EFFECT OF SUPERVISED
AND DIRECTED EXERCISE
ON LOW BACK PAIN
AND FUNCTIONAL ACTIVITY

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CHAPTER ONE

Introduction

Overview

Low back pain can be physically debilitating and years ago total bed rest seemed to be the most common prescribed medical treatment. There were, however, harmful effects from bed rest including loss of maximal aerobic capacity, elevation of resting heart rate, reduced bone mineralization, etc. (Dugan, 2006). During the last thirty years, increasing attention has been given beyond bed rest and research and investigation of lumbar stabilization programs have taken place for low back pain (LBP) (MacDonald et al., 2006; Kavcic et al., 2004B). Even though the cause of LBP is still unknown, clinicians understand the purpose in treating chronic back pain. In 2004, Rainville et al, conducted a meta analysis review of safety and efficacy of exercise as a treatment for LBP and determined that exercise either had a neutral effect or may slightly reduce risk of future back injuries. In the review, most studies indicated a reduction in back pain intensity that ranged from 10-50% after exercise treatment.

Today, next to the common cold, LBP is the most common reason that people visit a physician's office (Teyhen et al., 2007). It is so common that between 50-85% of individuals will experience LBP during the course of their lives (Byrne et al., 2006; Dugan, 2006; Shen et al., 2006; Herrington & Davies, 2005; Mayer et al., 2005; Liddle et al., 2004; Panjabi, 2004; Standaert et al., 2004; Aure et al., 2003; Beckkering, 2003; Jenkins, 2003; Lang, 2003; Vogt et al., 2003; Staal et al., 2002; Sculco et al., 2001). This includes all age groups, both sexes, and every ethnic and socioeconomic group. It is the leading cause of disability in persons younger than age 45 years and the third leading cause of disability in persons aged 45 and older (Dugan, 2006).

Besides the frequency and prevalence of LBP, the cost of clinical treatment has been exorbitant. Fewer than 25% of the cases account for more than 75% of the cost (Ferreira et al., 2007; Shen et al., 2006; McGeary et al., 2003). In 1994, Panjabi estimated the cost of low back pain in the USA surpassed $15 billion per year (Panjabi, 1994). By 2002, Staal and colleagues estimated that this cost had surpassed $50 billion per year (Staal et al., 2002).

In addition, low back injuries occur in approximately two percent of the workforce each year, resulting in workers' compensation costs of more than $20 billion (Shen et al., 2006; Luo et al., 2004). Spinal stabilization exercises have become an integral component in the treatment of the injured worker, and exercises have been useful in improving the function and return-to-work rate in this population (Janeck et al., 2006). On the average, individuals with back pain incurred 60% more in health care expenditures than individuals without back pain (Luo et al., 2004). It is estimated that 85% have had a recent diagnosis of "nonspecific low back pain;" of which the cause is unknown (Shen et al., 2006; Panjabi, 2003; Lang et al., 2003; Staal et al., 2002; Ng et al., 2002), but the diagnosis is pain. Empirical research reveals that physiologic changes occur in the lumbar spine in tandem with initial episodes of low back pain, often identified as muscle dysfunction. Unfortunately, these physiological changes often remain after the pain has subsided (Golby et al, 2006; Sung, 2003) which often leads to pain reoccurrence at some later time. It is noted that if intervention is not received, there will be pain recurrence in more than 50% of the cases (Dugan, 2006; Golby et al., 2006; Shen et al., 2006; Slade et al, 2006; Mayer et al., 2005).

As a result of the recurrence, the main focus in both rehabilitation efforts and preventative care is spine stability along with low back stabilization exercises (MacDonald et al., 2006; Kavcic et al., 2004B). Dugan (2006) adds that spinal stability exercise has been one of the methods used in the practice of medicine in treating and preventing acute LBP, especially as a means of avoiding disability.

Stability is a dynamic process that includes both static positions and controlled movement (Barr et al., 2005; Wagner et al., 2005). A stable spine allows for the movement of body parts carrying of loads, as well as protection of the spinal cord and nerve roots. The spinal stability mechanism is thought to be an integration of active, passive, and neural feedback systems (Janeck et al, 2006).

Under normal circumstances, spinal stability is maintained by a combination of the spinal column and the muscles. After an injury, disease and/or degeneration of the spinal column, the stability of the system may be compromised. Within certain limits this may be compensated by the muscles, which when dysfunctional could cause clinical problems, such as low back pain (Panjabi, 1994). There are multiple muscle groups that are involved with the stability of the spine. When certain muscles are weak or dysfunctional this causes compensation and possibly increased pain within the low back region.

In a recent systematic reviews of randomized controlled trials of exercise therapy for chronic LBP, exercise treatment worked best if it consisted of an individually designed program delivered with supervision that included stretching and strengthening exercises (Barr et al., 2007; Hayden et al., 2005A; Wagner, et al., 2005; Standaert et al., 2004). An individual with LBP referred for physical therapy would have supervised care (Barr et al, 2007). With individual programs utilized in physical therapy, reaction patterns vary for spinal stabilization. This implies that muscular activation of trunk muscles differs between individuals (Wagner et al., 2005) and if not supervised, reactions may not be properly directed to achieve optimal solutions. Despite the prevalence of stabilization exercises in fitness and rehabilitation programs, very little research has attempted to quantify the stability in the lumbar spine resulting from the muscle activation patterns generated during specific exercises (Kavcic et al., 2004A). Very little research has been conducted specifically with supervised vs. non-supervised exercise treatment. As a result, this research will focus on supervised vs. non-supervised exercise treatment.

Statement of the Problem

The prevalence of LBP is costly and an irritant to many people. Often in our society, individuals experience LBP and either ignore the pain, attempt to "deal" with the pain, or seek to obtain medication to treat the symptoms, but never determine the cause or explanation of the pain. Their pain decreases their ability to have quality daily living activity. If mechanical pain is experienced, proper muscle activation and engagement will increasingly secure and support the vertebrae and often decrease low back pain. However, without immediate feedback, individuals initially or eventually perform exercises incorrectly, or do not achieve immediate results and/or do not remain focused.

Purpose of Study

The focus within this study was to investigate the performance of spinal stabilization exercises in a supervised vs. non-supervised group setting. Since the cause of mechanical low back pain is often unknown, the results of exercise vary among individuals. The focus was also to determine if functional activity would improve when supervised. Initially both groups received instruction, but the control group (unsupervised) did not have the constant feedback, adjustments and interaction. The principal investigator directly assisted the experimental group (supervised) for six weeks. Individualized and ongoing support, direction, and demonstration of the exercises were provided in the attempt to stabilize the spine, reduce low back pain and improve functional activity.

Hypotheses

The following null hypotheses were tested for statistical significance. Investigation of each hypothesis was made on comparison of pain and functionality at the pre and post intervention time periods.

Ho_1: There will be no significant difference in low back pain between groups (supervised and unsupervised) after performing specifically selected low back exercises for six week time period.

Ho_2: There will be no significant difference in functional activity between groups (supervised and unsupervised) after specifically performing low back exercises for six week time period.

Limitations

One of the limitations within this study includes the minimal selection and the degree of difficulty of the exercises utilized. The exercises were obtained from a pool of scientific based exercises that are known to address low back pain that progress from supine, sitting and standing positions. However, there were hundreds of additional exercises that could have been applied to this study. Other limitations might have been the lack of unsupervised low back exercises completed, the effect of pain medications taken, whether or not the participants answered the questionnaire with complete honesty, whether the exercises were performed as when they were demonstrated at the beginning of the study, and measuring if deep muscles are truly engaging during the physical activity of this study.

Delimitations

Participants were fitness club members, individuals who were referrals from fitness club members, and individuals responding to a local newspaper article who had been diagnosed with LBP. Three individuals were retired, while the rest were gainfully employed. Within the unsupervised group, the subjects ranged in ages from 38-67, with the average age of 54.3 years. For the supervised group, the subjects ranged in age from 40-75, with the average age of 58.7 years.

Instruments for the study included the Oswestry Disability Index (ODI) and SF-36v2 Health Survey: Your Health and Well-Being. The ODI questionnaire is designed to assess regarding how back or leg pain affects ability to manage everyday life (Fairbank & Pynsent, 2000). The SF-36v2 test surveys views about the subject's health (Ware et al, 2002).

There were 12 categories of exercises. Within 8 categories, the subjects could progress from beginning to intermediate level of the same type of exercise. And within three of these 8 categories, the subjects could progress from beginning, to intermediate, to an advanced level of the same type of exercise. Each group was instructed to progress themselves as they achieved each step within a category without pain. Even though each client met the criteria, some subjects were limited to what they could do as a result of the condition they presented prior to the study.

The supervised group met two to three times per week for six weeks at 5:30 p.m. (Depending on the week, Monday and Wednesday [5:30] one week and Monday [5:30 p.m.], Wednesday [5:30] and Saturday [9:30 a.m.] the next week.) The times presented some challenges as this is a favorable time to workout for the general membership of the fitness club. Each group had 14 exercise session opportunities. The unsupervised group averaged 10.8/14 sessions, while the supervised group averaged 10.9/14 sessions.

Assumptions

It is assumed that the unsupervised group practiced and continued to exercise independently. It is also assumed that those participating in the study answered their pre and post test questionnaires as honestly as possible. To the principal investigator's knowledge, no other treatment was being experienced by any subject participating within the study, such as physical therapy, personal training, medication, etc. The exercises chosen were appropriate and correct and it is hoped the sessions were challenging to promote increased functionality and less pain.

Significance

Over 30 million people currently have LBP and between 70-85% of individuals will experience LBP during the course of their lives. Regardless of the treatment, it is estimated that 80-90% of patients will recover within 6 weeks. Yet, over 80% of such patients report recurrent episodes. And of those who have recurrent episodes, 5-15% will develop chronic low back pain in 12 weeks or more. (Liddle, et al., 2004)

The reoccurring pain creates limitations and that decreases quality of living if intervention is not performed. (Liddle, et al., 2004) Once the inner core muscles become dysfunctional, they must be trained to engage in contraction at appropriate times or reoccurring pain will take place. Many individuals do not know how to re-teach their muscles to function correctly; thus, pain will reoccur. As a result, the purpose of this study is to directly provide direction and focus so that the individual can re-teach the muscles to perform correctly to decrease pain and improve functionality.

Definitions

1. **Active system** – muscles and tendons that surround and act on the spinal column. The function of the active system is to provide dynamic stability during spinal stabilization exercises (Sung, 2003).
2. **ALBP** – Acute Low Back Pain – short term (< 3 months) pain in the lower region of the back (Dugan, 2006; Shen et al, 2006).
3. **Bending moment** – at the time when the moment plane is parallel to the long axis of the structure. (Barnett & Gilleard, 2005)
4. **Bracing** – performed by laterally flaring the abdominals (Barnett & Gilleard, 2005).
5. **CLBP** – Chronic Low Back Pain – long term (>3 months) pain in the lower region of the back and often changes in the central neuromodulation of pain are part of the pathophysiology (Shen et al, 2006).
6. **Core of strengthening** – a description of the muscular control required around the lumbar spine to maintain functional stability. Core Strengthening has been used to connote lumbar stabilization, motor control training, etc. (Akuthota, V. and S.F. Nadler, 2004).
7. **Displacement** – change in the position of a vertebra from position 1 to position 2. The displacement has two components: rotation and translation (Panjabi, 2004).
8. **Force** – Force cannot be seen, but can feel the effects. Example: standing on a sandy beach. The force, which is the weight of the body, is applied to the feet producing the impression (Panjabi, 2004).
9. **Functional restoration programs** – offer a combination of progressive exercise programs, cognitive behavioral therapy, occupational therapy, work hardening and clinical psychology support. They aim to reduce disability and psychological distress, improve general health, improve coping mechanisms and return patients to work or their normal activities of daily living (Frost et al., 2000).

10. **Hollowing** – drawing in of the naval towards the spine (Barnett & Gilleard, 2005).
11. **Load** – It is an action of one body over the other. There are two components: force and moment (Panjabi, 2004).
12. **Lumbar** – The vertebral section of the spine (L1-L5) that is immediately below the thoracic spine, that has a normal curve, with slightly convex anteriorly. (Kendall et al, 2005)
13. **Moment** – It is the set of two parallel and equal forces that are opposite in direction and separated by a distance. The effect is of this force couple is rotatory. This effect is called moment and is measured as the one force times the distance. The moment acquires two names: torque and bending moment, depending upon the orientation of the moment plane (Panjabi, 2004).
14. **Multidisciplinary intervention** – described as either functional restoration or pain management program (Frost et al., 2000).
15. **Neutral zone** – an important measure of spinal stability and is influenced by the interaction with the passive and active control systems (Panjabi, 2002).
16. **Pain management programs** – similar to functional restoration programs but include more psychological intervention (Frost et al., 2000).
17. **Rotation** – It is that displacement in which a line in the vertebra does not remain parallel to itself (Panjabi, 2004).
18. **Stiffness** - physical property of being inflexible and hard to bend (http://www.websters-online-dictionary.org).
19. **Supervised** – to oversee (http://www.websters-online-dictionary.org).
20. **Test of function** – examination of "to be in action" or "operation" (Akuthota, V. and S.F. Nadler, 2004).
21. **Thoracic spine** – Vertebral section of the spine, T1-T12, that has a normal curve, slightly convex posteriorly. (Kendall et al, 2005).
22. **Translation** – It is that displacement in which all points in the vertebra move in parallel paths (Panjabi, 2004).
23. **Torque** – A twisting force (http://www.websters-online-dictionary.org).
24. **Unstable spine** – Significant decrease in the capacity of the spine's stabilizing system to maintain intervertebral neutral zones within physiologic limits (Panjabi, 2002).
25. **Unsupervised** – to not oversee (http://www.websters-online-dictionary.org).

CHAPTER TWO

Review of Literature

The literature has indicated repeatedly that exercise is a treatment for LBP. Barr (2005) indicates that each episode of back pain (acute or chronic) generally has a good prognosis (Byrne et al., 2006; Golby et al., 2006; Barr et al, 2005; Hicks et al., 2005; Hayden, et al., 2005A; Bogduk, 2004; Mahar, 2004; Jenkins, 2003; Hides et al., 2001). However, the evidence or effectiveness for a specific approach is sparse and interpretation is unclear (Hicks et al., 2005; Bogduk, 2004).

Understanding how the spine moves and interacts with the rest of the body is critical to determine where dysfunction occurs. The spinal column transfers loads from torso to lower extremities, both in static and dynamic situations (Barr et al, 2005). As the spine moves it is required to dissipate forces and minimize energy expenditure. When the spine becomes unstable or motor control errors occur, the results present improper muscle forces and potential fatigue which can reflect a lack of muscular endurance (Higgins, 2004).

Panjabi (2003) indicates that in order to carry large loads, to allow movement between the head, thorax and pelvis, and to protect the neural elements, the spine should be mechanically stable. Higgins (2004) indicates that endurance of the lumbar stabilizers is potentially the most important aspect of maintaining and preventing lumbar pain.

Years ago, Panjabi (1992) indicated that biomechanical studies of the spinal column provided insight into the role of the various components of the spinal column in providing spinal stability One of the first models for spine stability was developed by Panjabi (1992) and consisted of three components: 1) Bone and ligamentous structure, 2) Muscles that surround the spine, and 3) Neural control system. Each of these components contributes to the overall program of spinal stability. Eleven years later, Panjabi (2003) remained supportive of his stabilizing system but slightly modified the focus to include: 1) The spinal column, 2) The spinal muscles, and 3) The neural control unit. In 2004, Panjabi reiterated his support and concluded that two fundamental principles that underpin exercise programs are that trunk muscle activity is necessary to 1) control and 2) stabilize the lumbar spine.

Stabilization training involves isolated local muscle contraction and an integration of the local and global muscle systems during particular movement patterns. The co-contraction of muscles may restore stability to the spine and, theoretically, may protect the spine from biomechanical stresses and further injuries. As mentioned earlier, the lack of co-contraction of lumbar muscle is related to lumbar instability, and is a significant factor in chronic low back dysfunction (Wagner et al., 2005; Sung, 2003).

Lumbar Pelvic Anatomy

Muscles that surround the spine and co-contract to support the spine are classified as the core within the lumbar-pelvic region. In general, the core has been described as a box with the abdominals in the front, paraspinals (ie: local muscles) and gluteals in the low back, the diaphragm as the roof and the pelvic floor and hip girdle musculature as the bottom. The core serves as a muscular corset that works as a unit to stabilize the body and spine, with and without limb movement. The core serves as the center of the functional kinetic chain that is the foundation or engine of all limb movement (Akuthota & Nadler, 2004).

A large number of muscles cross the spine and all contribute to the stability and movement at some point in time (Barr et al., 2005). The tissue (ligaments, tendons, etc.) and muscles are categorized into two groups, the deep local muscle system and the global muscles system. The deep local muscle system (inner unit) is a complex system that involves deep muscles that have their origin or insertion upon the lumbar vertebrae, which theoretically are responsible for the control of hypomobility and intervertebral relationships. The global muscle system (outer unit) that encompasses the large superficial muscles of the trunk (the torque generators for spinal motion) handles external loads applied to the spine (Golby et al., 2006; Barr et al, 2005; Richardson et al., 2005; Higgins, 2004).

Table: RL1

Global Muscles (outer unit) (dynamic, phasic torque producing)	**Local Muscles** (inner unit) (postural, tonic, segmental stabilizers)
Rectus abdominis	Multifidi
External oblique	Psoas major
Internal oblique (anterior fibers)	Transversus abdominis
Iliocostalis (thoraci portion)	Quadratus lumborum
	Diaphragm
	Internal oblique (posterior fibers)
	Iliocostalis and longissimus (Lumbar portions)

Local Muscles (inner unit)

Often the focus of many lumbar stabilization programs resides with the local muscles (inner unit). This cylinder of deep muscles surrounds the spine to provide stability and the function of these muscles is an area of increasing research. Patients with LBP, often have a dysfunctional deep stabilizing system, (Barr et al, 2005; Herrington & Davies, 2005) such as atrophy of the multifidi and weak spinal extensors (Barr et al., 2007; Wagner et al., 2005; Johnson, 2002). Hides et al (1994) identified significant ispsilateral atrophy in the lumbar multifidi of individuals with unilateral low back pain, and noted very little asymmetry in these muscles within a control group of subjects without LBP.

The local muscles are deep and are comprised of the multifidi, transverse abdominis, diaphragm, and pelvic floor. The multifidi muscle, which have short intervertebral attachments and control vertebral movement while maintaining posture and spinal movement protect the articular structures, discs, and ligaments from excessive strain and injury (MacDonald et al., 2006; Barr et al, 2005; Stevens et al., 2006). Sung (2003) reports that the multifidi muscles have a significant role in stabilizing the spine and are important for patients with CLBP (Sun, 2003). Studies of the multifidi have found muscle dysfunction and atrophy in patients with LBP. However, there is evidence that with specific exercise training, multifidi atrophy can be reversed. (MacDonald et al., 2006; Barr et al, 2005; Stevens et al., 2006)

The transverse abdominus, which attaches to the vertebra through the thoracolumbar fascia, seems to secure the spine by increasing intra-abdominal pressure, and stabilizing the sacroiliac joint as well (Stevens et al., 2006; Barr et al, 2005; Higgins, 2004; Ebenbichler et al., 2001; Cholewicki & VanVliet IV, 2002). In 2002, Choleswicki and VanVliet IV stated that the transverse abdominus is the most important muscle controlling the stability of the lumbar spine based upon the work of Hodges and colleagues. This muscle is consistently involved in generating intra-abdominal pressure which has the potential to stabilize the spine (Cholewicki & VanVliet IV, 2002).

Johnson (2002) states that when the transverse abdominus contracts, the multifidi contracts. Both muscles are categorized as stabilizers and must co-contract to stabilize the spine. However, in unilateral movement the multifidi is contracting but this does not necessarily mean the transverse abdominus is contracting (Akuthota & Nadler, 2004; Johnson, 2002).

In individuals that do not have LBP, the transverse abdominus is the first muscle activated and contracts before limb movement, regardless of the direction of motion (Standaert et al., 2004). However, in patients with LBP, the transverse abdominus does not function normally, specifically during muscle recruitment. (Barr et al, 2005). Because of their short movement arms, the multifidi are not involved much within gross movement either. However, Ng and colleagues (2002) claim that there has been evidence of multifidi muscle wasting in patients who have low back pain.

In addition, the obliques and transverse create a cylinder of support and stiffness that assist in spinal stability (Higgins, 2004; Ebenbichler et al., 2001). McGill (2006) further reported that activating the internal oblique will always cause contraction of the transverse abdominus (McGill, 2006).

The pelvic floor is also a part of the inner most unit of the abdominal muscles. It has an important role in proper muscular activation for lumbar stabilization. The pelvic floor forms the base of the abdominal cavity, so pelvic floor muscles must contract during tasks that elevate intra-abdominal pressure to maintain continence and contribute to pressure increases. (Barr et al, 2005; Akuthota & Nadler, 2004) In subjects without LBP, strong voluntary abdominal muscle contraction causes pelvic floor muscle activity at the same intensity as maximal pelvic floor muscle effort. Not only does the pelvic floor respond to increases in intra-abdominal pressure, the pelvic floor contracts prior to the abdominal muscles (Barr et al, 2005).Lastly, the diaphragm is also a major contributor to intra-abdominal pressure and therefore lumbar stability. The diaphragm also contributes to intra-abdominal pressure to assist with spinal stability, which occurs independently of the respiratory phase (Barr et al, 2005; Ebenbichler et al., 2001).

Global muscles (outer unit)

The more superficial muscles (global muscles – outer unit) may become dysfunctional in LBP patients as well. Global muscles/outer unit include the following muscles: - latissimus dorsi and paraspinals and abdominal musculature (obliques, rectus abdominus, iliocostalis) They have also been shown to affect lumbar stiffness and stability, particularly in direction-specific movements and in carrying weights. As a result, these muscles (internal and external obliques, rectus abdominus, other paraspinal muscles, and the iliopsoas muscle) are also a focus in lumbar stabilization exercise programs (Barr et al, 2005). These muscles seem to be activated to assist with stability by direction and load-specific activity. They prevent potentially harmful trunk movement caused by limb movement and the acceptance of heavy loads to the trunk (Barr et al., 2005; Stevens et al., 2006).

The global muscles cannot provide control over individual spinal segments and they have a limited ability to control shear forces when compared with the deep stabilizers (Barr et al, 2005). In fact, several studies have shown that patients with LBP have weaker extensor muscles. The ratio between trunk flexor-to-extensor strength ratios is abnormal as well. Weak lumbar spine extensor muscles are also a risk factor for the development of LBP (Barr et al, 2005).

One other muscle contributing to the lumbar stabilization is that of the quadratus lumborum (Barr et al, 2005; Akuthota & Nadler, 2004; Higgins, 2004). It is attached to the transverse processes of the lumbar spine through the thoracolumbar fascia and therefore increases lumbar stiffness, and lateral instability (Barr et al, 2005).

Considering all of these muscles and their contribution to lumbopelvic stability, Cholewicki and VanVliet IV (2002) hypothesized that there is no one muscle or muscle group prevailing over other muscles in their spine stabilizing function under all loading conditions.

Spinal Dysfunction

Researchers have hypothesized that when dysfunction occurs in the passive stabilizing system, the global muscles (outer unit muscles) may try to compensate by co-activating. Although global co-activation increases spine stability and stiffness, this can increase compressive load on lumbar segments and lead to spinal pain (Barr et al, 2005).

Standaert et al., (2004) indicated that dysfunction can be better understood when it is recognized that the spine generally serves three primary functions, especially when participating in sports: 1) force generation, 2) force absorption, and 3) force transfer. Excessive absolute loading, ineffective force dispersion, and problems with technique, range of motion, or endurance may all impair the ability of the lumbar spine to withstand the forces to which it is exposed on either an acute or repetitive basis (Standaert et al., 2004).

When people experience low back pain, they do not often have physical solutions for pain relief. They often avoid daily activities for concern that they may experience pain again. As a result, this can lead to spinal dysfunction or atrophy of lumbopelvic muscles, especially lumbar multifidi muscles and will eventually lead to more pain and enhance the avoidance cycle since they are neglecting the use of these muscles (Kankaanpaa, 1998).

After the initial onset of LBP surpasses 2-3 months, over 40% of acute LBP cases can often become chronic and lead to disability (Dugan, 2006; Mahar, 2004). During this time the intensity of pain varies and is influenced by the time of day and prolonged positions such as bending and lifting (Rainville et al., 2004).

Wagner and colleagues indicated that patients with chronic low back pain (CLBP) seem to have a reduced stability of their spine due to a reduced stiffness of the ligaments, muscle weakness, poor flexibility, poor endurance, and/or malfunctioning motor control (Akuthota & Nadler, 2005;

Wagner et al., 2005; Barr et al, 2005; Ng et al., 2002). The neuromuscular system modulates stiffness and movement to match the demands of internal and external forces. Hypomobility causes unnecessary energy expenditure and increased loading of spinal segments (Barr et al, 2005). Eventually, the decreased stability or abnormal neural control may cause tissue damage.

Tissue damage eventually leads to decreased stability of spinal structures which increases challenges to the already inefficient muscles, and the onset of pain and structural dysfunction (Barr et al, 2005; Kavcic et al., 2004B). Structural changes such as disc disease, muscular changes such as weakness and poor endurance, or ineffective neural control all contribute to this instability (Barr et al, 2007; Barr et al, 2005).

In 2002, Ng and colleagues concluded that neuromuscular dysfunction could contribute to spinal instability and result in pain. An unstable system can also be formed by just the skeletal elements. It is necessary to have both passive and active structures for the stability of the spinal column. The passive structures alone are not strong enough to guarantee the stable function of the spine, (Wagner et al., 2005) especially without muscular support. Likewise, Standaert et al, 2004 and Schonstein et al, 2003 agree and claimed that the focus lies in functional restoration of muscles to reduce pain and improve function in patients with CLBP.

Introduction to Spinal Stabilization

Standaert et al, (2004), indicated that the recovery stage should include progressive tissue loading, range of motion, strengthening, proprioception training, and conditioning. Standaert also believed that alterations in the function of the kinetic chain should be addressed, and motion patterns, neuromuscular control, and technique issues should be incorporated into training.

Akuthota and Nadler (2004) claimed that research studies are hampered by the lack of consensus understanding of what constitutes core-strengthening of the body. As defined by Akuthota and Nadler (2004), core strengthening stabilizes the spine and supports the opposite contracting muscles of the lumbar region of the body. Some programs have been titled: 1) remedial neuromuscular retraining; 2) sports-specific training; 3) functional education. Later in 2007, Barr indicated that the purpose of lumbar stabilizing program is to 1) normalize function of the deep stabilizers such as the transverse abdominis and multifidi; 2) restore normal strength and endurance to the muscles that affect the spine, and; 3) improve neural processing so that the muscles contract in a normal and efficient manner (Barr et al., 2007).

Reduced muscular endurance has also been correlated with the mal-coordination of trunk muscle instability. Muscle co-contractions influence both the spinal load and stability and protect the spine from biomechanical stresses and further injuries (Janeck et al., 2006; Wagner et al., 2005). These biomechanical stresses include tension, compression, torsion, and shear, which occur as a result of occupational activities involving spinal flexion, extension, and rotation and could further injury (Janeck et al., 2006).

Wagner and colleagues (2005) stated that the stability of spinal movements depended primarily on the geometrical arrangement of muscles and the position of the centre of rotation of the spine (Wagner, 2005). By understanding spine biomechanics and function and how spinal stability is altered in those with LBP, a rational approach to treatment of this condition can be developed (Barr et al., 2005; Wagner et al., 2005).

Exercise and Spinal Stabilization

In the study by Kavcic et al, (2004), seven stabilization exercises were used to determine the individual motor control strategies used by different people. This study demonstrated that as loads are applied to the spine, there is an integration of the many different muscles in order to balance the stability and moment demands. The researchers found no single muscle dominated securing the spine's stability. Muscle roles during the activity continuously changed across tasks (Kavcic et al., 2004A; Cholewicki & VanVliet IV, 2002).

According to Hicks et al., 2005, all muscles play a role in ensuring spine stability and that the motor patterns of co-contraction between the full complement of muscles are of utmost importance to ensure spinal stability and pain minimization (Hicks et al., 2005). Many clinicians use exercise approaches to train motor patterns for the purpose of improving spine stability (Herrington & Davis, 2005; Kavcic et al., 2004A).

However, MacDonald and colleagues (2006) suggest that there is good evidence that exercises that target deep multifidi muscles within the early phases of management are effective in reducing the recurrence rate of LBP and have a more substantial recovery of multifidi muscle mass following a first episode of acute LBP (Goldby et al, 2006; MacDonald et al., 2006; Mahar, 2004; Standaert et al., 2004). In addition, these muscles are supplemented with exercises for the pelvic floor and breathing control (MacDonald et al, 2006; Mahar, 2004; Standaert et al., 2004).

Protocols for exercises to improve lumbar stabilization vary from training multifidi and transverse abdominus muscles with isometric contractions to using weight machines designed to strengthen the primary movers of the spine. Other studies have found that cardiovascular exercises such as swimming, walking, and trunk curls, but not necessary specific stabilization programs improved function, decreased pain, and improved performance on functional tasks specifically in patients with non-specific LBP (Barr et al, 2007). The selected exercises used within this study involved isometric contractions in supine position and progressed to bands, balls, steps, etc., in standing positions utilizing both sagittal and transverse planes but did not include weight machines. Cardiovascular exercises utilitizing the full body motions can also increase the core strength. The type of exercise selected depends upon the individual and how long they have been in pain, or the activity they have been attempting. The exercises selected for this study can be considered mild-moderate level of intensity.

Another option within isometric contraction is abdominal bracing which has been studied as a method of retraining abdominal muscles and as a method of increasing spine stability in preparation for loads rapidly applied to the spine (Brown et al., 2006). When the abdominal oblique musculature activates during the abdominal bracing, there is equal activation across the extensor musculature as well (Kavcic et al., 2004A).

A study was conducted to determine whether the performance of abdominal hollowing and bracing could promote the voluntary recruitment of the transverse abdominus and oblique internus muscles prior to abdominal strengthening exercise variations. By co-contraction of the transverse abdominus and oblique internus muscles, a corset-like support is created for the lumbar spine, reducing both spinal load and the possibility of injury. Specifically, McGill (2006) studied 18 male subjects who performed a series of four abdominal strengthening exercises variations. Using surface electromyogram, a pressure transducer under the lumbar spine was used to detect spinal movement. Results indicated that the transverse abdominus and oblique internus were recruited first in the majority of subjects during exercises where stabilization techniques of hollowing and bracing were used (McGill, 2006; Barnett & Gilleard, 2005).

Further studying spinal movement and the co-contraction of muscles, Granata et al., (2005) studied the co-contraction and spinal load differences during isometric flexion and extension exertions. The goal was to provide insight into the mechanisms requiring greater co-contraction during trunk flexion exertions compared to extension exertions. The results indicated that co-contraction accounted for up to 47% of the total spinal load during flexion exertions. Spinal compression during the flexion tasks was nearly 50% greater than during extension exertions despite similar levels of trunk moment (Granata et al., 2005).

Exercise training is thought to be used to change lumbar posture during standing, sitting, and walking so that the neutral zone is maintained rather than excessive lordotic or kyphotic conditions. However, Barr et al (2005) indicated that studies have been inconclusive whether patients with balance and proprioception deficits and LBP improve with a lumbar stabilization program. Yet, when testing the ability to react to unexpected trunk perturbation, such as dynamic movements and suddenly becoming unstable, Barr et al (2007) and Barr et al (2005) determined that lumbopelvic stability requires control of whole-body equilibrium and that there is a close link between lumbar stabilization and posture, balance, proprioception of the spine. Specifically Barr et al (2005) and McGill (2002) determined that balance can be tested by the patient performing a simple balance exercise such as single-limb stance, a single-stance knee bend, or lunges in different planes. Patients may have difficulty with this and require extensive training and cues to accurately reproduce spinal positions required for exercises (Barr et al, 2005; McGill, 2002).

For patients with LBP, Barr et al. (2005) reported that deficits mostly relate to muscular and neurological function. In spinal segments with structural damage, proper muscular function seems to be able to compensate for structural deficits. Research in this area is often difficult since testing the muscles that are deep requires invasive measurements to accurately determine muscular activity. It is often unclear what degree of difference is clinically significant and what is “normal” as applied to strength, flexibility, and movement patterns (Barr et al, 2005).

In 2006, Brown et al. stated that the musculature surrounding the spine acts to provide a stiffening mechanism to the vertebral joints, thereby reducing the likelihood of a net energy loss in response to an applied perturbation and increase the stiffness and stability of the trunk. Similar to the guy wire system on a ship's mast, the muscle tensions and stiffness must be in balance and tuned to one another (Brown et al., 2006).

Trunk muscles in patients with LBP exhibit impaired responses to perturbation that could contribute to decreased postural stability. In a research study involving 82 subjects, researchers found that LBP was associated with significantly delayed onset of engagement for several trunk muscles. Significantly fewer muscles activated in response to a self-generated upper extremity disturbance. As a result, neuromuscular training may help improve postural stability in LBP patients (Bieze Foster, 2007).

Researchers have hypothesized that muscular endurance is more important than absolute muscle strength for proper lumbar stabilization since only a small percentage of maximum muscular force is used to stabilize the spine during daily activities (Barr et al 2007). A study involving 346 subjects compared the efficacy of two components of musculoskeletal physiotherapy on chronic low back disorder: 1) manual therapy, and 2) exercises to rehabilitate spinal stabilization. The participants were randomly selected for each group for 10 weeks of manual therapy, a spinal stabilization rehabilitation program, or a minimal intervention control group. Data was collected at baseline, and 3, 6, 12, and 24 months after intervention (Goldby et al., 2006). The results indicated statistically significant improvements in favor of the spinal stabilization group at the 6-month stage in pain (65.9 percent reductions in symptoms). Goldby (2006) concluded that as a component of musculoskeletal physiotherapy, the spinal stabilization program is more effective than manually applied therapy or an education booklet in treating chronic low back disorder over time. It consists of manual (joint manipulation and mobilization) and exercise therapy directed at or applied to the patient's musculoskeletal system. Goldby and colleagues (2006) cited that recent advances have been acknowledged that there have strong evidence to justify formal exercise programs, but there is a lack of evidence supporting manual therapy.

Koumantakis et al (2005) found that patients with recurrent LBP who underwent stabilization training and trunk-strengthening exercises showed improvements in pain, disability, and pain belief scales after eight weeks of exercise. This was maintained at three months follow-up.

Supervised vs. Unsupervised Spinal Stabilization

Comparing the results of supervised and unsupervised stabilization exercises suggest that there are some benefits with supervised instruction for performing the exercises.

Based upon verbal and tactile cues from a physical therapists, Barr et al (2005) and Wagner et al, (2005) indicated that the subjects can learn to activate their deeper stabilizing muscles rather than more superficial muscles during exercises independently practice this for at least a week between physical therapy sessions.

Hayden et al, (2005A) conducted a systematic review identifying particular exercise intervention characteristics that decrease pain and improve function in adults with nonspecific chronic low back pain. Forty-three randomized controlled trials were evaluated for exercise therapy in populations with chronic low back pain. The results revealed that exercise therapy that consists of individually designed programs, including stretching or strengthening, and is delivered with supervision may improve pain and function in chronic nonspecific low back pain. The review encouraged adherence strategies.

Regarding exercise compliance, Liddle's review indicated that the advantages of supervision and exercise compliance was 75% when trials were high or medium methodological quality and exercise compliance was 15% when trials were low methodological compliance. This may indicate that low quality trials do not value the importance of compliance levels and as a result, do not report them. More high quality trials are needed to accurately assess the supervision role and follow-up (Liddle et al., 2004).

Maher's systematic review (2004) located a limited number of head-to-head comparisons of various exercise programs. The review concluded there was evidence that the intense programs were more effective than the gentle programs, the provision of supervised programs were more effective than unsupervised, and the inclusion of principles of cognitive-behavioral treatment all influenced treatment efficacy (Mahar, 2004). Nine volunteers participated in three months of active outpatient rehabilitation (4-6 times supervised in a rehabilitation clinic, supplemented with at home exercises). Pre- and post- treatment electromyography measurements were taken. Five days per week participants were to perform the exercises at home unsupervised. Per the participant's diaries, none of the patients performed the home exercises 5-6 times per week. Three subjects exercised more than three times per week. The results of this study indicated, active physical rehabilitation had no effect on the abdominal and back muscle activities or on pain and functional disability indices (Arokoski, 2004) when conducted at home, unsupervised.

In a randomized, controlled trial of 39 subjects with acute first episode of unilateral LBP with multifidus atrophy, subjects were randomized to a control group that received education and regular care and a treatment group that received specific exercise training for multifidi activation and strengthening. Both groups had near resolution of LBP and returned to baseline function at 4 weeks of treatment (Barr et al., 2005).

Rainville and colleagues (2004) cited that several randomized controlled studies using a variety of types of exercise have demonstrated a positive effect on pain. A study consisting of an active exercise program of eight sessions over four weeks was found to be superior to unsupervised home exercise instructions for pain reduction (38% in the exercise versus 13% in the home exercise group). Another study compared active graded exercise program consisting of three weekly sessions for 12 weeks with conventional physical therapy and an unsupervised walking program. They observed a 30% pain reduction in the active exercise group versus a 23% pain reduction in the physical therapy group and a 9% pain reduction in the walking group at the end of the treatment (Rainville et al., 2004). The results of this review suggest that when experimental and control groups are given supervised exercise programs of variable content, both groups achieve a positive result.

An unsupervised study conducted by Koumantakis et al. (2005) compared general endurance exercise with stabilization training and general endurance exercise only for nonspecific back pain patients. The randomized controlled trial occurred with a total of 55 patients with recurrent back pain. Each group received an eight-week exercise intervention and written advice. No differences were detected between groups. It was concluded that physical exercise alone and not the exercise type was the key determinant for improvement in this patient group (Koumantakis et al., 2005).

Considering low back dysfunction, 16 patients were evaluated pre- and post treatment for outcomes of functional status and muscle fatigued after a supervised four-week spinal stabilization exercise program for patients exercising 3 times a week over a four-week period. The follow-up post-test concluded that spinal stabilization exercise program significantly improved functional status in patients presenting with LBP (Sung, 2003).

Spinal Stabilization: Acute vs Chronic LBP

Regarding the acute first episode of LBP, Hide et al. (2001), found that patients who received training in multifidi and transverse abdominus co-contraction recovered from acute episodes at the same rate as the control group, but had much less chance of recurrence of the LBP than those who did not receive this training. Specifically, both the exercise group and the control group had improvement of symptoms at 4 weeks, 1 year and 3 years. Telephone follow-up revealed that those in the control group were 12 times more likely to experience recurrence of LBP than the experimental group in the first year and nine times more likely in years 2-3. Although, a weakness of this study was the small sample size, the marked difference between groups leads to the notion that specific exercise training can prevent recurrence (Hides et al, 2001).

Many studies have indicated that exercise therapy for LBP was not effective for patients with acute LBP, but may be helpful for those with chronic LBP (Hayden et al., 2006; Hicks et al., 2005; Fritz et al., 2004; Bekkering et al., 2003). Shen and colleagues (2006) agreed and added that during the acute period of pain, exercise therapy could mechanically stress the back more than the endurance exercises (Byrne et al., 2006; Shen et al., 2006). A few years earlier, in separate studies Aure (2003) and Bekkering (2003) noted that without therapy at all, 80-90% of those with acute low back pain would improve within 6-8 weeks (Bekkering et al., 2003; Aure et al., 2003). Even despite symptomatic improvement, patients with acute, first-episode LBP did not recover multifidus muscle strength over 10 weeks (Stadaert et al., 2004). What remains unknown is what causes the pain to return, since frequently the LBP returns within six months after initial onset.

Dugan (2006) reported that up to 40% of acute low back pain cases can become chronic and lead to disability in some cases. Yet, Shen agreed with the majority of the literature supporting that exercise therapy is effective in the management of CLBP (Kofotolis et al, 2006; Hayden et al, 2005A; van Tulder et al, 2000; Frost et al, 1998). Of all patients who suffer from LBP, 73-77% suffer from *chronic* low back disorder (Goldby et al, 2006).

Exercise programs for chronic low back pain may be designed to reverse de-conditioning or the fear of movement associated with pain, or both. Such exercise programs are often conducted in groups and typically include aerobic exercise such as walking or stationary cycling, as well as strengthening and stretching exercises (Ferreira et al., 2007 in print; Hayden et al., 2005B). This is supported by Cohen & Rainville (2002) who claim that no scientific evidence reports that activity and exercises are harmful or that pain-inducing activity must be avoided by this patient population (Cohen & Rainville, 2002).

Spinal Stabilization: Strengthening Approach

In 2004, a review by Liddle et al. (2004), found that 12 out of 16 trials focused upon strengthening exercises. Within this review, the lumbar spine or lower limbs were commonly the targeted body site. Abdominal strengthening was often incorporated with strengthening of the lumbar spine to facilitate trunk stabilization (Liddle et al 2004).

A study by Rielly and colleagues (2005) concluded that improvements in strength correlated well with improvements in pain and disability. One hundred twenty subjects completed a six week rehabilitation program averaging 13 sessions each. Treatment consisted mainly of progressive resistance exercises for the lumbar extensors and abdominal musculature on specialized equipment. Exercise was continued to failure and progressed weekly (Rielly et al., 2005). Bogduk (2004), on the contrary, states there is strong evidence that strengthening exercises are not more effective than other types of exercises.

A 2005 Cochrane review on exercise therapy for the treatment of nonspecific LBP includes six randomized controlled trials of exercise programs that included strengthening or trunk stabilizing exercises. It concludes that, overall, this type of exercise is effective for chronic LBP, particularly in health care settings (Hayden et al., 2005; Hayden et al., 2005A).

There does not seem to be an agreement which exercise or muscle involvement is necessary to produce positive results for LBP. However, specifically stated, when experimental and control groups were given supervised exercise programs of variable content, both groups achieve a positive result (Liddle et al., 2004)

However, Barr and colleagues (2007) summarized recently that the following muscular components can be improved by exercise:

1. the deep musculature that provides intersegmental lumbar vertebral control, such as the multifidi,
2. muscles that increase intra-abdominis, diaphragm, and pelvic floor,
3. global muscles that control trunk movement and provide co-contraction during activities such as walking and lifting, such as the latissimus dorsi, quadratus lumborum, and superficial spine flexors and extensors,
4. the precise neural control of these muscles.

Spinal Stabilization Programming: Inner Unit vs. Outer Unit

Keep in mind that exercises for lumbar stabilization programs demonstrate that the biomechanics of those with nonspecific low-back pain often differ from those who do not have back pain. (Barr et al., 2007)

Table: RL2

Goals for stabilizing the local muscular system (inner unit) of the spine (Richardson et al., 2005):

1. develop the skill of an independent contraction of the local muscle synergy;
2. decrease the contribution of the overactive global muscles;
3. use of motor relearning approach to reteach the skill of developing a ‘corset’ action of transverseus abdominis and multifidus in response to the cue to draw in the abdominal wall
4. use specific facilitation and feedback techniques to ensure each segment of multifidi is activated
5. use specific feedback techniques to develop kinesthetic awareness of local muscle contractions
6. develop ability to hold the ‘corset’ action over extended periods of time
7. use repeated movements of the lumbopelvic region, in non-weight bearing positions initially, to improve position sense

Because strength is less important than endurance for lumbar health, traditional weight training protocols that focus on strength only are most likely not applicable to the lumbar stabilizers (Higgins, 2004).

Table: RL3

Goals for stabilizing the global muscular system (outer unit) of the spine (Richardson et al., 2005):

1. treating the local and weight bearing muscles is likely to reverse impairments in the non-weight bearing muscles
2. initially use specific facilitation techniques for dysfunctional weight bearing muscles, with emphasis on increasing weight bearing load cues
3. use optimal weight bearing postures (neutral lumbopelvic region) to re-establish recruitment of both the local and weight bearing muscles.
4. weight bearing muscles should be trained under the stretch from gravity in flexed and more upright postures.
5. Use static weight bearing postures with increasing holds and/or very slow and controlled weight bearing exercise to enhance the feedback mechanisms.
6. Increase gravitational load cues (ie: unstable surfaces) gradually, ensuring local and weight bearing muscles are responding to the increases in load
7. may need to add specific muscle-lengthening techniques for non-weight bearing muscles

No matter what the exercise stages, the emphasis is on isometric holding contractions in static positions or exercise via very slow and controlled movements (Richardson et al., 2005).

Spinal Stabilization Programming: Prevention

Table: RL4

Guidelines and direction for preventing low back pain (Higgin2004):

- Stabilization exercises are most beneficial when performed daily
- Traditional strength training routines for other body parts are not applicable to the spinal stabilizers.
- Spinal stabilizers are used to provide feedback and stability throughout the course of an activity
- Cardiovascular health is important for low back health and endurance as it seems to enhance the effects of low back exercise programs.
- Functional ROM spinal exercise should be avoided early in the day due to the increase in disk pressures.

- Normal breathing during stabilization exercises helps to maintain abdominal activation for spinal stability.
- Repetitive activities in positions associated with high disk pressures should be avoided.

Suggested Exercises

Many thoughts exist of progression and approach to the exercises appropriate for spinal stabilization. Mechanically, technique is critical to the efficiency of the exercises. Aure et al., (2003) reported that via the published report by the International Paris Task Force on Back Pain, it was concluded that regardless of physical, therapeutic, or recreational exercises there is no specific active techniques or methods superior to another (Aure et al., 2003).

Barr (2007) and Akuthota & Nadler (2004), contrarily suggested similar classifications of progression, such as beginning, intermediate and advance levels that focus upon exercises that balance between strength and flexibility of the muscles that act on the spine. They suggest that the amount of time taken to advance to the next level varies depending on many individual factors. Some participants with limited functional goals never progress to the advanced stage, while others do not wish to progress to the advanced stage. This perhaps suggests that those limited to progress may have progressed to the furthest possible with their individual situation. Others may not wish to progress if their pain has improved but not necessarily ceased.

Exercise can cause changes in muscle mass and increase strength and endurance. Lumbar stabilization exercises designed to target the multifidi can increase their muscle mass in patients with LBP and multifidi atrophy. (Barr et al, 2005)

In summary, Barr (2007) suggests that the following goals be the focus for each level:

Beginning - developing core awareness by learning how to activate the transverse and multifidi and to be able to find and maintain a neutral spine position. Examples: contracting the transversus in supine, side lying and prone position. These examples are then progressed by adding limb movement while contraction is maintained. One of the goals is to avoid the stronger global (superficial) muscles from taking over during these exercises. These exercises extend beyond simple activation of the deep stabilizers (Richardson et al., 2005).

Intermediate – Once the beginning exercises are accomplished then participants can advance to intermediate level. The goal is to continue to stabilize the spine with increasing challenges to the muscles. Examples of exercises may include moving the arms and legs simultaneously and through larger range of motions to challenge the muscles that maintain neutral spine. Multiple studies indicate that efficacy with a stabilization program stopped at this intermediate level (Fritz et al, 2005; Koumantakis et al, 2005; Richardson et al., 2005; Hides et al, 2001; O'Sullivan et al, 1997).

Advanced – The goal is to perform high level activities, work, and sports while still stabilizing the spine. The advanced stage directs progression so that all muscles are integrated into functional movement tasks in a formal way. In addition, training on unstable surfaces such as an exercise ball and rocker board will continue to challenge the musculature and train the body to handle unexpected gravitational forces. Weights, pulleys, and other equipment can be used for functional exercises such as lunges with arm movement, and more intense flexion and extension exercises. If the participant is an athlete, sports-specific activities are added (Richardson et al., 2005; Akuthota & Nadler, 2004).

Several studies have indicated that common stability exercises that provide compression forces across the L4-L5 segment were as follows: bridging, trunk curl, quadruped exercises, and sitting on a physio-ball. These exercises were compared with the stabilizing effects of the exercises and challenges to the muscles (Barr et al, 2005; Kavic, 2004; Higgins, 2004).

Frost et al., (2000) studied 129 patients in the United Kingdom with CLBP and utilized an outpatient functional restoration program. Even though Frost's study surpassed the time frame of this study, it is important to reveal that exercise was individually tailored to the patients' ability by the physiotherapist. Exercise included a combination of stretching exercises, general muscle strengthening, spine stabilization exercises, endurance and low impact aerobic exercise (Slade et al, 2006; Frost et al., 2000). These exercises were progressed over a three week period and surpassed the time frame of this study. It appears that after 7, 15, 27, and 55 weeks of inclusion of these exercises, progress was made via the Oswestry Low Back Pain Disability index. The scores were small to moderate. However, the effectiveness of functional restoration programs was not properly assessed and further randomized controlled trials need to be conducted (Frost et al., 2000).

McGill (2002) describes three clinical tests for determining spinal stabilizer muscle endurance. These exercisers test the global musculature rather than the deep stabilizers and when repeated over consecutive days had success. The period of time the patient can maintain the proper position is measured.

1. **Lateral musculature endurance** – patient lies full side-bridge position and supports himself on one elbow and the feet while lifting the hips off the mat to create a straight line between the shoulders to the feet.
2. **Trunk flexor endurance** – patient lies supine and flexes the hips and knees to 90 degrees and isometrically holds the trunk at 60 degrees of flexion
3. **Back extensor endurance** – patient lies prone with the legs supported on a table and the feet secured, with the trunk unsupported. The patient holds the upper body in a horizontal position. (McGill, 2002)

Treatment for LBP has support and has conflicting results. As the literature indicates, the treatment is often individualized in nature. Since the etiology is often unclear, assessments must be available to determine where the exact cause of low back pain may be originating. Acute vs. chronic pain, supervised and unsupervised, first episode or recurring episodes, recurring pain, there is evidence that exercise can be helpful.

CHAPTER THREE

Methodology

Preliminary Procedures:

This study was approved by the Institutional Review Board at Oklahoma State University and also approved to take place at Genesis Health Club, 1551 N. Rock Road, in Wichita, Kansas. All subjects meeting qualifications participated for six weeks and had access to the fitness facility. As mentioned earlier, the purpose of this study was to directly assist the experimental group for six weeks. Individualized support, direction, and demonstration of the exercises were provided in the attempt to stabilize the spine, reduce low back pain and improve functional activity. The control group initially received the same instruction and booklet, but conducted the exercises on their own.

Subjects

Qualified participants were 18 years or older at the time of the study and were obtained via a formal mailing to members of the Sedgwick County Medical Society (SCMS), from a local newspaper article and via advertisement postings at the fitness club.

Medical specialists included within this mailing were family practice physicians, surgeons, and physical therapists. Contents within the mailing included the following: letters of endorsements from the three physician/surgeons, subject qualification information, medical release, a letter of informed consent and medical waiver.

Subjects who qualified for the study were those who had been diagnosed with mechanical low back pain (without chronic radiculopathy or radiating pain down the leg), disc disease without herniation or disc desiccation (dryness). Subjects were required have the ability to travel to the fitness center, and deemed medically fit for the study by their general practitioner.

Those excluded from this study were individuals who had previous surgery, fractures, spondylolisthesis, stenosis, inflammatory joint disease, present or past history of metastatic disease or currently pregnant. Individuals with a history of anxiety neurosis were also excluded from this study.

All qualified subjects were required to sign a letter of informed consent, and medical waiver. Respective primary care (personal) physicians were required to complete the medical release indicating a release to participate and to "rule out" any previously low back pain diagnosis.

Instruments

The pre-test was administered to all participants prior to the six weeks of training. Two tests were provided. The first test was a survey of function entitled Oswestry Disability Index (ODI) , version 2.0 (Appendix A) a questionnaire seeking information in how the LBP is affecting managing every day life. Topics within the questionnaire include the following: pain intensity, personal care, lifting, walking sitting standing, sleeping, sex life, social life, and traveling. This questionnaire was designed in 1976 by John O'Brien to provide information in how the pain of the back or leg affects the ability to manage everyday life (Fairbanks et al, 1980), but was not disseminated until 1981 (Fairbank & Pynsent, 2000). The Oswestry Disability Index (ODI) has become one of the principal condition-specific outcome measures used in the management of spinal disorders. The ODI remains a valid and vigorous measure of condition-specific disability. Many validity and reliability tests have been conducted since 1980. In 1997, Fisher and Johnson conducted one of the most detailed validations of the questionnaire. They related patient behavior while they were completing the ODI and other questionnaires to their responses within the questionnaires. In 2000, more than 200 citations exist in the Science Citation Index (Fairbank & Pynsent, 2000).

Scoring for ODI is as follows: There is a total score of 5 points per section. Each of the eight sections has six statements. The first statement is equal to "0" and the sixth statement is equal to "5". There are six statements within each of the eight sections. The total points are added for each section and divided by 100. If a section is not answered, that section is not included into the total points. Example: 16 (total score)/40 (total possible score) x 100 = 40%. Each percentile range is categorized as follows: 0-20% - minimal disability, 21-40% moderate disability, 41-60% severe disability, 61-80% crippled, and 81-100% potentially bed bound.

The second instrument was a questionnaire regarding pain entitled: SF-36v2 Health Survey (Appendix B). This tests measured the length or intensity of pain and/or function observation, such as how far they could walk pain free. The SF-36v2 Health Survey has been documented in nearly 4,000 publications and is the most widely-used health status questionnaire in the world, most likely because it is simple and very useful. It is also psychometrically sound, and readily available and well documented. The survey yields an 8-scale profile of functional health and well-being scores as well as psychometrically-based physical and mental health summary measures and a preference-based health utility index. It is a generic measure, as opposed to one that targets a specific age, disease, or treatment group (Ware et al., 2002).

Scoring includes algorithms for norm-based scoring for all eight scales as well as the same standardization of scoring (mean = 50, standard deviation = 10) that has made the SF-36v2 easier to interpret. Specifically, the instrument items and scales are scored so that a higher score indicates a better health stage. For example: functioning scales are scored so that a high score indicates better functioning and the pain scale is scored so that a high score indicates freedom from pain. (Ware et al., 2002)

At the conclusion of the six weeks, both groups gathered at the Genesis Health Clubs and the same tests (post-tests) were administered.

Study Site

Genesis Health Clubs is a full functional fitness facility that includes a nursery, restaurant, salon, pro shop, massage services, dry cleaning, and physical therapy. Exercise equipment is all located on the second floor, with the exception of the Pilates reformers, which are located on the third floor. The resistance equipment includes name brands such as: Nautilus, Free Motion, and Hammer Strength. Other equipment available to the subjects will include, Physio balls 45, 55, 65, and 75 CM; JC Bands (all various strengths – purple, pink, orange, yellow, blue and black); massage/stretch tables (height adjustable); weighted small balls (2lbs., 4lbs., 6lbs., 8lbs., 12lbs. and 15lbs.), and Reactive Neuromuscular Training bands.

Each participant received a temporary membership card and was required to sign-in and date their attendance when using the facility. During this study, all facility privileges were made available to the participants with the exception of private personal training.

For safety and management issues, Genesis Health Clubs were provided a comprehensive list of participant's names, addresses, and emergency numbers. Parking was readily available to participants.

Each group (control and experimental) followed the exercise booklet provided to them at the onset of the study.

Operational Procedures

Once the requirements were met for study qualifications, each subject was notified of a meeting date via telephone. All qualifying subjects attended the initial meeting, and check-in procedures with Genesis Health Clubs were explained. The pretest surveys were administered and collected. Each subject received an exercise booklet illustrated with pictorial direction of each stage of the exercises. Each exercise within the booklet were demonstrated and reviewed.

During the meeting, all subjects' names were randomized to determine sampling for each group: control and experimental. The marketing director of Genesis Health Clubs drew 50% of the names for the experimental group. The remaining names were assigned to the control group. Once the groups were determined, the two groups were divided and addressed separately.

Control Group (unsupervised group): This group was unsupervised and exercised independently from the principal researcher. These subjects were encouraged to come to the fitness club at least three times per week to conduct the booklet exercises previously reviewed. Each subject documented their attendance as they checked-in. At the conclusion of the six weeks, the control group reconvened to complete the post tests.

Experimental Group (supervised group): A schedule of session dates were distributed to members of the experimental group. The schedule included two calendar dates and sometimes three calendar dates per week. Each subject was encouraged to attend at least two sessions per week during the study. During the scheduled sessions, the principal researcher was present to assist, provide any further biomechanical instruction for the subjects, and progress subjects as needed. At the conclusion of the six weeks, the experimental group reconvened to complete the post tests.

Exercises

After the research subjects arrived to the fitness club, they provided their temporary IDs, signed-in at the front desk, and proceeded to warm up for 5-10 minutes. A walking track and cardiovascular equipment, such as a recumbent bicycles, upright bicycles, treadmills and EFX or elliptical machines was available. Any subjects using cardiovascular equipment were recommended to keep the elevation flat or at 0-1 ramp measurement level, while the resistance level could have been set to what ever was individually appropriate. The warm-up was highly encouraged, but was not monitored by the principal investigator.

The exercises were selected from the spinal stabilization research that presented low to medium intensity and from the experience of the principal investigator in working with other individuals. During the spinal stabilization exercises, the goal was set to maintain a neutral spine and controlled limb position during the session (Kavcic et al, 2004). Progression of these exercises for the experimental group remained in the sagittal plane until the last several weeks of the study. Each individual progressed through the following exercises in the following manner: unloaded positions (on floor) to seated, from seated to unstable surfaces, and then to standing positions. Each individual progressed to the transverse plane when appropriate.

Each of the following exercises was explained thoroughly during the initial session. The subjects were advised to perform the exercises by also mentally focusing upon the abdominal muscles (Note: The booklet has actual pictures, and similar instructions. For most of the exercises, the subjects were advised to perform two sets of 12-15 repetitions.)

Pelvic tilt – (hollowing) – in a supine position, knees bent and feet on the floor, hold small weighted ball between knees to keep hips neutral. Draw naval in toward spine while maintaining neutral alignment. Although not necessary, some may feel the lumbar curve flatten against floor, during the pelvic tilt (Reynolds, 2006; Hicks et al, 2005).

Isometric hold with assistance – In supine position, knees bent and feet on the floor with toes elevated but heels down on the floor/table, hold small weighted ball between knees to keep hips neutral, and place hands together in "praying position" with elbows next to sides. Assistance is provided by providing resistance to left side of hands and right side of knees. Have subject, press against resistance in opposite directions. The pressure should be applied to create isometric resistance.

Abdominal curl – in a supine position, arms across chest, knees bent and feet on the floor. Curl shoulders up and forward, letting the head follow, contracting mid-section of thoracic body (Jenkins, 2003; Sung, 2003; Kavcic et al, 2004).

Oblique Abdominal curl and reach - in a supine position, knees bent and feet on the floor, hold small weighted ball between knees to keep hips neutral. Reach right hand toward left knee by lifting the shoulder and head off of the floor. (If too difficult, reach hand towards knee without lifting shoulder and head off of the floor. Once strong enough then lift shoulder and head off of floor). Make sure abdominals are drawn in as hand is reaching towards knee. Repeat by reaching left hand toward right knee (Jenkins, 2003; Sung, 2003).

Advanced Oblique Abdominal curl and reach - in a supine position, knees bent and feet on the floor, hold small weighted ball between knees to keep hips neutral. Lift left foot off of the floor, and proceed by reaching right hand toward left knee by lifting the shoulder and head off of the floor. The left foot should not be lifted higher 90 degrees off of the floor. Repeat by reaching left hand toward right knee and have right foot off of the floor. Keep in mind that if it is too difficult to lift shoulder and head off of the floor, this exercise is too advanced for the individual (Jenkins, 2003; Sung, 2003).

Bridging – in a supine position, knees bent and feet on the floor, hold small weighted ball between knees to keep hips neutral. While pressing through heels, lift hips 6-8 inches off of the floor. It is important to avoid pressing through elbows resting on floor at sides of body (Hicks et al., 2005; Kavcic et al, 2004). During this exercise, it is important to squeeze buttocks while performing bridging with both legs and bridging with single leg.

Advanced Bridging - Single foot on table: Begin in a supine position, knees bent and feet on the floor, hold small weighted ball between knees to keep hips neutral. Lift left foot off the floor, and push through right foot and lift hips off of floor. The left foot should not be lifted higher 90 degrees off of the floor. Repeat in same position, but change feet so that right foot is lifted off of table (Hicks et al., 2005; Kavcic et al, 2004).

Side Bridging on knees – Laying on right side with knees flexed, elevate body between knees and elbow. It is important to keep body in straight line between knees and shoulders (Hicks et al., 2005; Kavcic et al., 2004; Jenkins, 2003; McGill, 2003).

Advanced Side bridging – Laying on right side, elevate body between feet and elbows. It is important to keep body in straight line between knees and shoulders (Hicks et al., 2005; Kavcic et al., 2004; McGill, 2003).

Quadruped (a.k.a.: four-point kneeling position, birddog) – Lay prone on floor, with head on 1 inch deep towel, and extend right arm and left leg between 4-6 inches off of floor. Hold for 6-8 seconds, and switch to lift left arm and right leg between 4-6 inches off of floor (Reynolds, 2006; Hicks et al., 2005; Kavcic et al, 2004; Jenkins, 2003; McGill, 2003; Sung 2003).

Advanced Quadruped (a.k.a.: four-point kneeling position, birddog)– Kneel on floor with knees directly under hips and hold upper body by placing hands on floor with shoulders directly over hands. Elbows should be pointed backwards. With head neutral with spine and facing down, lift right arm and left leg 10-12 inches off of the floor. Hold for 6-8 seconds. As difficulty eases, extend lift right arm in shoulder flexion (parallel to the floor) and extend leg by lifting right leg (parallel to the floor). Only hold this position for 6-8 seconds (Hicks et al., 2005; Kavcic et al, 2004; Jenkins, 2003; McGill, 2003; Sung, 2003).

Plank – Lying prone on elbows, balance and hold body straight between forearms and feet. Initially, hold for 10 second intervals and lengthen time to 30 seconds. (McGill, 2003)

Seated Band Row – While seated in chair (sitting erect and not laying back against chair back), holding a small weighted ball between knees; create adequate resistance between band attachment and individual, and begin rowing.

Standing Band Row – Using JC bands, create adequate resistance between band attachment and individual. Holding a small weighted ball between knees, lower body in comfortable squat position, with shoulders slightly forward or directly over hips and knees directly over feet, pull band in rowing motion with both hands at the same time. The difficulty lies with the various levels of tension of the JC bands.

Advanced Standing Band Row - Using JC bands, create adequate resistance between band attachment and individual. Holding a small weighted ball between knees, lower body in comfortable squat position, with shoulders slightly forward or directly over hips and knees directly over feet, pull band in rowing motion with both hands at the same time. The difficulty lies with the various levels of tension of the JC bands. Now, lift right foot 4-6 inches off of floor, so that the body weight is resting on left foot. Repeat by lifting right foot 4-6 inches off of floor, so that the body weight is resting on right foot.

Low bench step ups – Using a low level 2-4 inches bench (group fitness step bench), step up on bench with right leg and balance. Repeat exercise 10 times trying not to touch left foot on bench. Switch legs by stepping up on the bench with left leg and balance.

Advanced bench step ups – (higher bench height) Step up on 6-10 inch bench with right leg and balance. Repeat exercise 10 times trying not to touch left foot on bench. Switch legs by stepping up on the bench with left leg and balance.

Isometric hold seated in chair – Seated in chair with a small weighted ball between knees keeping the hips neutral, hold a cable coming from the left side of the chair with both hands directly in front (6-8 inches from body) of the body. Repeat holding cable coming from the right side of the chair with both hands directly in front (6-8 inches from the body) of the body. Hold this position with erect position.

Isometric hold seated on physio ball – (exactly the same as **Isometric hold seated in chair** except sitting on unstable physio ball) Seated on physio ball with a small weighted ball between knees keeping the hips neutral, hold a cable coming from the left side of the physio ball with both hands directly in front (6-8 inches from the body) of the body. Repeat holding cable coming from the right side of the physio ball with both hands directly in front (6-8 inches from the body) of the body. Hold this position with erect position.

Isometric cable (or JC Band) hold standing – Standing perpendicular to the cable or band attachment, in slight squat (knees should be directly over ankles and torso should be upright and in erect position. With good resistance, hold cable or band directly in front of body (6-8 inches from body) with both hands.

Torso Twist seated in chair - Seated in chair with a small weighted ball between knees keeping the hips neutral, hold a cable coming from the left side of the chair with both hands directly in front (6-8 inches from body) of the body, then pull the cable in an arc movement across the body. Repeat holding cable coming from the right side of the chair with both hands directly in front (6-8 inches from the body) of the body and pull the cable in an arc movement across the body. Maintain an erect position while performing this exercise.

Torso Twist seated on physio ball - Seated on physio ball with a small weighted ball between knees keeping the hips neutral, hold a cable coming from the left side of the chair with both hands directly in front (6-8 inches from body) of the body, then pull the cable in an arc movement across the body. Repeat holding cable coming from the right side of the physio ball with both hands directly in front (6-8 inches from the body) of the body and pull the cable in an arc movement across the body. Maintain an erect position while performing this exercise.

Torso Twist standing - Standing perpendicular to the cable or band attachment, in slight squat (knees should be directly over ankles and torso should be upright and in erect position). With good resistance, hold a cable or band coming from the left side with both hands directly in front (6-8 inches from body) of the body, then pull the cable in an arc movement across the body. Repeat holding cable or band coming from the right side with both hands directly in front (6-8 inches from the body) of the body and pull the cable in an arc movement across the body. Maintain an erect position while performing this exercise.

These exercises are considered low to moderate level exercises. The role of the primary investigator within the supervised capacity was to provide biomechanical direction, focus, and correction to efficiently perform the above exercises. In addition, the primary researcher advanced the exercises when appropriate for each subject. The unsupervised (experimental group) received the same initial instructions, have the same equipment and instructions but did not have direct biomechanical direction, or assistance in correcting exercises for efficiency. Each individual within the unsupervised group progressed his/her exercises when appropriate for themselves.

Design and Analysis

The analysis is 2 x 2 repeated measures ANOVA with Group at two levels (experimental vs. control group) and Time at two levels (pre and post) via the SPSS (13.0 for Windows) . Five separate analyses were conducted on the two dependent variables (pain and unsupervised/supervised group). One test evaluated the pain score and four sub tests of the functionality scores were performed. All statistical tests were performed at the .05 level of significance.

This repeated measure was selected to evaluate pain levels after duration of time when a group had directed (supervised) or indirect (unsupervised) levels. Daily functionality was also reviewed. The repeated measure was evaluated via pre and post tests after six weeks of exercise.

Variations of the exercises were performed by each group. For clarification, some of the exercises, there were three phases of the exercise. Each subject may have selected the phase that best suited them for the individual situation. Most of the subjects advanced to the second or third phase of many of the exercises, but this was not the case for all subjects. One particular subject was not able to perform all of the exercises due to pain she was experiencing. According to this individual, the pain originated from something that had happened at the subject's employment.

Regarding the number of set and repetitions conducted by each subject. Each individual was instructed to perform what they could, but to try to achieve two sets of 12-15 repetitions. Any isometric contraction holds were to be held for approximately 5-8 seconds.

CHAPTER FOUR

Results and Discussion

Introduction and Descriptive Data

This chapter reports on the analysis of the data from the pre- and post-test and discusses the results that were significant to the stated hypothesis. The intended purpose of the study was to determine the effects of supervised vs. unsupervised exercises session for low back pain. Twenty three individuals qualified for this research study but only 20 (N=20) completed the six weeks of supervised (10) and unsupervised (10) exercise program for low back pain. The subjects ranged from 38-75 years of age. Six men and 14 women participated. (*Table 11*) Each group received identical demonstration of the exercises, a complete booklet of exercises, and initially completed two pre-tests: Oswestry Disability Index (ODI) and Your Health and Well-being (SF-36v2). The supervised group met with the primary investigator 2-3 times per week for six weeks at the fitness center, while the unsupervised group was encouraged to complete the exercises 2-3 times per week also at the fitness center for six weeks. At the conclusion of the six weeks each group completed the same (post) tests.

The Oswestry Disability Questionnaire (Appendix A) is a questionnaire seeking information in how the LBP is affecting managing every day life. Topics within the questionnaire include the following: pain intensity, personal care, lifting, walking sitting standing, sleeping, sex life, social life, and traveling.

Table 1: ODI Mean and SD

ODI	N	Mean	SD
Pre Pain	10		
Unsupervised		17.00	8.55
Supervised		28.00	13.73
Post Pain	10		
Unsupervised		8.40	7.17
Supervised		14.00	14.00

Between the pre-test and the post-test (*Table 1*), the mean score of the ODI pain test decreased among the unsupervised group from 17.00 to 8.40; while the supervised group was decreased from 28.00 to 14.00. The Standard Deviation between the pre-and post-test among the unsupervised and supervised groups remained very similar.

Table 2: ODI ANOVA Summary Table

ODI	**SS**	***df***	***F***	**Sig.**
Group	688.90	1	3.78	.068
Error	3280.20	18		
Time	1276.90	1	30.88	.000*
G x T	72.90	1	1.80	.201
Error	744.40	18		
Total	2094.20	20		

* All groups over time is significant at the .05 level

The Pre- and Post- Owestry Disability Index (*Table 2*) indicated statistical significance of pain ($df_{(1,18)}$, $.000 = p < .05$). when time was the main factor. There is no significant difference between groups when each group was tested for six weeks. Therefore, Ho_1 was not rejected. The results of the ODI indicate that pain can be significantly reduced regardless of performing exercises within a supervised group or an unsupervised group.

The Health and Well-Being (SF-36v2) test is a questionnaire that asks for the subjects views about his/her health and has multiple sub-sections. For this research, the following four mini components applicable to this study: 1) General Health, 2) Physical Functioning, 3) Bodily Pain, and 4) Role – Physical.

The General Health questions (*Figure 1*) referred to interpretation of overall health.

Figure 1: General Health Questions (SF-36v2)

General Health question:
In general, would you say your health is:

General Health questions:
11a. I seem to get sick a little easier than other people
11b I am as healthy as anybody I know
11c I expect my health to get worse
11d My health is excellent

This section indicated (*Table 3*) that the mean score increased between each group at the pre and post test (unsupervised pre-test 19.10 to post test 20.80; supervised pre-test 18.48 to post-test 20.52), while the SD increased slightly between the pre and post test for the unsupervised group (2.63 to 2.95) and decreased slightly between the pre- and post-test for the supervised group 3.17 to 2.27).

Table 3: General Health Mean and SD

General Health	**N**	**Mean**	**SD**
Pre General Health	10		
Unsupervised		19.10	2.63
Supervised		18.48	3.17
Post General Health	10		
Unsupervised		20.80	2.95
Supervised		20.52	2.27

The General Health questions of the Health and Well-Being (SF-36v2) test indicated time was the only factor proved to be statistical significant (*Table 4*) between the pre- and post-tests ($df_{(1,18)}$, $.002 = p < .05$). There is no significant difference between the supervised or unsupervised groups when each group was tested for six weeks. This indicates when considering general health, there is significant difference when performing the same exercises over a six week period but not between the two groups: the supervised or unsupervised group.

Table 4: General Health ANOVA Summary Table

General Health	**SS**	***df***	***F***	**Sig.**
Group	2.12	1	.165	.690
Error	231.49	18		
Time	34.60	1	13.59	.002*
G x T	.32	1	.127	.725
Error	45.84	18		
Total	80.76	20		

* All groups over time is significant at the .05 level

As indicated in Figure 2, the questions addressing Physical Functioning involve events or activities, such as: such as climbing stairs, walking various distances, lifting or carrying groceries, vigorous activities, etc.

Figure 2: Physical Functioning Questions

Physical Functioning questions: Answered to yes, limited a lot; Yes, limited a little; No, not limited.

3a Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports
3b Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf
3c Lifting or carrying groceries
3d Climbing several flights of stairs
3e Climbing one flight of stairs
3f Bending, kneeling, or stopping
3g Walking more than a mile
3h Walking several hundred yards
3i Walking one hundred yards
3j Bathing or dressing yourself

This section (*Table 5*) indicated that the mean score increased between the pre- and post-test between each group (unsupervised 25.90 to 27.40; supervised 20.90 to 24.60). The

SD decreased between pre- and post-test for the unsupervised group (3.90 to 2.37), but slightly increased for the supervised group (4.43 to 4.88). At the end of this study, it appears that the subjects could do more with less pain.

Table 5: Physical functioning Mean and SD

Physical Functioning	**N**	**Mean**	**SD**
Pre Phys. Functioning	10		
Unsupervised		25.90	3.90
Supervised		20.90	4.43
Post Phys. Functioning	10		
Unsupervised		27.40	2.37
Supervised		24.60	4.88

The Physical Functioning of the Health and Well-Being (SF-36v2) test (*Table 6*) demonstrated statistical significance ($df_{(1,18)}$, $.025 = p < .05$) between groups and statistical significance regardless of groups with duration ($df_{(1,18)}$, $.005 = p < .05$) There is no statistical significance when comparing separate groups over time together. This indicates when considering Physical Functioning, that each group achieved statistical significance of functional improvement between the pre- and post-test, and over time, but there was not statistical improvement between groups over time.

Table 6: Physical Functioning ANOVA Summary Table

Physical Functioning	**SS**	***df***	***F***	**Sig.**
Group	152.10	1	5.99	.025*
Error	457.30	18		
Time	67.60	1	10.03	.005*
G x T	12.10	1	1.60	.197
Error	121.30	18		
Total	201.00	20		

* All groups over time is significant at the .05 level
* There is significant difference between groups at the .05 level

The Bodily Pain questions of the Health and Well-Being (SF-36v2) test only involved two questions, *Figure 3*, and reflected as to the amount of pain subjects might have experienced during the past four weeks.

Figure 3: Bodily Pain Questions

Questions:
7. How much bodily pain have you had during the past 4 weeks?
8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

The test (*Table 7*) indicated that the mean score increased between the pre- and post-test (unsupervised pre-test 8.17 to post test 9.63; supervised pre-test 6.70 to post-test 8.70) between each group. The SD decreased between pre- and post-test for the unsupervised group, but slightly increased for the supervised group. The scores appear to indicate the mean scores for bodily pain increased between pre- and post-tests.

Table 7: Bodily Pain Mean and SD

Bodily Pain	**N**	**Mean**	**SD**
Pre Bodily Pain	10		
Unsupervised		8.17	2.01
Supervised		6.70	1.31
Post Bodily Pain	10		
Unsupervised		9.63	1.61
Supervised		8.70	1.65

The Bodily Pain questions of the test (*Table 8*) indicated time was the only factor proved to be statistically significant between the pre- and post-tests (*Table 8*) ($df_{(1,18)}$, $.001 = p < .05$). There is no significant difference between groups, nor was there any difference between groups over a given time period. However, when both groups performed the exercises over a lengthy amount of time, there was a significant difference.

Table 8: Bodily Pain ANOVA Summary Table

Bodily Pain	**SS**	***df***	***F***	**Sig.**
Group	14.4	1	2.88	.107
Error	90.14	18		
Time	29.93	1	34.35	.000*
G x T	.73	1	.84	.372
Error	15.68	18		
Total	46.34	20		

* All groups over time is significant at the .05 level

The questions for the sub-section of Role- Physical address whether the subject has accomplished of getting more done than originally thought he/she could do.

Figure 4: Role-Physical Questions

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

4a Cut down on the amount of time you spent on work or other activities
4b Accomplished less than you would like
4c Were limited in the kind of work or other activities
4d Had difficulty performing the work or other activities (for example, it took extra effort)

The Role-Physical section of the Health and Well-Being (SF-36v2) test mean scores between pre- and post-tests (*Table 9*) improved during the six weeks for both supervised and unsupervised groups (unsupervised pre-test 16.10 to post test 18.30; supervised pre-test 11.10 to post-test 17.40). The SD scores decreased during the six weeks for both supervised and unsupervised groups.

Table 9: Role-Physical Mean and SD

Role-Physical	**N**	**Mean**	**SD**
Pre Role-Physical	10		
Unsupervised		16.10	3.60
Supervised		11.10	3.41
Post Role-Physical	10		
Unsupervised		18.30	1.49
Supervised		17.40	2.76

Table 10: Role-Physical ANOVA Summary Table

Role-Physical	**SS**	***df***	***F***	**Sig.**
Group	87.03	1	5.86	.026*
Error	267.45	18		
Time	180.63	1	75.88	.000*
G x T	42.03	1	17.65	.001*
Error	42.85	18		
Total	266.51	20		

* All groups over time is significant at the .05 level
* There is significant difference between groups at the .05 level
* There is significant difference between groups and over time at the .05 level.

The Role-Physical questions (*Figure 4*) proved statistical significance at the .05 level in (*Table 10*) all three categories: 1) between each group $df_{(1,18)}$, $.026 = p < .05$), 2) from the beginning of the study to the end, $df_{(1,18)}$, $.000 = p < .05$), and 3) comparing each group at the beginning of the study to the end of the six weeks $df_{(1,18)}$, $.001 = p < .05$). This indicates subjects are able to do more functional activities with less pain after completing the same exercises among all groups, between groups and for the duration of six weeks. .

Discussion

This study compared the effect of two hypotheses regarding pain and functionality of individuals with mechanical low back pain. Five separate analyses were conducted on two dependent variables. This section will further expound on the findings from the study and to help formulate other areas of investigation for future studies.

The hypothesis' (Ho1 and Ho2) both state that the specific low back exercises will not decrease pain, nor improve functionality in the supervised group when compared to the unsupervised group. Within the Role-Physical test, all three effects were found to be statistically significant (*Table 10*) which supports what the experimental group indicated during their sessions.

Five repeated measures of ANOVA were used on two hypotheses. Only one test was statistically significant between groups (supervised vs. unsupervised) over the duration of time. In all five ANOVA tests, time or duration proved significant when the exercises were performed.

The two instruments, ODI and SF-36v2, were somewhat effective but often asked questions repeatedly with different phraseology. Subjects felt the functionality test, Sf-36v2, had questions that were vague and they were torn in how to answer the questions. Even though researched and thoroughly studied, they were found to be the best for this research.

Having a reference of exercises in pictures and written detailed instruction proved extremely valuable and consistent among all subjects. The booklet was the commonality among all participants. However, Stuart McGill (2003) states he has determined that there is no such thing as an ideal set of exercises for all individuals addressing LBP.

The groups were very motivated and had a vested interest in reducing their low back pain. As stated within the delimitations, each individual seemed motivated to participate prior to the onset of the study as a result of their LBP. Each subject that participated in the study was referred by word of mouth and via the advertisement posted at Genesis Health Clubs (Rock Road location) or local news paper, *The Wichita Eagle*. Physicians, surgeons, nor physical therapists referred subjects. Although numerous medical professionals visited with the principal investigator, it was determined that many potential subjects had issues beyond mechanical low back pain and were not accepted for this study.

It is also believed that the characteristics of the subjects whether motivated and diligent about consistency and focus assists in positive results. The psychological impact of pain and determination was not calculated with in this study or studies that were reviewed. Pain often creates fear and reluctance which has an impact on motivation to seek out further options. A more in depth study might be necessary to include the psychological factor as well.

Every one in the experimental group illustrated and indicated that they felt they had improved during the course of the six weeks. Specifically, they mentioned that they could do more with less pain. Their stability sensation and balance demonstration also improved that during each of the sessions. However, as pain subsided and the study reached the end of the six weeks, consistency of attending sessions (experimental group) seemed to waiver.

The results indicate that over time and consistency, pain and functionality can be improved. The Physical Functioning test (*Table 6*) and the Role-Physical test (*Table 10*) both indicated that after the six weeks, the subjects were able to functionally accomplish more with less pain. However, what was confusing was that the Bodily Pain means increased proving inconsistency with all of the other tests. Means increased from 1.5 to 2.0 points. Perhaps, this is as a result that only two questions (*Figure 3*) were considered for this mean score, while all of the other sections had at least four questions answered.

The control and experimental groups were similar in age and their consistency in performing the exercises (*Table 11*). Average age for the control (unsupervised) group was 54.3 years of age with ages ranging from 38-67, and for the experimental (supervised) group the average age was 58.7 years of age with ages ranging from 40-75.

Table 11: Average Subject Age and Attendance

Subjects	**Gender**	**Age**	**Avg. No. of session attended**	**Age Range**
Unsupervised (control)	M=4, F=6	54.3	10.8	38-67
Supervised (experimental)	M=2, F=8	58.7	10.9	40-75

During the six weeks, there were fourteen scheduled days for the principal investigator to meet with the experimental group. The average number of sessions for each individual within the experimental group was 10.9. The average number of sessions for each individual within control group was nearly identical at 10.8 (*Table 11*).

As a result, when considering age and attendance, the random sampling between groups proved very similar. During the course of the six weeks, every participant within the experimental group performed the exercises nearly twice per week, approximately one hour per session. It is unknown how much time the unsupervised group utilized to perform the exercises.

When working with the supervised group, the repetitiousness of the exercises created a habitual environment. The principal investigator assisted in biomechanical position, creating focus of the exercise, assisting in the isometric hold exercise and in exercise progression for each group member. Ensuring stability and reducing pain via exercise and creating motor patterns was supported by Hicks (2005), Herrington & David (2005), and Kavcic (2004A). However, longevity and consistency seems to be the key within this study. Perhaps what Barr et al (2007) concluded was true in that muscular endurance is more important than absolute muscles strength for proper lumbar stabilization.

Remember Koumantakis et al (2005) concluded that physical exercise alone and not the exercise type was the key determinant for improvement stabilization training and general endurance exercises. Sung (2003) indicated the same when he concluded that spinal stabilization exercise program significantly improved functional status in patients presenting with lbp in pre and post test studies, but did not separate groups between supervised and unsupervised.

Pain and functionality are extremely individualize factors and at any given time, some of the subjects may have had more pain than others depending on what they did that day from sitting, standing, lifting or whatever the case may be. As Barr (2007) indicates, the purpose of the lumbar stabilizing program is to 1) normalize function of the deep stabilizers; 2) restore normal strength and endurance to the muscles that affect the spine, and 3) improve neural processing. The exercises that both the control and experimental group received were identical and focused on stabilization and balance. Exactly which exercise worked for each individual is not known.

CHAPTER FIVE

Summary, Findings, Conclusions, and Recommendations

Summary

Overall pain was reduced with time regardless if either group had specific supervision or not. The hypotheses were not rejected but important information was still retrieved from this study. It would seem, that since the null hypothesis was not rejected in more than one of the five tests that consistency in conducting the same exact exercises seem to be more meaningful than the experimental group that received directed supervision.

Twenty individuals received valuable information and direction during this study. The focus and direction helped many who would not normally have had the assistance. Through the course of the study, they asked questions, and were extremely interested in participating while gaining insight and knowledge about their bodies, specifically, low back.

Findings

The duration of the study resulted in main effects being statistically significant. There was no significant difference between the supervised or unsupervised group, with the exception of the Role – Physical test. Time, consistency, focus and diligence paid off for those participating in the experimental and control group.

Conclusions

Strength and stabilization exercises appear to work as found through various studies. What has been found are the limited specific spinal-stabilization exercises. These types of exercises need to be studied further to support the theoretical conclusion that education is a key element of the management of both acute and chronic low back pain. Education should include information about correct posture, biomechanics of the spine in activities of daily living and simple methods that can reduce symptoms. Patients should also be informed about the expected outcome and favorable natural history of low back pain. Patients must understand the significance of a lifelong commitment to an active treatment program because the most important risk factor for future episodes of back pain is a previous episode. There is no evidence that back schools prevent low back pain; however, some evidence supports back schools as helpful when combined with other rehabilitation efforts. (Shen et al, 2006; Bogduk, 2004)

Human behavior has always and will continue to be an enormous factor in compliance regarding physical activity. Twenty individuals were motivated as a result of low back pain. It did not matter within this study if they had full time instruction or not. The fact that they had the tools of knowing what exercise to do and the instruction in how to perform the exercise that was crucial. Reduction of pain and improved functionality over the course of time and consistency was the result of this study regardless if the subjects were part of the control or experimental group.

Recommendations

Having 20 individuals complete the study was adequate, but obviously a larger group might have proven stronger results. There are many, many exercises that could have been suggested. However, a series of 12 exercises might be a great place to start most individuals that suffer with mechanical LBP. Listening to the experimental group express their thoughts regarding the study, it was understood that specific exercises worked best for some, while others had their favorites.

Barr et al (2007) reported that there are varying degrees of exercise to improve lumbar stabilization varying from training of the multifidi and the TA. Barr also reported that other studies have incorporated cardiovascular exercise and not necessarily stabilization programs to improve function, and decrease pain specifically in patients with non-specific LBP. Perhaps a firm combination of both lumbar stabilizing exercises and cardiovascular exercise would provide additional results.

Lastly, Rainville et al (2004) sited several randomized control studies using a variety of exercises in which demonstrated a positive impact on pain. As a result, the sampling of subjects may be the primary indicator of significance. In other words, a different set of folk at another time and place may have proven differently.

These findings are difficult to measure since each and every person will respond differently to a variety of stabilization exercises. Providing a pool of exercises that will hopefully reach the majority of the subjects is challenging at best but will aid in the outcome of improving pain and dysfunction. Like mentioned earlier, a larger sampling would have been ideal, but a larger group might also have presented greater complicated low back injuries. Whether in this study or reviewing previous studies and literature, physical activity (whether directed or not) seems to be better than not doing any thing to improve pain and functionality.

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Appendix A.

Oswestry Disability Index (ODI) Questionnaire

OSWESTRY 2.0

INSTRUCTIONS: Could you please complete this questionnaire. It is designed to give us information as to how your back (or leg) trouble has affected your ability to manage in every day life. Please answer every section. Mark one box only in each section that most closely describes you **today.**

Section 1 – Pain intensity:
- I have no pain at the moment. (0 points)
- The pain is very mild at the moment. (1 points)
- The pain is moderate at the moment. (2 points)
- The pain is fairly severe at the moment. (3 points)
- The pain is very severe at the moment. (4 points)
- The pain is the worst imaginable at the moment. (5 points)

Section 2 – Personal care:
- I can look after myself normally without causing extra pain. (0 points)
- I can look after myself normally, but it is very painful. (1 points)
- It is painful to look after myself, and I am slow and careful. (2 points)
- I need some help, but I manage most of my personal care. (3 points)
- I need help every day in most aspects of self care. (4 points)
- I do not get dressed, I wash with difficulty, I stay in bed. (5 points)

Section 3 – Lifting:
- I can lift heavy weights without extra pain. (0 points)
- I can lift heavy weights, but it gives me extra pain. (1 points)
- Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, e.g., on a table. (2 points)
- Pain prevents me from lifting heavy weights off the floor, but I can manage light to medium weights if they are conveniently positioned. (3 points)
- I can only lift very light weights. (4 points)
- I cannot lift or carry anything at all. (5 points)

Section 4 – Walking:
- Pain does not prevent me from walking any distance. (0 points)
- Pain prevents me from walking more than 1 mile. (1 point)
- Pain prevents me from walking more than ½ of a mile. (2 points)
- Pain prevents me from walking more than 100 yards. (3 points)
- I can only walk using a stick or crutches. (4 points)
- I am in bed most of the time and have to crawl to the toilet. (5 points)

Section 5 – Sitting:
- I can sit in any chair for as long as I like. (0 points)
- I can sit in my favorite chair for as long as I like. (1 point)
- Pain prevents me from sitting more than 1 hour. (2 points)
- Pain prevents me from sitting more than ½ an hour. (3 points)
- Pain prevents me from sitting more than 10 minutes. (4 points)
- Pain prevents me from sitting at all. (5 points)

Section 6 – Standing:
- I can stand as long as I want without extra pain. (0 points)
- I can stand as long as I want but it gives me extra pain. (1 point)
- Pain prevents me from standing for more than 1 hour. (2 points)
- Pain prevents me from standing for more than ½ an hour. (3 points)
- Pain prevents me from standing for more than 10 minutes. (4 points)
- Pain prevents me from standing at all. (5 points)

Section 7 – Sleeping

- My sleep is never disturbed by pain. (0 points)
- My sleep is occasionally disturbed by pain. (1 point)
- Because of pain, I have less than 6 hours of sleep. (2 points)
- Because of pain, I have less than 4 hours of sleep. (3 points)
- Because of pain, I have less than 2 hours of sleep. (4 points)
- Pain prevents me from sleeping at all. (5 points)

Section 8 – Sex Life (if applicable)

- My sex life is normal and causes no extra pain. (0 points)
- My sex life is normal but causes some extra pain. (1 point)
- My sex life is nearly normal but is very painful. (2 points)
- My sex life is severely restricted by pain. (3 points)
- My sex life is nearly absent because of pain. (4 points)
- Pain prevents any sex life at all. (5 points)

Section 9 – Social Life:

- My social life is normal and causes me no extra pain. (0 points)
- My social life is normal but increases the degree of pain. (1 point)
- Pain has no significant effect on my social life apart from limiting my more energetic interests, e.g., sports, etc. (2 points)
- Pain has restricted my social life and I do not go out as often. (3 points)
- Pain has restricted social life to my home. (4 points)
- I have no social life because of pain. (5 points)

Section 10 – Traveling:

- I can travel anywhere without pain. (0 points)
- I can travel anywhere, but it gives extra pain. (1 point)
- Pain is bad, but I manage journeys over two hours. (2 points)
- Pain restricts me to journeys less than one hour. (3 points)
- Pain restricts me to short necessary journeys less than 30 minutes. (4 points)
- Pain prevents me from traveling except to receive treatment. (5 points)

Scoring:

Simply count up all the points and divide 50 (or 45 if they leave out one section) and multiply by 100 to get your score.

Example: on my last ODI I scored a 16. So, 16/50 x 100 = 32% disability:

Categories:

0% to 20%: minimal disability: The patient can cope with most living activities. Usually no treatment is indicated apart from advice on lifting sitting and exercise.

21%-40%: moderate disability: The patient experiences more pain and difficulty with sitting lifting and standing. Travel and social life are more difficult and they may be disabled from work. Personal care sexual activity and sleeping are not grossly affected and the patient can usually be managed by conservative means.

41%-60%: severe disability: Pain remains the main problem in this group but activities of daily living are affected. These patients require a detailed investigation.

61%-80%: crippled: Back pain impinges on all aspects of the patient's life. Positive intervention is required.

81%-100%: These patients are either bed-bound or exaggerating their symptoms.

Appendix B.

SF-36v2:
Your Health and Well-Being

Your Health and Well-Being

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. ***Thank you for completing this survey!***

For each of the following questions, please mark an ☒ in the one box that best describes your answer.

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

Excellent	Very good	Good	Fair	Poor
▼	▼	▼	▼	▼
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

2. <u>Compared to one year ago</u>, how would you rate your health in general <u>now</u>?

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

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

	Yes, limited a lot	Yes, limited a little	No, not limited at all
a Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	☐ 1	☐ 2	☐ 3
b Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	☐ 1	☐ 2	☐ 3
c Lifting or carrying groceries	☐ 1	☐ 2	☐ 3
d Climbing several flights of stairs	☐ 1	☐ 2	☐ 3
e Climbing one flight of stairs	☐ 1	☐ 2	☐ 3
f Bending, kneeling, or stooping	☐ 1	☐ 2	☐ 3
g Walking more than a mile	☐ 1	☐ 2	☐ 3
h Walking several hundred yards	☐ 1	☐ 2	☐ 3
i Walking one hundred yards	☐ 1	☐ 2	☐ 3
j Bathing or dressing yourself	☐ 1	☐ 2	☐ 3

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

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Cut down on the amount of time you spent on work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b Accomplished less than you would like	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Were limited in the kind of work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d Had difficulty performing the work or other activities (for example, it took extra effort)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

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

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Cut down on the amount of time you spent on work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b Accomplished less than you would like	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Did work or other activities less carefully than usual	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

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

Not at all	Slightly	Moderately	Quite a bit	Extremely
▼	▼	▼	▼	▼
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

7. **How much <u>bodily</u> pain have you had during the <u>past 4 weeks</u>?**

None	Very mild	Mild	Moderate	Severe	Very Severe
▼	▼	▼	▼	▼	▼
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

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

Not at all	A little bit	Moderately	Quite a bit	Extremely
▼	▼	▼	▼	▼
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

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

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Did you feel full of life?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b Have you been very nervous?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Have you felt so down in the dumps that nothing could cheer you up?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d Have you felt calm and peaceful?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
e Did you have a lot of energy?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
f Have you felt downhearted and depressed?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
g Did you feel worn out?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
h Have you been happy?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
i Did you feel tired?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

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

All of the time	Most of the time	Some of the time	A little of the time	None of the time
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

11. How TRUE or FALSE is <u>each</u> of the following statements for you?

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false
a I seem to get sick a little easier than other people	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b I am as healthy as anybody I know	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c I expect my health to get worse	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d My health is excellent	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

THANK YOU FOR COMPLETING THESE QUESTIONS!

Appendix C.

Exercise Booklet

Exercise booklet for Research Project

Title:

Effect of supervised and directed exercise on low back pain and functional activity

Principal Investigator:

Wendy Williamson,

Oklahoma State University

Exercises

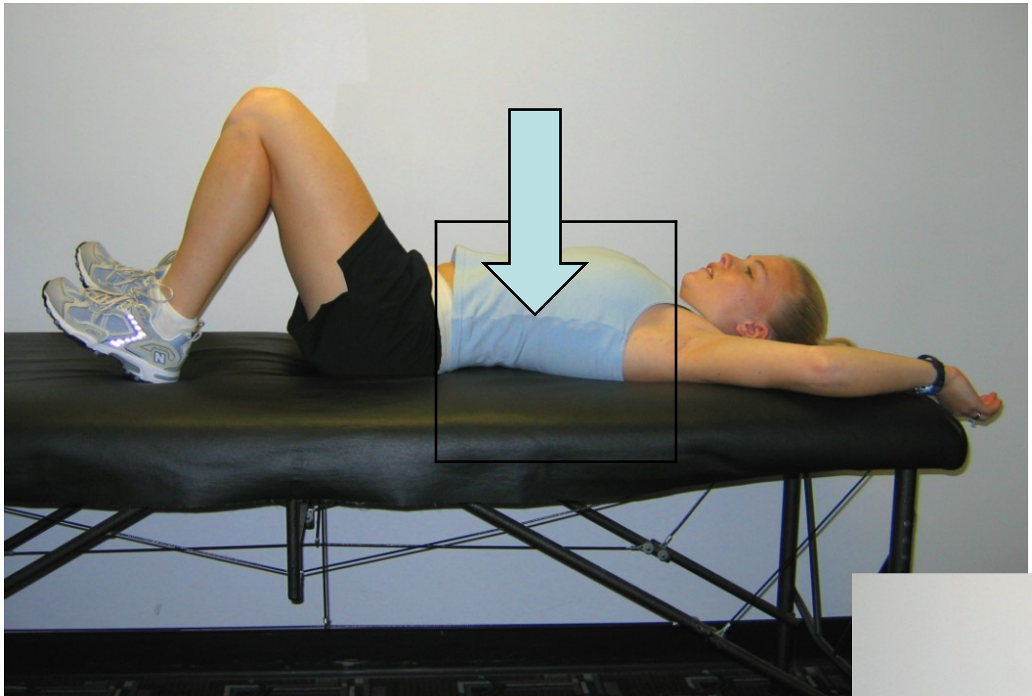
1. Pelvic tilts (hollowing)
2. Isometric hold with assistance
3. Abdominal curl
4. Oblique abdominal curl and reach
    a. Oblique abdominal curl and reach with head and shoulder lift.
    b. Advanced oblique abdominal curl and reach
5. Bridging
    a. Advanced bridging – single foot on table
6. Side bridging on knees
    a. Advanced side bridging
7. Quadruped
    a. Advanced quadruped (all fours)
8. Plank

Exercises

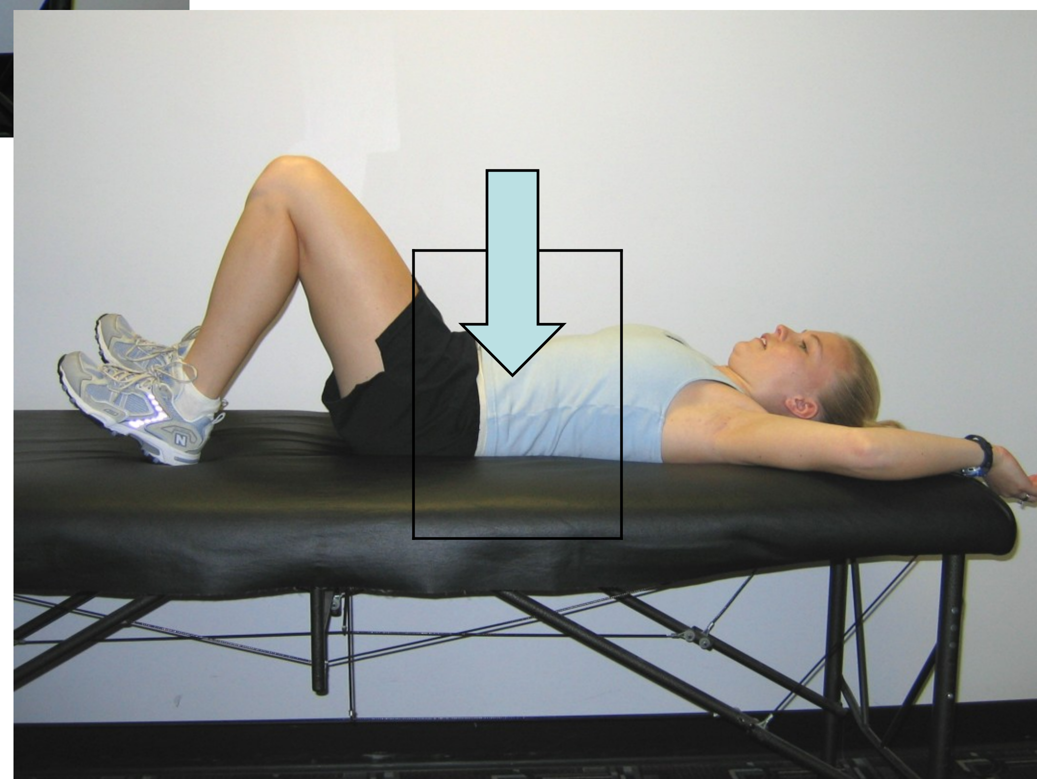
9. Seated band row
    a. Standing band row
10. Low bench step ups
    a. Advanced bench step ups
11. Isometric hold seated in chair
    a. Isometric hold seated on physio ball
    b. Isometric cable (or JC Band) hold standing
12. Torso twist seated in chair
    a. Torso twist seated on physio ball
    b. Torso twist standing

1. Pelvic Tilts

(hollowing)



- With knees bent, toes off of the table and pressing through the heels, flatten back against floor. Hold for 6-8 seconds.



Pull belly button “in” toward your spine while tilting pelvis.

✓S

2. Isometric hold with assistance

- Supine position
- Feet in dorsal flexion
- Squeezing ball between knees
- Contracting abdominals
- Elbows in 90 degree flexion with hands together above torso
- Knees and hips in 90 degree flexion
- Resist pressure against knees and hands in opposite direction

3. Abdominal Curl

- Squeeze ball between knees

- Arms across chest
- Feet dorsal flexion
- Lift shoulders off table contracting abdominals

4. Oblique Abdominal Curl and Reach

- Supine position
- Head remains down
- Contract abdominals while reaching across body to opposite knee
- Feet in dorsal flexion

4a. Oblique Abdominal Curl and Reach with head and shoulder lift

- Supine position
- Squeezing ball between knees
- Contract abdominals while reaching across body to opposite knee
- Feet in dorsal flexion
- Head may be elevated during exercise

4b. Advanced Oblique Abdominal curl and reach

- Supine position
- Squeezing ball between knees
- Contract abdominals while reaching across body to opposite knee

- Feet in dorsal flexion
- Hips and knees flexed 90 degrees
- Head may elevate during exercise

5. Bridging

- On back with knees bent and arms at side.
- Squeezing ball between knees

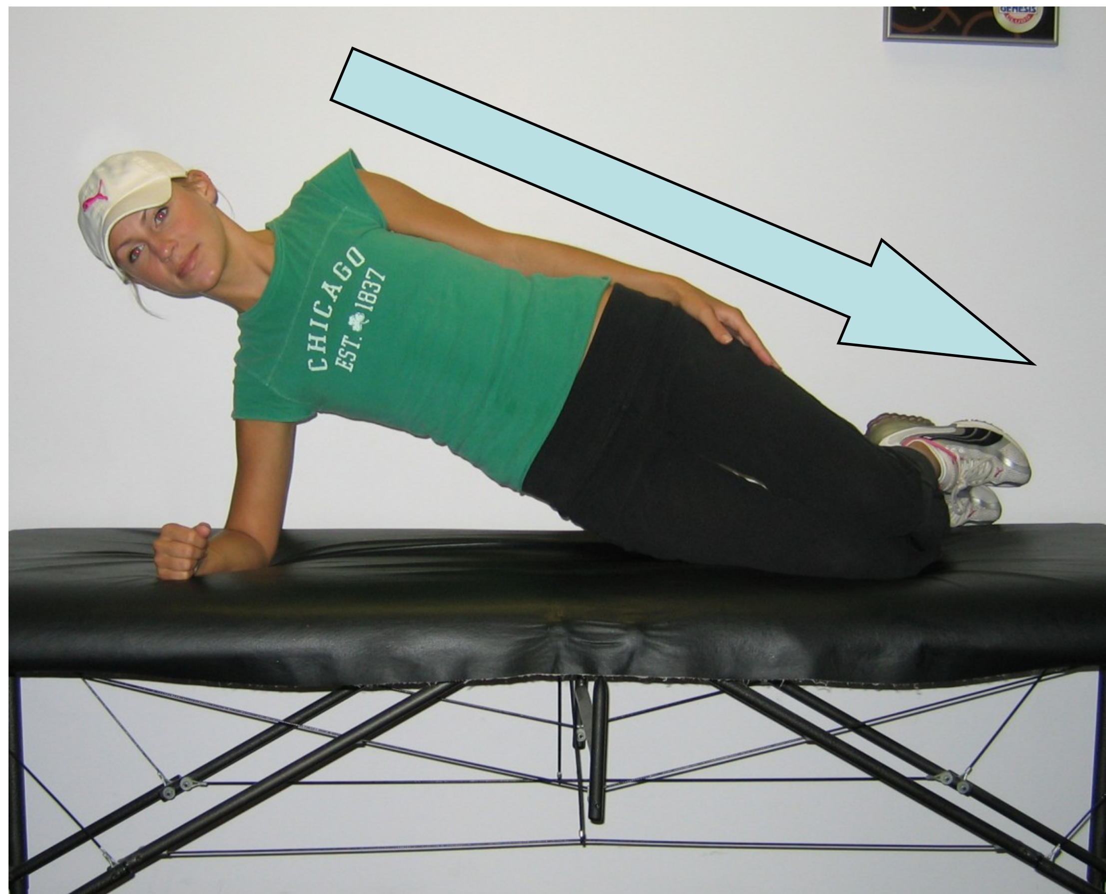
- Tighten the abdominal muscles and slightly squeeze the buttocks
- Tilt the pelvis into a "neutral" position and raise pelvis off the floor (2 sets of 12-15 repetitions)
- Hold this position for a 6-8 seconds, then return to the starting position.

5a. Advanced Bridging – Single foot on table

- Repeat No. 5 bridging (squeeze ball between knees
- Add the following: Lift one lower leg 90 degrees off of the floor
- Press through the foot remaining on the floor
- Repeat with opposite leg
- 2 sets of 12-15 repetitions

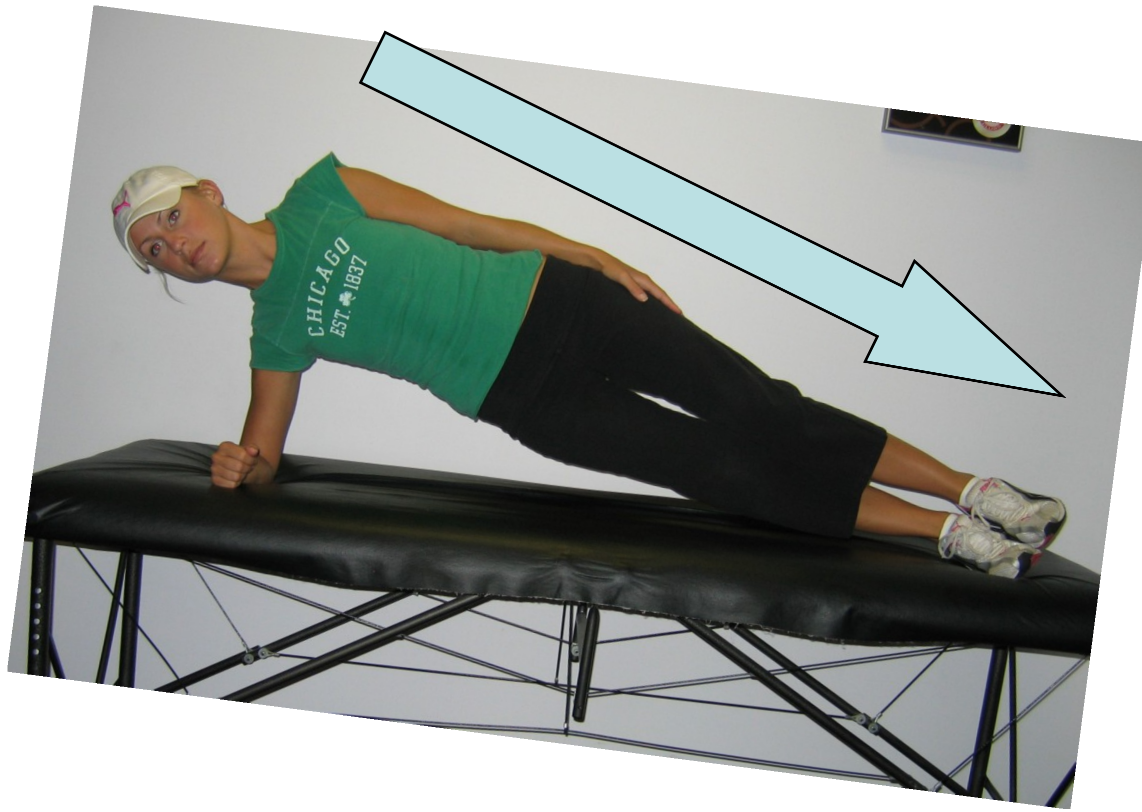
6. Side Bridging on knees

- Support body on forearm and bent knees.
- Body should be in a straight line
- Hold 15 seconds
- Repeat 6 times
- Lay on opposite side and repeat



6a. Advanced Bridging – Single foot on table

- Full side bridge
- Body is supported from forearm to feet.
- Body is straight from shoulders to feet
- Hold position for 10 seconds and try to reach 25-30 seconds.



7. Quadruped –

- In prone position (on stomach) with arms extended and forehead down
- Raise opposite arm and leg at the same time
- Raised arm and leg should not be elevated more than 6 inches off of floor
- Repeat with other arm and leg.
- Hold for 6-8 second
- 2 sets of 10 repetitions

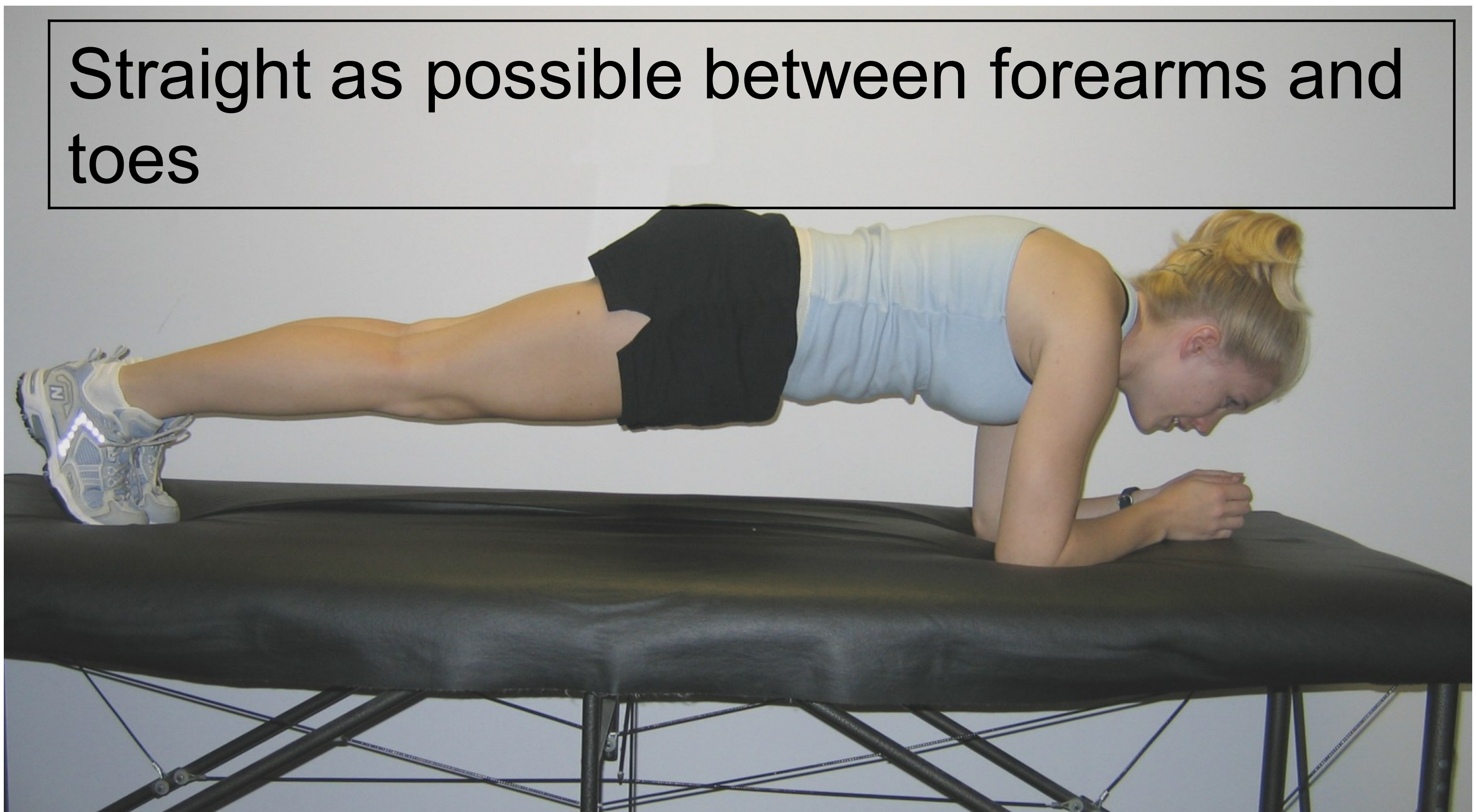
7a. Advanced Quadruped

- Support body hands on and knees. (knees should be directly under hips and hands should be directly under shoulders).

- With head neutral, extend opposite arm and leg.
- Be careful to keep low back square or flat without rotating hip
- Hold position for 6-8 seconds; 2 sets of 10 repetitions

8. Plank

- Resting on forearms and toes
- Hold position for 10, 15, and eventually 30 seconds
- Abdominals must be engaged.



9. Seated Band Row

- Seated in chair with feet on the floor
- Position chair with enough tension of a JC band that is appropriate for the strength of the user.
- Sitting erect and tall, engage abdominals and begin rowing with both arms by pulling band toward torso
- 2 sets of 12-15 repetitions

9a. Standing Band Row

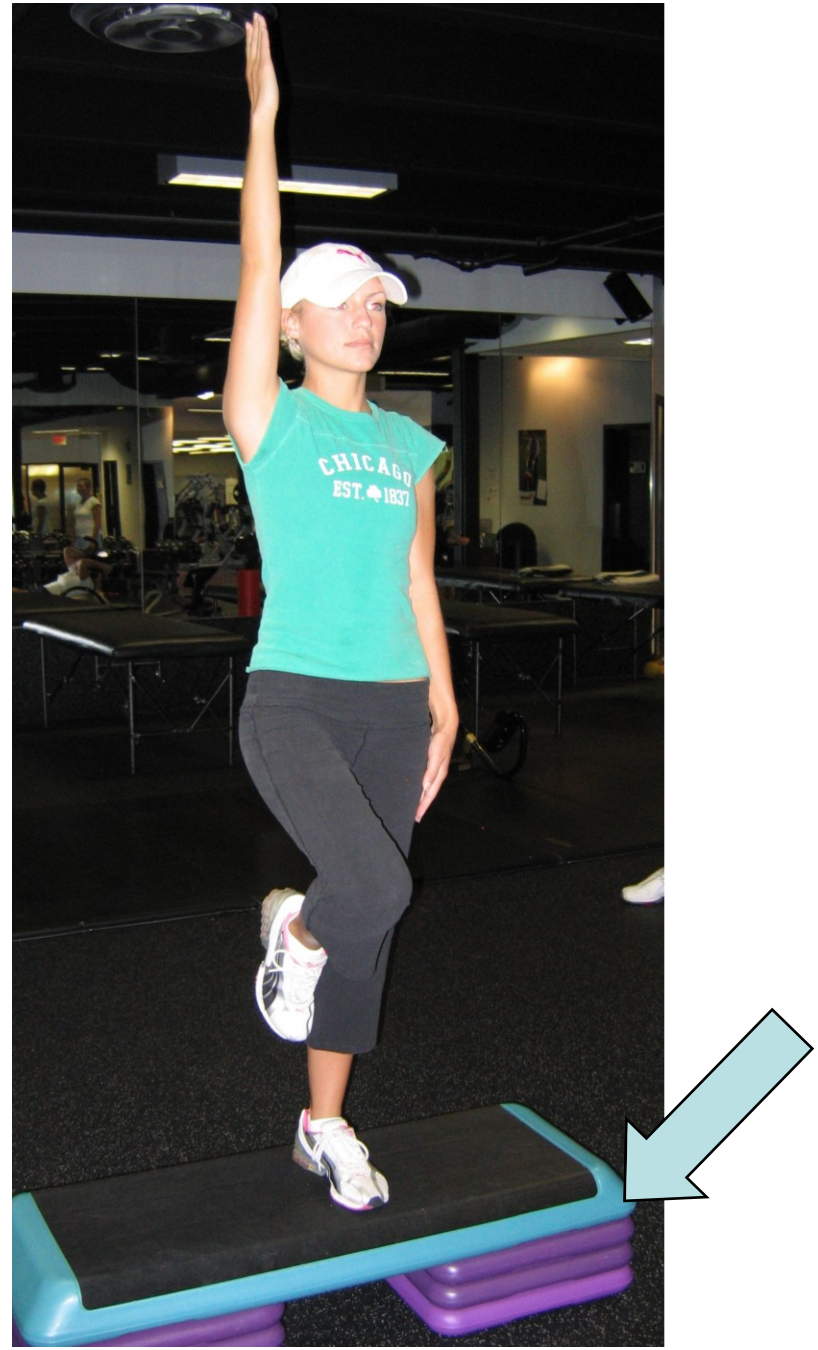
- Feet shoulder width apart
- In squat position, pull band back in a row
- The depth of squat is determined by strength of individual;
  2 sets of 12-15 repetitions

10. Low Bench Step Ups

- Bench should be no more than 2-5 inches tall
- Step up on bench balancing on left foot and raise right foot. Right arm is extended over head
- Balance on left foot for 5 seconds and repeat 10 times
- Repeat by stepping up on right foot and raise left foot. Left arm is extended over head
- Make sure entire foot lands on bench

10a. Advanced Bench Step Ups

- Repeat, just like no. 10
- Bench should be more than 6 inches off of the ground. Holding a weight in each hand is optional



11. Isometric hold seated in chair

- While seated in chair and squeezing 2-4 lb. ball, hold hands neutrally in front of body via 1) manual resistance or 2) JC band coming laterally across body

11a. Isometric hold seated on Physio ball

- While seated on physio ball, squeezing 2-4 lb. ball, hold hands neutrally in front of body via 1) Cable or 2) JC band coming laterally across body

- Hold position for 10 seconds 3 times from each side of body

11b. Isometric cable (or JC Band) hold, standing

- While standing (optional: squeeze 2-4 lb. ball, hold hands neutrally in front of body via 1) Cable or 2) JC band coming laterally across body
- Hold position for 10 seconds 3 times from each side of body

12. Torso twist seated in chair

- While seated in chair, squeeze 2-4 lb. ball
- Sitting erect, pull 1) cable or 2) JC band appropriate strength across the body in an arc.
- Abdominals must be engaged.
- While cable or band is being pulled across the body, the head, shoulders, and hands all move together as one.
- Conduct exercise from left to right and from right to left

12a. Torso Twist Seated on Physio Ball

- Cable should be slightly lower than shoulder high

- Engage abdominals and with slightly bent arm and pull across body
- Conduct the exercise from left to right and then from right to left.

12b. Torso Twist Standing

- While standing, create enough tension in JC band.
- Standing in semi-squat, engage abdominals and with slightly bent arms pull band across body
- Conduct the exercise from left to right and then from right to left.

Appendix D.

Health Screening Questionnaire

GENESIS HEALTH CLUBS

HEALTH SCREENING QUESTIONNAIRE

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active. Your health and safety are important to us; therefore, we would appreciate you taking a few minutes to answer the following questions. This questionnaire is an evaluation that will provide for you an assessment of your status or capacity for exercise. It will also identify any potential health problems that should be professionally evaluated or re-evaluated prior to participation in exercise/recreational activities. These results will be used to provide general recommendations for improvements in the health-related components of physical fitness.

NAME:____ DATE: __________
(Last) (First) (M.I.)

ADDRESS:
____
(Street) (City) (State) (Zip)

TELEPHONE: _________________ / __________________ SEX: M____ F _____
(Home) (Work)

BIRTHDAY: ____ / ____ / ____ PERSONAL PHYSICIAN:__________________________

1) Do you now have or have you ever had any of the following conditions:
   - Elevated blood pressure or cholesterol ____YES ____ NO
   - Chest pain at rest or during exertion ____YES ____ NO
   - Uneven, irregular, or skipped heartbeats ____YES ____ NO
   - Any chronic illness or condition ____YES ____ NO
   - Coronary Artery Disease ____YES ____ NO
   - Congestive Heart Failure ____YES ____ NO
   - Stroke ____YES ____ NO
   - Shortness of breath or shortness or breath w/mild exertion ____YES ____ NO
   - Diabetes or thyroid condition ____YES ____ NO
   - Family history of coronary artery disease or sudden death before age 55 ____YES ____ NO
   - Hernia or any other condition that may be aggravated by lifting weights ____YES ____ NO

- Muscle, joint, or back pain/disorder ____YES ____ NO
- Pregnancy (now or within last 3 months) ____YES ____ NO
- Any other heart problem that would make exercise unsafe ____YES ____ NO

2) Have you been told by a physician not to exercise?
   ____YES ____ NO
3) Do you smoke cigarettes or have you smoked in the past 2 years? ____YES ____ NO
4) Are you taking any prescription drugs? ____YES ____ NO
5) Are you a male 45 years or older/female 55 years or older?
   ____YES ____ NO
6) Explain any "YES" answers
   ____
   ____
   ____

NOTE
When completed, a staff Fitness Specialist will review your questionnaire. Members who answered "YES" to any one of the questions may be at increased risk for injury during exercise. These members should obtain a physician's release before starting an exercise program.

RESPONSIBILITIES OF PARTICIPANT

Information you possess about your health status or previous experiences of unusual feelings with physical effort may affect the safety and value of your exercise program. Your prompt reporting of adverse feelings during exercise is of great importance. Please report any such feelings to a Fitness Specialist immediately.

INFORMED CONSENT

I have read the foregoing information and understand it. Questions concerning this evaluation have been answered to the best of my knowledge. I voluntarily assume all risks for damages that may be associated with my participation in an exercise program. I waive and release all rights and/or claims for damages I may have against Genesis Health Clubs, its Personal Trainers, and those administering the Personal Fitness Assessment, which may arise from my participation in such activities.

I acknowledge that all information given on this is true to the best of my knowledge.

Participant's Signature: ______________________________ Date: ______________

____ Date: ____________

HEALTH
GENESIS
CLUBS

LOCATIONS

West 13^{th}	3725 W. 13^{th}	Wichita, KS 67203	(316) 945-8331
East Central	6100 E. Central	Wichita, KS 67208	(316) 681-3010
West Central	854 N. Socora	Wichita, KS 67212	(316) 721-6600
Rock Road	1551 N. Rock Rd.	Wichita, KS 67206	(316) 634-0094
Hutchinson	412 E. 30^{th} Ave.	Hutchinson, KS 67502	(620) 663-9090

Appendix E.

Medical Release Form

MEDICAL RELEASE FORM

In general, all participants must complete a Health Screening Questionnaire. However, because you have had a **history of mechanical lumbopelvic dysfunction**, you are classified as a “high risk” client.. You are required to have this Medical Release Form executed by a medical practitioner before being allowed to participate in a dissertation research project by principal investigator, Wendy Williamson .

Per current HIPAA Guidelines, your Patient has authorized the release of his/her information executing this request below.

Authorization To Release Information Approved: ______________________
(Patient Signature & Date)

Dear Doctor:

Your patient, _________________________, wishes to participate in a research project. Random sampling will result in your patient being a part of a supervised or unsupervised spinal stabilization program. The activities will be structured similar to what is listed below in type, frequency, duration, and intensity:

Type: **Resistance Training, Mobility/Stability Training, Spinal Stabilization Training, Neuromuscular Training**

Frequency: **2 to 3 times per week**

Duration: **Initially for 30 Minutes but eventually up to 60 Minutes per Training Session**

Intensity: **Variable Intensity: From 40 to 70 Percent of Max**

If your patient is taking medications that will affect her exercise program (i.e. heart rate, blood pressure, muscular function, etc.), please indicate the medication and its effect on your patient.

Type of medication(s) ____

Physiological Response to Exercise: __________________________________

Please indicate whether or not your patient has any of the following:

Peripheral Neuropathy:

Legs/Feet: _____________

Are there any recommendations or restrictions that are appropriate for your patient that may preclude her from participating in a structured exercise program:

____

____.

__________________________ has my approval to begin an exercise program with the recommendations or restrictions stated above.

____
(Physician’s Signature)

Thank You,

Wendy Williamson, Principal Researcher, OSU
GENESIS Senior Personal Trainer
FAX (316) 684-2661

Appendix F.

Informed Consent Document

INFORMED CONSENT DOCUMENT

Project Title: *Effect of supervised and directed exercise on low back pain and functional activity*

Investigator: Wendy Williamson, PhD candidate

Purpose: The purpose of this research study is to determine if there is a difference in the pain outcome and functional activity levels after six weeks of supervised or unsupervised exercise participation for low back pain. Individuals with mechanical low back pain are encouraged to participate. Pre and post test of pain and functional activity levels will be assessed for this research study.

Procedures: Subjects participating within this research study will be asked to complete two questionnaires prior to the study. These tests ask their current level of low back pain, and functional activity. All subjects meeting the criteria will gather for an orientation meeting. All names will be placed into a hat and one name will be drawn at a time to determine random sampling and who will be in the supervised or unsupervised group. The marketing director of Genesis Health Clubs will draw half the names to be the Experimental (supervised) group. The remaining names within the hat will constitute the Control (unsupervised) group.

The supervised group will meet directly with the principal researcher 2 times per week for 45-60 minutes for 6 weeks. The unsupervised group will be strongly encouraged to independently participate twice per week during regular Genesis Health Club hours, 1441 N. Rock Road, Wichita, Ks. The exercises are specific for stabilizing the muscles surrounding the lumbopelvic/spinal chord area of the body. The unsupervised group will not have continuous or monitored direction, while the supervised group will have continuous and monitored direction. During the study, each group may experience moderate muscle fatigue and soreness initially. At the conclusion of the research study, all subjects will be asked to repeat the tests taken and the onset of the study. The pre and post tests will be statistically analyzed for effect of the project.

Each referring medical professional will be provided with information regarding the random sampling group in which his/her patient is associated and will be provided detailed description and pictures of the exercises to be conducted.

During this study, subjects will have temporary membership to Genesis Health Club (Rock Road location only) and have access to all amenities excluding private personal training. The temporary membership will terminate at the conclusion of the study.

Risks of Participation: Subjects will be required to complete an informed consent, waiver, and have completed a medical release from their respective physician. Subjects may experience initial muscle soreness from the exercises. Committing to this group will require attendance twice weekly for 45-60 minutes for a six week duration of the research study.

Benefits: Potential benefits for the subjects participating within the study include pain relief, a booklet of exercises of which to continue using and interacting with others who also have low back pain.

Confidentiality: The records of this study will be kept private. Any written results will discuss group findings and will not include information that will identify you. Research records will be stored securely and only researchers and individuals responsible for research oversight will have access to the records. It is possible that the consent process and data collection will be observed by research oversight staff responsible for safeguarding the rights and wellbeing of people who participate in research.

Specifically, please sign with your initials immediately below if you give the principal researcher permission to discuss your specific participation and progress.

________ participants initials

The only foreseeable minimal confidentiality issue that may arise during this study is the concern that participation of this study will be observed and known via traditional members of this health club. Since this research study will be conducted during regular business hours, traditional members will be present.

Compensation: There will be no compensation during this research study.

Contacts: Any question regarding this research, please contact Wendy Williamson, 316-371-6971, or Dr. Steve Edwards, 405-744-7476.

If you have questions about your rights as a research volunteer, you may contact Dr. Sue C. Jacobs, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405-744-1676 or irb@okstate.edu.

Participant Rights: Participation within this research study is voluntary. Subjects can discontinue the research activity at any time without reprisal or penalty. If the participant fails to follow the agreed research activity, participation may be terminated.

I understand the risks associated with this study and voluntarily choose to participate. I understand that in case of injury or illness resulting from this study and voluntarily choose to participate. I understand that in case of injury or illness resulting from this study, emergency medical treatment will be available via #911 to Genesis Health Clubs. I understand that no funds have been set aside by Oklahoma State University to compensate me in the event of illness or injury.

Signatures:

I have read and fully understand the consent form. I sign it freely and voluntarily. A copy of this form has been given to me.

________________________ _______________

Signature of Participant Date

I certify that I have personally explained this document before requesting that the participant sign it.

________________________ _______________

Signature of Researcher Date

VITA

Wendy Williamson

Candidate for the Degree of

Doctor of Philosophy

Thesis: EFFECT OF SUPERVISED AND DIRECTED EXERCISE ON LOW BACK PAIN AND FUNCTIONAL ACTIVITY

Major Field: Health, Leisure, and Human Performance

Biographical:

Education:
Completed the requirements for the Doctor of Philosophy in Health, Leisure, and Human Performance at Oklahoma State University, Stillwater, Oklahoma in December, 2007; received Masters in Health Science from Wichita State University, Wichita, Kansas in 1990; received Bachelor of Science from Emporia State University, Emporia, Kansas in 1984.

Experience:
- Certifications:
- Advanced Health and Fitness Specialist: American Council on Exercise [AHFS-ACE]
- Personal Trainer, American Council on Exercise [CPT-ACE]
- Reebok Reactive Neuromuscular Training [RNT] Specialist
- Personal Trainer: National Academy of Sports Medicine [CPT-NASM]
- Faculty and Board Member: EMAX, Esquerre Fitness Group, New York
- ACE Continuing education provider and CES Exam writer and reviewer
- ACE Advanced Personal Trainer Textbook– Chapter author – “Posture and movement”, 2008
- Faculty Member: GENESIS Fitness Training Institute, Wichita
- Training Personal Trainers: Technical Skills, Post Rehabilitation
- Fitness, Health & Wellness Program Design & Development
- Musculoskeletal Analysis & Structural Integrity Assessments
- Training Clients who have orthopedic conditions [Post-Rehabilitation]: e.g. chronic low back pain, shoulder, knee & hip dysfunctions;
- Training Clients who are classified as de-conditioned/special populations: e.g. hypertension, cancer, obesity, diabetes;
- Documentation & Liability Specialist

Name: Wendy Williamson Date of Degree: December, 2007

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: EFFECT OF SUPERVISED AND DIRECTED EXERCISE ON LOW BACK PAIN AND FUNCTIONAL ACTIVITY

Pages in Study: 107 Candidate for the Degree of Doctor of Philosophy

Major Field: Health, Leisure, and Human Performance

Scope and Method of Study: Next to the common cold, low back pain (LBP) is the most common reason that people visit a physician's office (Teyhen et al., 2007). With the prevalence of over 50% experiencing LBP during their lifetime and the costly nature of the pain, this study was to investigate the performance of spinal stabilization exercises in a supervised vs. non-supervised group setting. Twenty subjects (n = 20) completed the six week study of supervised (experimental) vs. unsupervised spinal stability exercises. Pre- and Post- tests were provided: 1) Oswestry Disability Index (ODI) and 2) SF-36v2 Health Survey measuring functionality, and pain levels. Progressive exercise booklets were provided to each participant for the study. The analysis of 2 x 2 repeated measures ANOVA with Group at two levels and Time at two levels (pre and post) was conducted at .05 level of significance.

Findings and Conclusions: Overall results indicated that during the course of the six weeks of exercise overall pain was reduced with time and on one occasion between supervised and unsupervised groups. The Pre- and Post- ODI indicated statistical significance of pain ($df_{(1, 18)}$, $.000 = p < .05$) when time was the main factor. In addition, the General Health of the Health Survey (SF-36v2) test – also was statistical significant ($df_{(1, 18)}$, $.002 = p < .05$) with both groups over time. The Physical Functioning of the Health Survey (SF-36v2) test demonstrated statistical significance ($df_{(1, 18)}$, $.025 = p < .05$) between groups and also with time ($df_{(1, 18)}$, $.005 = p < .05$). Lastly, the Bodily Pain of the Health Survey (SF-36v2) test indicated statistically significance ($df_{(1, 18)}$, $.001 = p < .05$) with time.

ADVISER'S APPROVAL: Dr. Steve Edwards