.91	29.60

Group	VAPS sitting wk0	VAPS sitting wk3	VAPS sitting wk6	VAPS standing wk0	VAPS standing wk3	VAPS standing wk6	Thomas Test (1=pos/2=neg) wk0	Thomas Test (1=pos/2=neg) wk3	Thomas Test (1=pos/2=neg) wk6
1	4	1	0.5	1	4	0.5	1	1	1
1	4	2	2	4	4	3	1	1	1
1	1	0	0	1	2.5	2	1	1	1
1	-1	4	2	5	0	2	1	1	1
1	0	0	0	2	1	0	1	1	1
1	1	2	2	0	4	2	1	1	1
1	1	1	1	3	3	3	1	1	1
2	0	4	4	2	2	1	1	1	1
2	0	4	4	2	2	4	1	1	1
2	4	4	1	4	4	1	1	1	1
2	2	1	1.5	4	1	0.5	1	1	1
2	4	2	2	2	1	1	1	1	1
2	2	2	1	4	3	1	1	1	1
2	4	2	1	3	1	1	1	1	1
3	1	4	1	5	4	3	1	1	1
3	2	7	3	2	7	2	1	1	1
3	2	2	2	1	1	1	1	1	1
3	0	0	0	2	1	1	1	2	2
3	4	4	3	8	4	5	1	1	2
3	1	1	1	3	3	3	1	1	1
3	4	2	4	5	4	3	1	1	1
3	1	6	5	3	4	5	1	1	1
3	3	4	3	2	4	1	1	1	1

Group	LBP wk 0 (1=pos/2=neg)	LBP wk 3 (1=pos/2=neg)	LBP wk6 (1=pos/2=neg)	ODI (raw score) wk0	ODI (raw score) wk3	ODI (raw score) wk6	VAPS walking wk0	VAPS walking wk3	VAPS walking wk6
1	1	1	2	9	6	5	1	0	0.5
1	1	1	1	28	22	22	5	2	3
1	1	1	1	11	8	10	1	4.5	4
1	1	1	1	11	15	9	1	2	1
1	1	1	2	8	5	2	4	1	0
1	1	1	2	8	4	7	1	4	3
1	1	1	1	24	22	20	3	3	3
2	1	1	1	13	9	9	-2	2	0
2	1	2	2	12	9	10	5	3	2
2	1	1	2	12	17	7	4	0	0
2	1	1	2	24	2	3	1	1	1.5
2	1	2	2	18	12	5	1	1	1
2	1	1	1	25	27	25	-1	-1	-1
2	1	1	2	25	16	10	3	1	1
3	1	1	2	14	10	9	5.5	4	3
3	1	1	1	37	21	23	3	6	2
3	1	1	1	22	24	22	1	1	1
3	1	1	1	5	4	4	2	1	2
3	1	1	2	16	14	9	3	5	2
3	1	1	1	19	20	20	1	1	1
3	1	1	1	22	24	21	6	4	4
3	1	1	1	22	29	31	3	5.5	6
3	1	1	1	12	12	9	1	2	1
3	1	1	1	17	32	24	4	3	3

Group	Lumbar Flex (°) wk0	Lumbar Flex (°) wk3	Lumbar Flex (°) wk6	Ex Lordosis (1=pos/2=neg) wk0	Ex Lordosis (1=pos/2=neg) wk3	Ex Lordosis (1=pos/2=neg) wk6
1	32	34	35	2	2	2
1	27	28	25	1	1	2
1	28	30	30	2	2	2
1	20	20	23	2	2	2
1	45	45	45	2	2	2
1	28	30	30	1	1	1
1	25	25	27	2	2	2
2	33	35	35	2	2	2
2	20	20	25	2	2	2
2	25	27	30	2	2	2
2	28	35	35	1	2	2
2	35	35	35	1	2	2
2	22	24	26	1	1	1
2	20	24	26	1	1	1
3	20	22	20	2	2	2
3	41	40	40	2	2	2
3	32	30	32	1	1	1
3	20	25	25	2	2	2
3	13	13	15	2	2	2
3	22	22	20	1	2	2
3	15	15	15	1	1	1
3	23	25	24	2	2	2
3	27	25	25	1	1	1
3	22	23	20	2	2	2