ABSTRACT

A Study of Non-Specific Low Back Pain in a College Population including a Case Study Analysis of Physical Therapy Patient Data

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This study will investigate the presence, causes, treatments, and effects of non-specific low back pain in a college population, between the ages of 18 and 24. It includes a literature review of the current research on the subject, as well as an extended case study of the evaluation, treatment, and outcomes of 30 patients treated by a local physical therapist. Non-specific low back pain is low back pain that does not have an anatomical cause; consequently, low back pain that is the result of a fracture, strained muscle, or other physical anomaly is not explored in this study. It is found that there are physical and psychosocial causes and treatments for non-specific low back pain, with little evidence of a standardized treatment plan. It is likely that no such plan exists given the varied nature of this type of pain, but several factors of the reviewed physical therapy treatment plan, including core strengthening and stretching, were seen to be helpful in reducing non-specific low back pain in the population examined.

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A STUDY OF NON-SPECIFIC LOW BACK PAIN IN A COLLEGE POPULATION INCLUDING A CASE STUDY ANALYSIS OF PHYSICAL THERAPY PATIENT DATA

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CHAPTER ONE

Literature Review

Introduction

Low back pain is a common problem throughout the United States that can affect most subsections of the population. It is not surprising that back pain would be pervasive through an elderly or aging population, when general joint pain and muscle weakness is common; it is more surprising that 1 out of 3 adolescents will experience low back pain by age 15 (Olsen et al., 1992). This percentage rises by the time these teenagers enter the target population of 18-24 years old. Non-specific low back pain is the subject of much debate as it is by definition not the result of any anatomical anomalies or disorders. This study focuses on non-specific low back pain, as it is less understood than low back pain from a specific, known cause. There are several theories regarding the causes and treatments of this phenomenon; doctors and therapists do not always agree on the correct approach to reducing this type of pain, or where it originates. The causes have been shown to range from physical habits to emotional disturbances, and as a result, the treatments are just as broad. Treatments can range from physical exercise to emotional therapy such as counseling. The effects of low back pain in this population are also explored as they relate to the emotional and relational status of a young adult, as this may lead to an exacerbation of the problem.

As a result of the uncertain nature of non-specific low back pain and its high prevalence, several studies have attempted to discern the best treatment plan so that

doctors and therapists can be equipped to treat such patients as effectively as possible (Olsen et al., 1992). One study by Kent, Keating, and Buchbinder surveyed the attendees of 2006 Amsterdam International Low Back Pain Forum in Melbourne regarding the nature of non-specific low back pain and found variation in nearly every aspect of the study (2009). Variation was found in the importance placed on physiological factors versus psychological factors, and whether cases of non-specific low back pain should be grouped based on pathoanatomy or symptoms. It was a more common belief that subgroups should be based on symptoms, largely due to the indeterminate pathoanatomy that goes along with non-specific low back pain (Kent et al., 2006). A different 2012 study by Jeffrey et al. showed that many physical therapists believe that non-specific low back pain does have an underlying mechanical, structural nature. For example, habitual poor posture can lead to back pain, which can be corrected with exercise and intentional behavior change. This is still considered non-specific low back pain, as there is not a direct anomaly causing the pain. There are many theories that surround the nature and cause of back pain, and many studies support each side of the argument.

Causes

Emotional and mental stresses can play a large role in the development and exacerbation of non-specific low back pain. Students between the ages of 18 and 24 tend to have large amounts of perceived stress and pressure on them to succeed and set up a successful future. These stresses, along with their beliefs about pain, can lead to the development of back pain. Smith, O'Sullivan, Beales, and Straker supported this idea, by showing that adolescents who have negative beliefs about the source, severity, and prognosis of back pain tend to have worse pain than those who have more positive beliefs

about the outcome of back pain episodes (2012). For example, a student with negative back pain beliefs may hold that back pain is an inevitable part of his day and that it can turn his experiences from positive to negative. He may also believe that it will not get any better tomorrow or next week. In contrast, a student with positive beliefs will not let his back pain influence him and may believe that it will progressively get better. More negative beliefs are associated with a higher level of disability, and are typically the result of educational status, depression, family beliefs and experience, and the level of limitation brought about by back pain (Smith et al., 2012). Family experience can play an important role in the development of low back pain. If a student feels that their parents struggle with a high degree of back pain, they may too begin to experience this pain (Yao, Lu, Ai, & Chen 2012). These two studies relate closely as they both show how strongly mental stresses and thoughts can influence an adolescent's experience with a physical pain.

College aged students typically keep very busy schedules – filled with classes, work, student organizations, friends, family obligations, and many other time commitments. This high level of personal commitment may cause a student's stress level to increase to the point that they begin to experience non-specific low back pain. The more hours a student spends at a job, the more likely they are to develop low back pain; there is a positive correlation between the amount of time a student spends working and the prevalence of back pain (Heuscher, Gilkey, Peel, & Kennedy, 2010; Taspinar F., Taspinar B., Cavlak & Celik 2013). This also includes the hours spent in classes, as students take on larger course loads, they are often more likely to develop low back pain (Taspinar et al., 2013). This could be due to the fact that extra time spent at work or in

classes takes away from time the student has to fulfill other expectations. This can lead to higher levels of stress and exhaustion as the student has more deadlines, assignments and projects to accomplish in even less time. As students are expected to complete more tasks, fatigue can begin to develop. If a student does not have adequate time during the day to finish the tasks expected of him, he may not get the proper amount of sleep. If this becomes a consistent habit, intense fatigue can begin to develop, which is correlated with higher levels of pain and disability (Snekkevik, Eriksen, Tangen, Chalder & Reme, 2014).

A final psychological factor that is highly correlated with the occurrence of non-specific low back pain is depression. Emotional turmoil can be both a cause and a consequence of chronic pain, including non-specific low back pain (Snekkevik et al., 2014). The ages of 18-24 are typically important years when critical life decisions are made. This weight can cause a student to feel uncertain or afraid for the future, which is a risk factor for developing depression. Many students move away from home when they go to college, which can increase discomfort as they are placed in a new environment without the support of family or the friends they have had for many years. This new environment and unfamiliarity can be part of the cause for non-specific low back pain (Unalan, Celikten & Mazicioglu 2009; Hauser, Schmutzer, Brahler, Schiltenwolf & Hilbert, 2014; Diepenmaat, 2006). If a student does not adjust well, they may begin to feel sad, exhausted, and overwhelmed, which are all factors related to the development of low back pain (Kennedy et al., 2008). Emotional and psychological factors can play a sizeable role in the development of non-specific low back pain in college students. The college aged years present a time with increased levels of expectation and stress, which is

an important key to understanding why the prevalence of non-specific low back pain is so high in this age group. It is important to keep in mind these potential causes, as one study found that back pain correlated even more with psychosocial factors such as these than with medical imaging findings, pointing even more dramatically to psychological causes for this common problem (Smith, 2013).

A unique factor to this population is the necessity of carrying a backpack. Oftentimes college students will require several textbooks, a laptop, and other notes whenever they go to class or to study. While backpacks are also used in younger populations, the weight of backpacks tends to increase in later high school years and in college. There are two theories on the impact of a backpack on non-specific low back pain: the perception of the backpack and the actual weight of the backpack. The feeling or perception that a backpack is causing discomfort can lead to the instigation of low back pain as the student is consciously aware of the extra weight, and it may cause deviations in their posture and gait (Yao et al., 2012). This theory purports that the actual weight of the backpack does not automatically play a role in whether or not a student is more likely to develop low back pain, indicating a more psychological cause of pain, while other studies have shown a direct correlation between weight of the backpack and the prevalence of low back pain, indicating a more physical cause (Heuscher et al., 2010). This makes sense as the weight of the backpack and the perception of it being uncomfortable are often correlated. If a student does not carry much in their backpack, it is less likely to feel noticeably uncomfortable, while a student that carries several books may notice the extra strain placed on their body.

Physical causes can also play a significant role in the development of non-specific low back pain. Low back pain is considered non-specific if there is not a mechanical, or structural, deformity in the back that is directly causing pain. Low back pain can be caused by structural problems, such as a herniated disc that presses on the spinal nerves to cause pain. This type of back pain cannot be classified as non-specific because it does have a direct, specific cause. However, there can still be physical causes of non-specific low back pain. A lack of muscle endurance can be one of these factors. Abdominal and back muscles help contribute to the position of the pelvis and the corresponding curvature of the spine. The abdominal muscles attach to the anterior part of the pelvis and help maintain posterior tilt of the pelvis as a counter to the pull of the back muscles, which attach to the posterior side of the pelvis and help maintain anterior tilt. Weak abdominal muscles can contribute to low back pain, as this weakness causes exaggerated anterior tilt and increased pressure on the spine (Handrakis et al., 2012). Pressure on the spine can be alleviated by high endurance of the back muscles, which shows a negative correlation with levels of back pain (Handrakis et al., 2012). As a result of these two correlations, it can be extrapolated that low levels of exercise can contribute to the exacerbation of low back pain, as abdominal muscles are more likely to be weak and back muscles are less likely to have high endurance levels. A final potential physical cause is posture. College students spend a large percentage of their time sitting, looking at textbooks or computers. Many times students are not sitting in a way that is ergonomically designed to reduce pressure on the spine. The more time a student spends sitting straight, as when studying or reading, the more likely they are to develop low back pain (Kennedy, Kassab, Gilkey, Linnel & Morris, 2008). Postural changes can also be linked to stress or depression, as

the student is coping with new situations and high expectations (Handrakis et al., 2012). All of these factors combine to create a lifestyle that is conducive to the development of non-specific low back pain. A college population is placed under emotional, mental, and physical stressors that can affect their mentality, beliefs, habits, and posture, which can increase their susceptibility to non-specific low back pain in a unique way. As a result, the cause of non-specific low back pain cannot be isolated for the population as a whole, but needs to be discussed with each patient to determine what psychological and physical factors may be playing a role in their development of pain.

Treatment

There are several forms of treatment for non-specific low back pain, but no study has definitively proven one method to be the most effective for all patients. This seems to be due to the fact that non-specific low back pain can have a multitude of causes that are not always resolved by the same treatment plan. As a result, an analysis of the patient's needs followed by patience in treatment is critical in the process of finding the treatment plan that will provide the most relief as quickly and permanently as possible. The treatment types fall into three main categories: exercise, conditioning, and psychosocial interventions.

The first line of treatment is usually physical therapy. This type of treatment can address the physical causes of back pain, as well as potentially providing an outlet for other stressors. Exercise is critical in maintaining a healthy body, and physical therapy provides a disciplined and safe way to perform exercises that will help relieve a patient's pain. It was found that an 8-week exercise program led to dramatic improvements in pain intensity in adolescents, as well as improvements in abdominal muscle strength (Jones,

Stratton, Reilly & Unnithan 2007). These results support the idea that physical causes, including weak abdominal muscles and low exercise levels, can lead to a low back pain episode and can be treated accordingly. Another type of treatment that can be effective is manual therapy and self-mobilization. Whal, Smith, Sesto, and Boissonnault showed in a 2013 study that 200 minutes per week of activity and these types of physical treatment led to improvements in pain, stiffness, and function. This can be accomplished through physical therapy visits or through independent exercise, as long as the patient is dedicated and disciplined to take care of his or her own health status. There are two main concerns in the health status of a patient with non-specific low back pain: reducing the current pain episode and preventing future pain. Physical therapy and continued exercise can help both of these objectives as the therapist can educate the patient on the lifestyle changes they should implement to prevent the same problem from recurring. In a college population, heightened emphasis should be placed on reducing future low back pain episodes, as developing a chronic problem so early in life can lead to increased stress, depression, and a lower quality of life, as well as potentially increasing medical expenses. Physical therapy can be crucial in preventing future episodes of non-specific low back pain, even if it does not solve a current episode (Macedo, Bostick & Maher, 2013). Additionally, patients who perform individual exercises after physical therapy treatment often experience a reduced recurrence rate of back pain episodes compared to patients who solely go through a physical therapy program and do not continue to exercise (Macedo et al., 2013). Physical exercise and activity can be very helpful in reducing low back pain, but it is not the only treatment option that should be considered.

Another potential treatment plan is the use of operant conditioning to train patients away from negative pain beliefs that are associated with the development and exacerbation of chronic non-specific low back pain. A review by Bunzli, Gillham, and Esterman examined several studies and found operant conditioning to be effective, but not necessarily more effective than other treatments (2011). Such operant conditioning works by helping a patient understand and participate in their treatment, as well as influencing their beliefs about back pain and their situation to be more positive. As previously discussed, a set of negative beliefs about back pain can actually be a risk factor for developing or worsening pain. It also seeks to free the patient from the fear avoidance cycle so that they may perform activities and exercise without fear of pain keeping them from excelling in their desired field of activity. With this tool, patients can be more confident in their progression and will likely have a more positive outlook on their treatment process and pain, which can lead to an effective reduction in pain.

Analogously, emotional therapies can be very useful in the treatment of chronic, non-specific low back pain. Because there is such an emotional and mental component to chronic pain, patients may greatly benefit from emotional therapy, similar to counseling, to improve their beliefs and outlook on back pain. Melloh et al. found that three psychological factors – depression, magnification, and rumination – lead to a significantly slower recovery (2013). If a patient, including young adult patients, does exhibit these factors, physical therapy or exercise may not be the sole most effective method of treatment. Melloh et al. suggested that at the time of initial evaluation, patients should be screened for depression or other stressors so that if this type of therapy would be useful, it could begin concurrently with physical therapy or exercise programs

initiated (2013). Further support for this idea came in an article by Smith, which discussed John Samo, MD, a physiatrist who found that in depth conversations with patients could actually help resolve their back pain (2013). Samo found that regardless of the interventions he used, the patients that improved the most significantly were the ones that he had talked with the most. The topic of these conversations was geared toward stressors and other factors that may be contributing to a less healthy mindset and overall individual. The author, Smith, encouraged psychosocial interventions like these conversations as an effective way to manage and treat patients with non-specific low back pain (2013). Stressors like the ones discussed in conversations with Samo or other physicians can actually trigger defense mechanisms that present the stress as physical pain. This physical pain will usually spur a patient to seek treatment for a physical cause, when they may benefit more from emotional therapies that can help them pinpoint and alleviate stress. However, there are a couple drawbacks to this idea that should be examined before implementing an emotional therapy treatment plan. The first is the diagnosis process. It is important that the patient undergoes complete medical testing to ensure that the problem is actually non-specific low back pain, and that there is not a more serious underlying medical cause for their discomfort. Secondly, as described by Smith, patients who have experienced chronic back pain for a long time may be highly resistant to a psychosomatic diagnosis, as it is increasingly difficult to believe that an emotional state of turmoil could cause such intense physical pain (2013). In light of these considerations, psychosocial interventions could be useful for many patients, but some precautions should be taken when proceeding in this way.

Finally, patient education is critically important, as it is with any disability. Brennan, Shafat, Donncha, and Vekins performed a study with college students in physically demanding programs and found that students who did not have an active coping mechanism were more likely to have disabling neck and back pain (2007). Many students avoided going to the doctor or simply avoided the problem itself, which led to an exacerbation of their pain and can actually indicate future pain problems as the students reach adulthood. The authors of that study highly recommend educational programs that will help students and other young adults to understand low back pain and how to deal with it, so that it does not continue to be a chronic problem as these students reach full adulthood (Brennan et al., 2007). If students do not understand that physical activity, effective stress management, and active attention to the problem are important in the reduction of future back pain, the problem will continue to be exacerbated and healthcare costs will continue to rise related to this disability. At this point, it is clear that there is not a single best treatment for non-specific low back pain. The most successful treatment will vary from person to person based on the specific needs and stresses placed on the individual. However, both physical and psychological factors should be addressed when dealing with a patient suffering from non-specific low back pain so that the chances of recurrence are diminished as much as possible.

Effects

The final important consideration when treating a patient with non-specific low back pain is the effect of the pain they are experiencing. Non-specific low back pain can easily become a recurrent, chronic problem if the source of the problem is not found and alleviated. As discussed previously, stress and depression can lead to the development or

worsening of low back pain, and depression is generally higher among chronic low back pain patients than the general population (Hong, Kim, Shin & Huh, 2014). Stress, depression, and fatigue can also be effects of any type of chronic pain, including non-specific low back pain. As a result, in many patients, there is often a cycle of depression, anxiety, and back pain. It is difficult to determine which causes the other, as described in an article by Snekkevik et al., as depression can be both a cause and a consequence of chronic non-specific low back pain (2014). It also has been shown that the severity of fatigue can predict disability at 3, 6, and 12-month follow ups, indicating that this factor is critical in assessing a patient's prognosis (Snekkevik et al., 2014). Fatigue can be linked the development of low back pain, but low back pain can also lead to sleep disruptions resulting in more intense fatigue. Like the cycle of depression, a fatigue cycle can develop, exacerbating the symptoms of both problems. The severity of emotional disruptions is also correlated with the severity of pain (Hong et al., 2014). This indicates that a highly stressed student may experience intense back pain that further causes stress, leading to a dangerous cycle. Many students who complain of back pain recurrently miss more days of school and sit out of physical activity more frequently than other students (Jones, 2004). This can have negative consequences in the life of a college student, as missed classes and other activities leads to increased stress as they get behind and have to spend more time catching up on missed work. Students are also less likely to exercise when they are experiencing low back pain, further indicating the need to educate and support active treatment programs so that the cycle can be halted and the effects can be resolved.

Conclusion

These studies have shown that non-specific low back pain is a phenomenon with many pieces that interlock and coexist to confound the treatment process. This type of pain can be acute or chronic, but acute cases can easily turn into chronic cases if the proper treatment and analysis is not performed. In young adults, and more specifically college-aged individuals, a major goal of treatment should be remedying the problem and decreasing the likelihood that it will return in the future. Smith et al. reports that by late adolescence, levels of non-specific low back pain reach the levels seen in adults, indicating that there is a large subsection of the population that would benefit from detailed research and a definitive plan regarding the care of this problem (2012). Emotional or psychosocial factors such as depression and negative back pain beliefs can lead to an adolescent carrying an acute low back pain problem into adulthood and forming a chronic problem. In light of this, comprehensive treatment techniques should be implemented so that students are aware of the psychosocial risk factors, as well as the physical causes, of non-specific low back pain. Education is an important key to reducing the problem of non-specific low back pain; if the population were aware and understood that much of their pain could be related to emotional stressors, there would be fewer people with this problem. However, this is not the only factor; physical fitness and exercise are also critical to a healthy, pain free life. As a result, both types of therapy treatment are necessary to help a college-aged individual overcome and heal from non-specific low back pain.

CHAPTER TWO

Methods

Introduction

The following is a case study review of physical therapy patient data obtained from a student health center on a university campus in central Texas. The goals of this review were to show whether or not physical therapy is successful in reducing non-specific low back pain in this population of college students between the ages of 18 and 24, and what therapy related factors have the best correlation to an improvement in non-specific low back pain.

Subjects

The subject information used in this study was gathered from a health center that predominantly treats the target population, university students between the ages of 18 and 24. Patients selected were those that were seeking physical therapy treatment for pain diagnosed as non-specific low back pain. Patients that presented with mechanical causes of back pain were excluded from the study.

Procedures

Information was collected from each evaluation and subsequent appointment regarding the overall progress of each patient. Detailed information was obtained from the evaluation notes about the patient's history, the nature of their pain, and their current

condition, including muscle tightness, initial deficits in range of motion, abnormalities in lumbar curvature, as well as the initial treatment plan. The relevant information gathered from each patient's evaluation can be found in Appendix A. Each patient had at least one follow up appointment, and most patients (*n*=22) had multiple of these sessions. Each follow up appointment documentation provided subjective information reported by the patient as well as objective information about the patient's pain level, range of motion, lumbar curvature, muscle tightness, exercises, and a continuing plan of care. The progress of each of these aspects of the patient's treatment were tracked individually to determine what percentage of patients improved, and were analyzed in relationship to each other to determine which factors had the most significant impact on overall improvement of the patients. Patients were then grouped based on the number of visits they attended including the evaluation; 27% of patients (*n*=8) had 7 or more treatments, 30% of patients (*n*=9) had 4-6 treatments, and 43% of patients (*n*=13) had 2 or 3 treatments. Relevant treatment data for each of these groups can be found in Appendices B, C, and D respectively. These groups were analyzed to determine the differences in progress based on length of time in physical therapy, by looking specifically at changes in pain level, subjective notes, range of motion, the effectiveness of certain exercises, and the patient's status at their last attended session. Relevant patient data regarding subjective notes can be found in Appendix E and treatment exercises can be found in Appendix F. Finally, documented suggestions and input from the physical therapist is reported in order to show what factors were most important to the therapist himself.

CHAPTER THREE

Results

Introduction

This analysis looked at several factors individually and in relationship to each other to determine the most important variables in the treatment of a patient with non-specific low back pain. Individually, it analyzed changes in pain level, range of motion, muscle tightness, and lumbar curvature, as well as the subjective notes made by the therapist. Next, it looked at the relationship between pain, range of motion, and tightness, as well as lumbar curvature and pain, the subjective progress in relation to objective factors, the effect of certain common exercises on pain level, and the relationship between the number of treatment sessions attended and overall improvement. Finally, it looked at the recommendations made by the therapist to determine what was important in the treatment and education of a patient.

Subject Demographics

Data was collected from a total of 52 patients presenting with symptoms of non-specific low back pain. Information was collected from two types of treatment documentations: an evaluation and at least one, and frequently more than one, follow up appointment for each patient. Several subjects (n=22) were removed from the study because they presented with neurologic symptoms (n=14), had a mechanical cause of back pain (n=4), were outside the age range (n=1), or never returned for a follow up appointment (n=3). With these exclusions, the data from 30 patients from a total of 148

treatment documentations were reviewed. Of these 30 patients, 47% (*n*=14) were male and 53% (*n*=16) were female, and all were within the target age range of 18 to 24.

Single Variable Analysis

Pain Level

The 30 patients examined in this study exhibited a wide range of pain levels. Pain was recorded on a 0-10 scale, with 0 meaning no pain and 10 being the highest level of pain. The highest recorded pain number at a particular treatment was an 8 out of 10, but the average over all the treatment notes (*N*=148) was 2.48 out of 10 (see Table 1 below). This is because there were many more instances of patients having a pain level of 0, 1, or 2 out of 10 (*n*=77) during their session than instances of patients having a 5 out of 10 or higher during the session (*n*=27). This is representative of the type of pain being studied – often it is more low intensity than high-intensity pain. It is also important to note that although a patient may have a very low pain level at the time of the appointment, this does not mean that his or her pain is non-existent or entirely resolved. Many patients explain, as seen in the subjective notes portion of the treatment documentation, that the pain comes and goes based on activity, position, and time of day. As seen in Table 1 below, the average initial pain level of all the patients at evaluation was 4.57 out of 10 while the average final pain level of all the patients was 1.2 out of 10, indicating a significant decrease in average pain level across the patient population.

Table 1
Average Pain Levels

Time	Average Pain (out of 10)	Number of data points included
Initial	4.57	30
Final	1.2	30
Overall	2.48	148

Out of the 30 patients, 24 patients experienced an improvement in their pain level. All 6 remaining patients remained the same from their first appointment to the last. Pain level is an important measure that will continue to be considered throughout this analysis, along with other significant factors.

Range of Motion (ROM)

It was found that many patients who exhibited this type of idiopathic back pain had deficits in their movement. These results are summarized in Table 2.

Table 2
Range of Motion (ROM)

Patient Status	At Evaluation	At Final Treatment
Deficits in ROM	18	7
Full ROM	12	23
Total	30	30

Sixty percent (*n*=18) of the 30 patients studied had less than full range of motion at the beginning of the treatment process, while the other 12 patients began with full range of motion. Many patients had deficits in multiple directions of movement, but the most common deficit was forward flexion with 16 of the 30 patients exhibiting this particular deficit. Other deficits recorded included extension, sidebending, and rotation, affecting nine, ten, and eight patients, respectively, with several patients experiencing more than

one of these deficits. Out of the 30 patients, 23 attained explicit full range of motion at some point during their treatment. Eleven of these patients began their treatment process with deficits in their range of motion. The other seven patients that did not achieve explicit full range of motion had a variety of deficits, but six of them did exhibit decreased flexion, in addition to other deficits. One confounding variable in this examination was the lack of clarity on the progress of the patient. It was unclear whether a patient with a previously recorded deficit attained full range of motion at a later treatment where no notation was made. A lack of documentation could mean the patient's range of motion appeared normal and did not warrant documentation, or it could mean a lack of improvement in the variable, as some patients' notes included explicit documentation of improvement. Due to the lack of explicit documentation, it was assumed that these patients did not achieve full range of motion. Therefore, it was possible that some subset of these seven patients did actually achieve full range of motion, but a lack of information at the final treatment session was not strong enough to support this claim. Five of the seven patients fell into this category. This left only 2 patients that had explicitly recorded deficits in range of motion at the final treatment. The improvements seen in range of motion over the course of treatment were an important factor to consider in the analysis of these non-specific low back pain patients.

*Muscle Tightnes*s

Twenty-two of the 30 patients examined exhibited at least one instance of muscle tightness, with 20 of these patients experiencing hamstring tightness. Tightness in the hamstrings was a well-documented, consistent finding in many of these patients. This information is summarized in Table 3 below.

Table 3
Tightness

Type of tightness	Number of Patients
Acute (1 instance)	8
Chronic (>1 instance)	14
Hamstrings	20
Explicit Improvement Seen	9

While 22 patients exhibited at least one instance of tightness, 14 exhibited chronic tightness – that is, more than one documented instance of tightness throughout their treatment process. Nine of these patients attained a specifically documented improvement in tightness, with an additional seven that did not have documented tightness at the end of their treatment. Similar to the ambiguity seen with range of motion, there was uncertainty in the way the notes were documented, it was difficult to ascertain whether a lack of information means a dissemination of the problem or a lack of change in the problem. Muscle tightness, and specifically hamstring tightness, was examined in relationship to back pain level and range of motion to be presented later in this analysis.

Lumbar Curvature

Another factor that was highlighted through many of the treatment evaluations and notes was the curvature of the back, specifically lumbar lordosis. Out of the 30 patients examined, 20 of them had a type of abnormal curvature documented at some point during their treatment process. Ten of these exhibited an increased lordotic curve, while the other 10 exhibited a decrease in this curvature. Most of the notation related to the lumbar curvature was made during the evaluation, so it was difficult to determine if it was a continuing issue or an isolated problem for each patient, but some of the patients

(*n*=11) had follow up data giving insight into the progress. Six patients had documented improvement, and an additional eight patients had no second mention of an abnormal curvature, possibly indicating an improvement. Another section of this analysis looked at the relationship between lumbar curvature and pain level to see if this was a determining factor in back pain.

Subjective Notes

Subjective notes consisted of things that the patient said or described, but what was actually documented was dependent on what the therapist chose to record. They provided small glimpses into the overall quality of life of the patient and gave an insight into any other factors that were affecting their back pain. Subjective notes seen in this study included mentioning a long study session with few breaks, indications of the degree of compliance with the home exercise program, feeling sore after a workout or a long work shift, and more. All 20 of the patients that reported doing their home exercise program during at least one treatment session saw an improvement in their pain level. A report of sitting or studying causing an increase in pain was another common notation. Seventeen patients mentioned in their evaluation that sitting caused their symptoms to worsen, and five patients mentioned it unprovoked during further therapy sessions, with several of these patients mentioning it more than once. Another common comment was that some type of exercise had caused the back to be sore. Six patients made this comment at some point during their treatment process, indicating that exercise, in the form of clinic treatment or otherwise, had caused them to be sore. This subjective section of documentation usually included a general feeling of the patient, indicating that they were feeling worse, about the same, or better over the previous few days. Ninety percent

of patients (n=27) claimed to feel better at a particular treatment session near the end of their treatment progression. Of the other three patients, one reported feeling about the same and did not come back, one only reported soreness from other exercise at her last treatment, and one reported increased pain from studying at her last treatment session.

All of these individual factors showed changes throughout the treatment process and could be important in the way therapists approach patients with non-specific low back pain. After looking at them individually, this analysis focused on the relationships between a few key variables to attempt to determine which ones were most important and how the therapist should direct his or her treatments and goals.

Multi-Variable Analysis

There were several relationships to be examined between many of the factors that have been discussed individually. These include the relationship between muscle tightness and pain, tightness and range of motion, range of motion and pain, lumbar curvature and pain, subjective progress and range of motion and muscle tightness, as well as analyses of number of treatment sessions and common exercises performed. By looking at the interrelationships between these variables, it is possible to determine the most significant factors relating to non-specific low back pain in the physical therapy setting.

Pain, Range of Motion, and Muscle Tightness

The goal of this analysis was to determine the relationship between improvements seen in range of motion, pain, and muscle tightness. First, the changes in range of motion in relation to changes in pain were analyzed. As mentioned previously, the pain level

reported gives an insight into how the patient was doing only at the beginning of treatment, and not the fluctuations over the previous few hours, days, etc. These fluctuations were important, but the objective pain number gives the most accessible look into progress and improvement in each patient. There were 12 patients who exhibited no deficits in range of motion at the treatment evaluation. For the purposes of analysis between pain and range of motion improvements, those patients have been discounted since they already had full range of motion, so any changes in their pain level were not related to an improvement in range of motion. As discussed previously, 11 patients achieved full range of motion after beginning the treatment process with noted deficits. Nine of these patients had decreased pain at the individual treatment session when full range of motion was documented, all of which were recorded at the patient's last treatment session. Only two of these 11 patients that achieved full range of motion reported that their pain was the same at the treatment session when full range of motion was documented. The average pain level at all treatment sessions once a patient reached full range of motion was 1.42 out of 10, while the average pain level of all treatment sessions of patients that had not yet or never reached full range of motion was 3.31 out of 10 (see Table 4 below). An improvement in range of motion seems to be linked to a decrease in pain level.

Next, the relationship between improvement in muscle tightness and pain was analyzed. The hamstrings, lumbar paraspinal muscles, and hip flexors were the most frequently documented locations of tightness in these patients. As seen in Table 4 below, the average pain of patients who had documented hamstring tightness, tight hip flexors, and tight lumbar paraspinal muscles at a particular treatment session was 2.57 out of 10,

3.5 out of 10 and 3.1 out of 10, respectively, with the overall average of any patient with tightness documented at a particular treatment session being 2.73 out of 10.

Table 4
Pain Level, Range of Motion, and Muscle Tightness

Characteristic	Average Pain (out of 10)	Number of instances included
Prior to full range of motion	3.31	59
Following full range of motion	1.42	17
Tight hamstrings	2.57	42
Tight hip flexors	3.5	2
Tight lumbar paraspinal muscles	3.1	10
Total tightness	2.73	56
No tightness	2.47	78

There were only two documented instances of tight hip flexors, so this number was slightly inflated due to higher pain numbers reported in those cases – one had tightness in multiple places, including hip flexors and hamstrings, possibly influencing a higher reported pain level. In contrast, the average pain of patients who did not have documented tightness at a particular treatment session was 2.47 out of 10. This was lower than the average of patients who exhibited muscle tightness of any type, possibly confirming that muscle tightness is closely related to pain level in patients with non-specific low back pain.

Finally, the relationship between muscle tightness and range of motion was analyzed to determine the link between these factors. An absence of tightness was seen in 15 out of the 23 patients who achieved full range of motion, including those that began with full range of motion. These patients exhibited no tightness in addition to full range of motion at their last treatment session. Similarly, out of the seven patients that did not

achieve full range of motion, five exhibited tightness at their last treatment session. In four of these five patients, there was documented tightness in the hamstrings, while one had documented tightness in the lumbar paraspinal muscles. All five of those patients had a significant history of muscle tightness, indicating a persistent problem that would likely contribute to the lack of flexibility. Out of the seven patients that did not achieve full range of motion, six had deficits in forward flexion. Muscle tightness and range of motion were closely related as range of motion is a measure of flexibility and muscle tightness inhibits flexibility.

Lumbar Curvature and Pain Level

As mentioned before, there were only six patients that experienced documented improvement in lumbar curvature, out of 20 that exhibited either increased or decreased lordosis. Out of those 6 patients, 3 saw improvement in pain level when it was documented that their lordosis improved. Two patients saw no change in pain level, with one only showing a minimal decrease in lordosis at one appointment and resolving the next, and with the other reporting a consistent pain level of 0 out of 10. Finally, one patient actually saw a slightly increased pain level (from a 2 out of 10 to a 3 out of 10), but it did eventually decrease to a 0 out of 10 at the following appointment. As seen in Table 5 below, the average pain of a patient with a documented abnormality in the lumbar curvature was a 3.45 out of 10, while the average pain level at treatment sessions where deviations in lumbar curvature was not documented was 2.27 out of 10.

Table 5
Pain Level and Lumbar Curvature

Type of Curvature	Average Pain (out of 10)	Number of Instances Included
Abnormal	3.45	33
Normal	2.27	106

Subjective Progress, Range of Motion, and Hamstring Tightness

Subjective progress was an important insight into the patient's quality of life and their personal assessment of their functional disability. As mentioned previously, 27 of the 30 patients felt subjectively better at the last treatment they attended, indicated by the physical therapist recording "feeling good" or "feeling better" in the treatment documentation for that day. Of these 27 patients, 23 of them had previously achieved or did achieve explicit full range of motion on that treatment day. Another indicator was muscle tightness, which can be inhibitory and discomforting. Only eight of the 27 patients exhibited documented hamstring tightness on the treatment day when the therapist recorded that he or she was feeling better, and six of those patients were recorded to have only minimal tightness. This indicated that there might be a relationship between generally feeling better and having full motion and a lack of muscle tightness, an important part of daily quality of life.

Number of Treatment Sessions and Pain Level

Another key factor that differentiates the patients is how many times they came to physical therapy. As seen in Table 6 below, there were 13 patients that came for either two or three treatment sessions. The average initial pain level of these patients was 3.1 out of 10, and the average final pain level was 1.46 out of 10. While this showed improvement overall, all six of the patients that showed no improvement in pain level

were in this category, meaning that only just over half of the patients (*n*=7) that came 3 or fewer times saw improvement.

Table 6
Number of Treatment Sessions and Average Pain Level

Number of treatments	Number of Patients	Pain at Evaluation (out of 10)	Pain at Final Treatment (out of 10)
2-3	13	3.1	1.46
4-6	9	6.1	0.8
7+	8	5.25	1.25

In contrast, there were nine patients that came 4, 5, or 6 times – with the average pain level going from 6.1 out of 10 initially to 0.8 out of 10 at the end of treatment. There were eight patients that came seven or more times, and their average pain went from a 5.25 out of 10 initially to 1.25 out of 10 at the end of treatment. The four to six treatment group had the highest initial and the lowest final pain level, while the two to three treatment group had the lowest initial pain level and highest final pain level. All 17 patients that came four or more times saw an overall improvement in their pain level, in contrast to only seven out of 13 patients that came three or fewer times.

During the initial evaluation, the therapist set the plan for how many treatments per week each patient should attend, and for how many weeks – most frequently the treatment plan was set up to be 1-2 times per week, for 4 to 6 weeks. This correlated to anywhere between 4 and 12 treatments for most of the patients. Some patients were prescribed less treatment time, but nearly all plans intended to have 4 or more treatment sessions in totality. As seen in Table 7 below, of the 13 patients that came to 2 or 3 treatments, 53.8% of patients (*n*=7) failed to show up to a scheduled appointment, and

46.2% of patients (*n*=6) were to call the therapist for an appointment if the symptoms returned.

Table 7
Effect of the Number of Treatment Sessions

Number of Treatments	Pain Level Improved	Percentage of Patients Completed Treatment*	Did not complete treatment
2-3	53.8%	46.2%	53.8%
4-6	100.0%	66.7%	33.3%
7+	100.0%	62.5%	25.0%

* Either reached discharge or would call when symptoms worsened

The average pain at the final treatment for this two to three treatment group was 1.46 out of 10, indicating an overall improvement in pain level, but not as strong of an improvement as the other groups. In the four to six treatment group, 66.7% of patients (*n*=6) reached discharge, meaning that they would only return if the symptoms worsened, and 33.3% of patients (*n*=3) failed to show up to a scheduled appointment. The average pain at the final treatment session for this group was 0.8 out of 10, the lowest average pain number for any group, indicating relative success. Finally, in the seven or more treatment group, 62.5% of patients (*n*=5) reached official discharge, 25% of patients (*n*=2) failed to show up to a scheduled appointment, and the final patient planned to continue physical therapy at home during the summer.

Common Exercises and Pain Level

Many patients performed similar exercises throughout the course of the treatment process. These included double-knee to chest exercises to stretch the lumbar paraspinal muscles, pelvic tilts to strengthen the core and take stress off of the back, hamstring stretches, and lumbar rotations to stretch the back, done by 16, 11, 11, and 10 of the 24

patients that saw improvement, respectively. Double-knee to chest exercises seemed particularly effective, as of the 19 patients that did them during at least 50% of their treatments, 16 saw improvement in pain and 14 of these cut their pain in half or better throughout the treatment process. Another frequent aspect of treatment was the use of manual therapy to mobilize the muscles and facet joints in the lumbar portion of the back. This technique was used in the lumbar region during 71 individual treatment sessions, in a total of 19 patients. Of these 71 uses of manual therapy, 11 were at the last treatment session so follow up data is not available. Of the remaining 60 uses, patients had decreased pain levels at 31 of the follow up treatments, the same pain level at 18 follow ups, and increased pain levels at 11 follow ups. While the fluctuation of this pain number does not directly correlate with the effectiveness of lumbar manual therapy, it was the best indicator of the effectiveness of this particular aspect of therapy. Additionally, 14 patients experienced this therapy consistently, meaning at 50% or more of treatment sessions. Out of these 14 patients, 12 saw pain improvement overall and two patients' pain stayed the same.

Core Strengthening, Number of Treatments, and Pain Level

An element of treatment that was pervasive throughout many treatment sessions was the performance of certain exercises. Exercise as tolerated was a key part of the therapist's treatment plan as nearly all of the evaluations concluded with a plan to introduce postural exercises, core strengthening exercises, or other types of stretching, especially in the home exercise program. During treatment sessions, many patients performed core-strengthening exercises, including crunches and diagonal crunches. A total of 18 patients did these core-strengthening exercises at 50% or more of their

treatment sessions. There was a trend between the length of treatment and the decrease in pain, especially when combined with a high frequency of core strengthening exercises. Out of the 13 patients who came to two or three treatment sessions, 10 did one of these exercises during at least half of their treatment sessions. Only four of these 10 patients saw an improvement in their pain level. Conversely, all eight patients that did them consistently over four or more treatment sessions saw an improvement in their pain levels, and often they showed drastic improvement, indicated by cutting their pain in half or more over the course of treatment. The only six patients that did not show improvement in pain level after doing core strengthening at half of their treatment sessions only came two or three times, which led to a low frequency of performance. The other 12 patients showed improvement after doing consistent core strengthening programs, with 66.7% of these patients (n=8) coming four or more times. The home exercise program for many of these patients included core-strengthening exercises, so the ones that consistently came to therapy and reported doing their exercises at home were much more likely to demonstrate improvement over a two to six week period.

Physical Therapist Input

Exercises were a large part of the treatment process in the clinic, as well as outside the clinic. The therapist instructed many of the patients (n=17) to increase their general activity level as they could tolerate, even while they were still experiencing back pain. All of the treatment sessions included some type of exercise, with the amount somewhat dependent upon pain level and the degree to which movement aggravated the patient's symptoms. The goal of all of the patient interactions was to increase patient activity and decrease functional disability. Another suggestion made by the therapist was

to take more frequent breaks during studying or other extended sitting. This was given to seven of the patients directly, as well as discussing with six more about their difficulty in sitting through longer class periods without a break. Finally, all of the evaluations ended with a plan of care that describes the focus of the treatment process, both at home and in the clinic. While there was some variation in the instructions provided, each patient received instruction on postural exercises, core muscle strengthening, or stretching to help relieve their back pain symptoms. While some patients received more than one of these categories, the most common instruction to patients at the end of evaluation was stretching (n=16), followed by core strengthening (n=12), and postural exercises (n=5). Also included were the recommendations to take breaks during studying and to modify current exercise patterns – either to increase light activity levels or to decrease weight training temporarily. These recommendations by the therapist showed the factors he considered to be important and guided the rest of the treatment process.

CHAPTER FOUR

Discussion

Introduction

Non-specific low back pain is a problem that plagues one out of three people, including college students. It was seen in the literature that by the target population of 18-24 years of age, the prevalence of non-specific low back pain has reached adult levels and thus needs to be addressed in order to reduce chronic pain into adulthood (Olsen et al., 1992). The treatments for this type of pain are varied and include various types of physical, emotional, and cognitive treatments; this study focused on the effects of physical therapy in the treatment of non-specific low back pain. The goal was to determine whether or not physical therapy is effective in the treatment of non-specific low back pain. Physical therapy, especially when conducted for more than four treatment sessions, was shown to be fairly effective in reducing non-specific low back pain in college students. The most important factors in this population included the number of treatment sessions attended, range of motion, muscle tightness, particular exercises including core strengthening and lumbar manual therapy, and the amount of time spent sitting. In contrast, changes in lumbar curvature did not appear to have a strong correlation with changes in back pain levels. However, there are other physical and emotional factors that should be taken into account when dealing with a patient with this ailment.

Discussion of Results

Number of Treatments

Physical therapy was an effective means to the reduction of non-specific low back pain in 24 of the 30 patients examined in this study. The other six patients saw no change in their pain level across their treatment. However, these six patients only came to two or three treatment sessions. It was clear that the number of treatment sessions a patient attends is an important variable in the prognosis of the patient, as only 53.8% (n=7) of the patients that came to three or fewer treatment sessions (n=13) showed improvement in their pain level, while 100% (n=17) of the patients that came to four or more treatment sessions saw an improvement in pain level. According to the information gathered in this study, it is recommended that patients come to at least four treatment sessions in order to have a higher likelihood that they will experience a decrease in pain level. Frequency and consistency of physical therapy was important in order to gain benefits seen in stretching and strengthening exercises performed in therapy sessions.

Exercises

The patients that claimed to perform the home exercise program saw improvement over the course of their therapy, and it was assumed that the patients that came to more treatment sessions performed the home exercise program more times, leading to a more effective outcome. This supported the literature that found that an 8-week exercise program led to significant improvement in pain intensity (Jones, Stratton, Reilly & Unnithan, 2007) – a consistent, long term physical therapy program is similar to this exercise program, especially if the patient is compliant with the assigned home

exercise program. Consistency in exercise was a key factor in decreasing pain level and the recurrence of non-specific low back pain, as seen in a study performed by Macedo, et al. in 2013 and in this study. This includes frequent exercise between therapy sessions as well as after therapy has been completed. The therapist recommendations centered around increasing activity levels as tolerated and making sure the patient could return to full activity levels, indicating the importance of exercise in the treatment process. Another important factor seen in the physical therapy treatment was the consistent use of core strengthening exercises. It was seen that weak abdominal muscles could be a factor in the development of back pain, which gives justification to the implementation of core strengthening exercises into the physical therapy treatment and home exercise program (Handrakis et al., 2012). As with the development of any type of strength, consistency and long term commitment is necessary to increase abdominal strength. As such, performing crunches or diagonal crunches at 1 or 2 appointments was not enough to see a significant improvement in abdominal strength. However, the longer a patient continued to come to physical therapy and remained compliant with the home exercise program, the more strength they were able to gain. All patients that came to four or more treatment sessions and did core strengthening consistently saw improvement in their pain levels, possibly indicating that these exercises were effective in reducing non-specific low back pain when performed over a period of time. Additionally, exercises to stretch the back, especially double-knee to chest exercises seemed to be particularly effective in reducing back pain levels, as 16 of the 19 patients that did them consistently saw an improvement in their back pain levels.

Lumbar Manual Therapy

Another factor in physical therapy that was shown to be effective in the literature is the use of manual therapy (Whal, Smith, Sesto, & Boissonnault, 2013). In this case study, lumbar area mobilizations were effective in reducing pain at the next treatment 52% of the time, but this type of treatment was not used in isolation so it is difficult to determine what effect the manual therapy had on the progress of the patient. However, 12 of the 14 patients who experienced this treatment at 50% or more of their treatments saw improvement in pain level, suggesting as seen in the 2013 study by Whal, Smith, Sesto, and Boissonnaul, that manual therapy can be effective, when combined with physical activity. However, it is difficult to determine whether or not the patients' improvement is due to the use of manual therapy. Further studies could use this treatment in isolation to determine its effectiveness on the reduction of non-specific low back pain.

Range of Motion and Muscle Tightness

Range of motion is an important consideration in the functional abilities of any physical therapy patient, including patients with non-specific low back pain. A decrease in range of motion could be functionally disabling to a patient with this type of pain, if he or she is unable to maneuver his or her body to produce the actions he or she wants to. For example, a patient with a significant decrease in forward flexion will struggle picking items up off of the ground without large compensations in the legs. Decreases in range of motion can have several causes, but a notable cause in this study was the extent of muscle tightness, especially in the hamstrings. Twenty-three total patients exhibited full range of motion at some point their treatment process, and 65.2% (n=15) did not exhibit muscle

tightness at this point. Out of the seven patients that did not achieve full range of motion during their treatment, five exhibited tightness, usually in the hamstrings. Tightness in the hamstrings reduces the extent of forward flexion possible, which was a deficit seen in six of these seven patients. Persistent tightness may have indicated a chronic lack in flexibility, which was directly correlated to a range of motion deficit. Both an increase in tightness and a decrease in range of motion were risk factors for pain, as seen that patients with muscle tightness and a deficit in range of motion exhibit an average pain of 2.73 out of 10 and 3.31 out of 10, respectively. This was in contrast to an average pain of 2.47 out of 10 and 1.42 out of 10 with no tightness and full range of motion, respectively. Physical therapy treatment to alleviate these symptoms was critical in the reduction of non-specific low back pain. Exercises such as hamstring stretches, mid or low back stretches, double-knee to chest exercises, and lumbar rotations worked to assuage muscle tightness and subsequently improve range of motion. Many patients (n=16) who performed double-knee to chest exercises specifically saw an improvement in pain, likely associated with the improvement in range of motion and muscle tightness.

Sitting

A physical factor that is associated with this population and was seen frequently in this case analysis is sitting and its effect on back pain. College students spend much of their time sitting – a combination of class time, study time, or working desk jobs. As seen in the literature, an increase in the amount of time spent sitting was correlated to an increase in back pain, as frequently the sitting position of a student was not the most conducive to reducing the stress placed on the spine (Kennedy, Kassab, Gilkey, Linnel & Morris, 2008). A large portion of the patients (n=17) indicated during the evaluation that

sitting made their pain worse, which was in alignment with the literature on the subject. In addition, five patients mentioned it in later sessions, indicating that prolonged sitting can have a continuing and notable effect on back pain. The amount of time spent sitting as well as the position that the student sits in needs to be addressed in the therapy session in order to understand how to improve the problem. Sitting in ergonomically designed chairs, as well as taking breaks during studying sessions, are a couple ways to decrease this pain with sitting, if the amount of time spent sitting cannot be reduced.

Lumbar Curvature

One factor that did not appear to have a significant relationship to the improvement of back pain levels was the improvement in abnormalities in lumbar curvature. As only six out of 20 patients with initial abnormal curvature notations saw improvements in their lumbar curvature, it was difficult to determine the significance of this factor. It is possible that the lumbar curvature improves over time and treatment, as a result of the improvement in muscle tightness and range of motion, but a lack of notation made this determination difficult to ascertain.

Limitations

One of the difficulties in this case study was the uncertainty in notation throughout the patient notes. This difficulty impacted the analysis of progress in range of motion, muscle tightness, and lumbar curvature most notably. In lumbar curvature notation specifically, several patients (n=8) were noted as having an abnormal curvature during the evaluation, but no future notation was made on the subject, while other patients have further notations indicating whether the problem persisted or improved. It

is unclear whether a lack of documentation indicates an improvement in the problem or a lack of change in the problem. It likely means that the therapist did not notice that the factor (lumbar curvature, tightness, range of motion deficit) was inhibiting the patient in his or her exercises or daily life. However, this does not emphatically mean that the factor improved, so it was conservatively assumed that the factor remained the same, and that noticeable improvement would be documented. By this assumption, it is likely that several patients were counted as not having improved when progress was in fact made, but it avoids artificially assuming that a patient made progress without explicit documentation that this was the case.

Another difficulty inherent in this analysis is that a patient's pain may fluctuate significantly throughout the days in between his or her physical therapy appointments. These fluctuations are important and directly impact the daily life of a patient, but only the objective number given at the treatment session could be used to determine overall progress. It was possible that the patient is having abnormally low or abnormally high pain level during the appointment, based on the activity or strain they have incurred that day or the day before, but the overall progress of a patient was typically witnessed by looking at these numbers as a snapshot of his or her day. Another difficulty associated with the patient in between therapy sessions was his or her compliance with the home exercise program. Continuous and habitual exercise was an important part of the treatment process, and performing the prescribed exercises once or twice a week was likely not sufficient to see significant progress in muscular strength or endurance. All of the patients that reported doing their home exercise program (n=20) saw improvement in their pain level, indicating a relationship between these factors, and that habitual exercise

was important in the reduction of pain levels. However, there were patients that did not report performing the exercises; some improved while others did not. Compliance with the home exercise program was a factor that was not controllable in the patients except through encouragement and reminders of its importance.

A final confounding factor was the manner in which a patient concludes his or her treatment process. In many cases, the patient and therapist discussed the lack of need in continuing therapy and either issued a formal discharge or a condition where the patient would call again if the symptoms worsen. However, some patients (n=12) did not show up to a scheduled appointment. This could have been the result of many factors, but it was difficult to know which one is most prevalent. Possible explanations could include a frustration with treatment progress, improvement in pain, or simple forgetfulness. If a patient did not show up, it is possible that his or her pain had improved and saw no reason to continue coming to therapy. However, this assumption cannot be made across the board and the patient's pain status at his or her last attended appointment is the reference for his or her final status.

Additional Recommendations for Clinical Practice

The treatment of a patient with non-specific low back pain can be as varied as the cause of the pain. In addition to the physical factors previously discussed, a few psychosocial factors need to be considered as well. A highly relevant factor in the development of non-specific low back pain in the college-aged population is the presence and level of stress. Stress is an emotional and psychological factor that can have intense ramifications on pain, as stress can manifest itself in physical pain. The demands placed on the time of college students can often be large, and an increase in these demands

between work and school can cause an increase in the intensity and frequency of pain in college students (Heuscher, Gilkey, Peel, & Kennedy, 2010; Taspinar F., Taspinar B., Cavlak & Celik, 2013). This is a factor that should be monitored in the subjective analysis of a patient coming in for physical therapy treatment, but was not frequently seen in this study. Additionally, the therapist should make the patient aware of the effect of stress on the body and suggest ways to deal with stress – most notably increasing physical exercise, since that is already a part of the goals of physical therapy.

Associated with an increase in stress and time demands is often a development of fatigue ranging from mild to intense in college-aged students. When intense fatigue begins to develop, the prevalence of chronic pain increases (Snekkevik, Eriksen, Tangen, Chalder & Reme, 2014). When the demands placed on a student are so high that sleep patterns are disrupted, this can be a risk factor for the development of back pain. As a result, the therapist should recommend that the patient learn how to efficiently manage time and complete tasks in order to sleep more and fight off the fatigue that can be causing or exacerbating back pain. Additionally, psychological factors such as depression can lead to slower recovery and if possible, should be screened for in the evaluation process (Melloh et al., 2013). While the diagnosis and treatment of psychological abnormalities is not the responsibility of a physical therapist, if these factors are noticed, the therapist should recommend seeking counseling in order to address these emotional factors. As chronic pain and depression are closely related, it may be difficult to determine which one is the cause, and which is the effect (Snekkevik et al., 2014). As a result, the therapist should be aware of this relationship and prepared

to refer the patient to another medical professional to meet the emotional needs of the patient, while continuing to treat the physical symptoms.

Recommendations for Further Study

This study gathered information on patients that had already been treated without the intent to analyze the recorded data. Future studies could look at patients as they are being treated and more closely monitor the variables that have been found to be important, including range of motion, muscle tightness, core strength, and level of exercise outside of the clinic. Additionally, future studies should look to isolate certain aspects of the treatment process in order to highlight the benefit of treatments such as lumbar manual therapy and core strengthening independently from other treatments. Finally, future studies could include a survey to better understand the impact of stress and fatigue on back pain, as well as the impact of back pain on the functional disability and overall quality of life of the patient.

Summary

It has been shown that physical therapy can be beneficial for patients experiencing non-specific low back pain. There are many factors that can lead to pain of this nature, including stress, fatigue, poor posture, and a lack of exercise, and all should be considered when treating a patient with this condition. Physical therapy can help with several of these factors, especially through patient education. Intentional patient education about stress level, sitting posture, and healthy sleep patterns can influence the patient's behavior in realms other than physical activity, while the assigned exercises in the clinic and home exercise program can aid in increasing physical endurance and

strength. In this way, the physical therapist can attempt to address more than just the physical nature of the pain. Additionally, a therapist should be knowledgeable about the signs of depression so that if a patient exhibits these signs, the therapist can recognize them and recommend additional treatment by a counselor or other, more qualified professional. Physical therapy and the associated increase in physical activity can successfully reduce non-specific low back pain, and with sufficient education, reduce future low back pain episodes. Physical therapy sessions and exercises should focus on improving range of motion, decreasing muscle tightness, and increasing core strength to have the highest chance of success in reducing or eliminating non-specific low back pain in this population.

APPENDICES

APPENDIX A

Evaluation Data for All Patients

Patient Number	1	2	5	6
M/F	Female	Male	Female	Male
Onset	No particular injury	No injury, a big cough aggravated it	No particular injury	No particular injury
Pain Number	6	3	8	3
Pain Nature	Sharp	Sore	Sharp	Sharp
Pain Nature 2		Tight	Shooting	Tight
Duration	Sitting	Constant	Constant	Constant
Worsened by	Sitting		Sitting	Twisting
Improved by	Easy movement		Lying down	Rest
Curvature	Lumbar lordosis	Lumbar lordosis		Rounded shoulders
Curvature detail	Dec	Inc		Inc
General				Full ROM in lumbar
Flexion	Dec	Dec	Dec	
Extension	Dec	Dec	Dec	
Sidebend	Dec	R pulling	Dec	
Rotation	Dec	R pulling		
Tightness				
Plan 1	Core strengthening	Core strengthening	Pt ed on HEP, heat and ice	Postural exercises
Plan 2	Low back stretches	Low back stretches		
Plan 3	Hamstring flexibility			
Visit Frequency	1-2/week	1/week	1-2/week	1-2/week
Treatment Duration	4-6 weeks	6 weeks	4-6 weeks	4-6 weeks

Patient Number	8	9	11	12
M/F	Female	Male	Female	Female
Onset	No particular injury	Playing basketball but no injury	No particular injury	No particular injury
Pain Number	5	6	0	7
Pain Nature	Ache	Sore		Sharp
Pain Nature 2		Tight		Shooting, achy
Duration	Constant	Constant		Constant
Worsened by	Sitting		Walking	Sitting
Improved by	Bending forward	Pop		Lying down
Curvature	Rounded shoulders	Lumbar lordosis		Lumbar lordosis
Curvature detail	Inc	Inc		Inc
General	Full ROM in lumbar		Full ROM in lumbar	
Flexion		Dec		Dec
Extension				
Sidebend		Dec		Dec
Rotation		L dec		
Tightness	Hamstrings	R paraspinal		
Plan 1	Low back stretches	Core strengthening	Core strengthening	Low back stretches
Plan 2	Upper back stretch	Stretching	Taking breaks	Hip flexor stretches
Plan 3	Strengthening		Walking	
Visit Frequency	1-2/week	1-2/week	1/week	1-2/week
Treatment Duration	4-6 weeks	6 weeks	2-4 weeks	4-6 weeks

Patient Number	12.1	14	15	16
M/F	Female	Female	Male	Female
Onset	No particular injury	No particular injury	No particular injury	No particular injury
Pain Number	6	8	0	6
Pain Nature	Ache	Sharp		Ache
Pain Nature 2		Shooting		
Duration	Constant	Constant		Constant
Worsened by	Sitting	Sitting		Bending forward
Improved by	Lying down	Lying down		Heat
Curvature	Lumbar lordosis	Lumbar lordosis	Lumbar lordosis	Lumbar lordosis
Curvature detail	Inc	Inc	Dec	Inc
General		Full ROM in lumbar		Full ROM in lumbar
Flexion	Dec		Dec	
Extension	Dec			
Sidebend	Dec			
Rotation	Dec			
Tightness	Hip flexors		Hamstrings	
Plan 1	Low back stretches	HEP	Core strengthening	Low back stretches
Plan 2			Hamstring stretches	Mid back stretches
Plan 3				Posture
Visit Frequency	1-2/week	1-2/week	1-2/week	1-2/week
Treatment Duration	4-6 weeks	4-6 weeks	4-6 weeks	4-6 weeks

Patient Number	20	21	23	28
M/F	Male	Male	Female	Male
Onset	Slept on couch	No particular injury	No particular injury	No particular injury
Pain Number	7	6	6	7
Pain Nature	Sharp	Sharp	Sharp	Sharp
Pain Nature 2	In lumbar			
Duration	Constant	Constant		Constant
Worsened by	Running	Moving	Sitting	Sitting
Improved by	Lying down	Lying down	Moving	Lying down
Curvature	Lumbar lordosis	Lumbar lordosis	Lumbar lordosis	Lumbar lordosis
Curvature detail	Dec	Dec	Inc	Dec
General		Full ROM in lumbar		
Flexion			Dec	Dec
Extension	Dec			Dec
Sidebend				Dec
Rotation				Dec
Tightness	Hamstrings	Hamstrings		Hamstrings
Plan 1	Low back stretches	Exercises	Core strengthening	Postural exercises
Plan 2	Posture		ROM	Exercise
Plan 3				
Visit Frequency	1-2/week	1-2/week	1-2/week	1-2/week
Treatment Duration	4-6 weeks	4-6 weeks	6-8 weeks	4-6 weeks

Patient Number	29	31	33	34
M/F	Female	Male	Female	Male
Onset	No particular injury	No particular injury	No particular injury	No particular injury
Pain Number	3	4	4	7
Pain Nature	Throbbing	Ache	Sharp	Dull
Pain Nature 2		Stabbing	Tight, ache, sore	
Duration	Constant	Constant	Constant	Constant
Worsened by	Running	Sleeping on stomach	Sitting	Sitting
Improved by	Rest	Heating pad	Movement	Lying down
Curvature			Lumbar lordosis	Lumbar lordosis
Curvature detail			Inc	Dec
General		Full ROM in lumbar		
Flexion	Dec		Dec	Dec
Extension	WNL			WNL
Sidebend	Dec			WNL
Rotation	Dec			WNL
Tightness	Hamstrings	Hamstrings		Hamstrings
Plan 1	Core strengthening	Low back stretches	X-rays	Core strengthening
Plan 2	Stretching	LE flexibility		Low back stretches
Plan 3	No running			
Visit Frequency	1-2/week	1-2/week	1-2/week	1-2/week
Treatment Duration	4-6 weeks	2-3 weeks	6-8 weeks	4-6 weeks

Patient Number	37	38	40	41
M/F	Male	Male	Female	Male
Onset	No particular injury	No particular injury	No particular injury	No particular injury
Pain Number	2	4	0	6
Pain Nature	Dull	Sharp	No	Sharp
Pain Nature 2	Ache			Throbbing
Duration		Occasional		Comes and goes
Worsened by	Twisting	Bending forward		Walking
Improved by	Change positions	Movement		Sitting
Curvature	Lumbar lordosis		WNL	
Curvature detail	Dec			
General			Full ROM in lumbar	
Flexion	Dec	Dec		Full
Extension	Dec	Dec		WNL
Sidebend	Dec	WNL		WNL
Rotation	Dec	WNL		WNL
Tightness		Hamstrings		B
Plan 1	Core strengthening		Core strengthening	Core strengthening
Plan 2	Low back stretches		Taking breaks	Taking breaks
Plan 3	Taking breaks, exercise			
Visit Frequency	1-2/week	1-2/week	1/week	1-2/week
Treatment Duration	6 weeks	4-6 weeks	2-4 weeks	6 weeks

Patient Number	44	45	46	47
M/F	Male	Female	Male	Female
Onset	No particular injury	No particular injury	No particular injury	No particular injury
Pain Number	6	5	5	2
Pain Nature	Sharp	Ache	Stiff	Ache
Pain Nature 2			Sore	
Duration	Constant	Constant		Constant
Worsened by	Standing	Sitting	Mornings	Sitting
Improved by	Lying on L	Lying down	Stretching	Movement
Curvature		Rounded shoulders		Lumbar lordosis
Curvature detail				Inc
General	Very decreased		Full ROM	Full ROM in lumbar
Flexion		Near full		
Extension		Dec		
Sidebend		Dec		
Rotation		Dec		
Tightness			Hamstrings	
Plan 1	HEP	Postural exercises	Low back stretches	Postural exercises
Plan 2	Heat, ice		Hamstring stretches	Taking breaks
Plan 3			Core strengthening	
Visit Frequency	1-2/week	1-2/week	1-2/week	1-2/week
Treatment Duration	3-4 weeks	6 weeks	4-6 weeks	4-6 weeks

Patient Number	48	50
M/F	Male	Female
Onset	No particular injury	No particular injury
Pain Number	2	3
Pain Nature	Dull	Sharp
Pain Nature 2		Burning
Duration	Movement	Constant
Worsened by	Bending forward	Sitting
Improved by	Light activity	Lying down
Curvature	Lumbar lordosis	
Curvature detail	Dec	
General		Full ROM
Flexion	Dec	
Extension	WNL	
Sidebend	WNL	
Rotation	WNL	
Tightness		
Plan 1	Light activity	Posture
Plan 2	Decrease wt training	Strengthening
Plan 3		
Visit Frequency	1-2/week	1-2/week
Treatment Duration	4-6 weeks	6 weeks

APPENDIX B

Treatment Objectives for Patients who Attended 7+ Treatments

Patient Number	Treatment Number	Pain Level	Flexion	Extension	Side bend	Rotation	Tightness	Tightness Detail	Curvature	Curvature Detail
1	0	6	dec	dec	dec	dec			lordosis	dec
1	1	3								
1	2	3	mod dec				lumbar			
1	3	6					hamstrings	L		
1	4	0	mod dec							
1	5									
1	6	3	improved							
1	7	2								
1	8	2					lumbar			
1	9	2	min dec	min dec	min inc		lumbar		lordosis	improved
1	10	1					hip flexors			
1	11	0					hamstrings			
12	0	7	dec		dec				lordosis	inc
12	1	6								
12	2	6								
12	3	5								
12	4	4								
12	5	4								
12	6	3					hamstrings	min		

Patient Number	Treatment Number	Pain Level	Flexion	Extension	Side bend	Rotation	Tightness	Tightness Detail	Curvature	Curvature Detail
12.1	0	6	dec	dec	dec	dec	hip flexors		lordosis	inc
12.1	1	6					hamstrings			
12.1	2	0								
12.1	3	1	min dec						lordosis	inc
12.1	4	2					hip flexors	improved	lordosis	inc
12.1	5								lordosis	inc
12.1	6	2		pain			lumbar			
14	0	8							lordosis	inc
14	1	0								
14	2	0					hamstrings	improved		
14	3	1								
14	4	0								
14	5	0							lordosis	min inc
14	6	0								
14	7	0							lordosis	min inc

Patient Number	Treatment Number	Pain Level	Flexion	Extension	Side bend	Rotation	Tightness	Tightness Detail	Curvature	Curvature Detail
21	0	6					hamstrings		lordosis	dec
21	1	0					hamstrings			
21	2									
21	3	2							lordosis	min dec
21	4	4								
21	5	3								
21	6	2								
21	7	0								
45	0	5	near full	dec	dec	dec				
45	1	3								
45	2	1								
45	3	3								
45	4	2								
45	5									
45	6	4								

Patient Number	Treatment Number	Pain Level	Flexion	Extension	Side bend	Rotation	Tightness	Tightness Detail	Curvature	Curvature Detail
47	0	2							lordosis	inc
47	1									
47	2	3					mid thoracic			
47	3	2					lumbar	lumbar		
47	4	2								
47	5	2								
47	6									
47	7	2								
47	8	2								
47	9	3								
47	10	2								
47	11	1								
48	0	2	dec				hamstrings	significant	lordosis	dec
48	1	0								
48	2	2	dec	WNL	WNL	WNL			lordosis	dec
48	3	1					hamstrings	improved		
48	4	1	pain				lumbar			
48	5	1	tightness	dec			hamstrings			
48	6	2					hamstrings			
48	7	0								
48	8	2					hamstrings	min		

APPENDIX C

Treatment Objectives for Patients who Attended 4-6 Treatments

Patient Number	Treatment Number	Pain Level	Flexion	Extension	Side bend	Rotation	Tightness	Tightness Detail	Curvature	Curvature Detail
8	0	5					hamstrings			min
8	1	3					traps			
8	2									
8	3	0								
8	4	2							lordosis	min inc
16	0	6							lordosis	inc
16	1	3								
16	2	6								
16	3	3								
16	4	0								
20	0	7		dec			hamstrings	50 degrees	lordosis	dec
20	1	5					hamstrings			
20	2	2					hamstrings			
20	3	0					hamstrings			
23	0	6	dec						lordosis	inc
23	1	4							lordosis	inc
23	2	0								
23	3	4								
23	4	2							lordosis	inc

Patient Number	Treatment Number	Pain Level	Flexion	Extension	Side bend	Rotation	Tightness	Tightness Detail	Curvature	Curvature Detail
28	0	7	dec	dec	dec	dec	hamstrings	L	lordosis	dec
28	1						hamstrings	min		
28	2	4					hamstrings			
28	3	4					lumbar			
28	4	2	dec	WNL	WNL	WNL	hamstrings	improved	lordosis	dec
28	5	1								
34	0	7	dec	WNL	WNL	WNL	hamstrings	mod	lordosis	dec
34	1	3								
34	2	3								
34	3	0								
34	4	0					hamstrings	min		
41	0	6	full with tightness	WNL	WNL	WNL				
41	1	6					lumbar	R		
41	2	5	near full				hamstrings	B		
41	3	0	full				hamstrings	min		
41	4	2					hamstrings	min	lordosis	min dec
41	5	2					hamstrings	min	lordosis	improved
44	0	6								
44	1	2								
44	2	3					hamstrings	mod	lordosis	dec
44	3	2					hamstrings	min	lordosis	dec
44	4	3	near full				hamstrings	improved	lordosis	min
44	5	0					hamstrings	much improved		

Patient Number	Treatment Number	Pain Level	Flexion	Extension	Side bend	Rotation	Tightness	Tightness Detail	Curvature	Curvature Detail
46	0	5					hamstrings			
46	1	0					hamstrings	min		
46	2	2					hamstrings	min		
46	3	1					hamstrings	improved		
46	4	0							lordosis	near normal

APPENDIX D

Treatment Objectives for Patients who Attended 2-3 Treatments

Patient Number	Treatment Number	Pain Level	Flexion	Extension	Side bend	Rotation	Tightness	Tightness Detail	Curvature	Curvature Detail
2	0	3	dec	dec	pulling	R pulling			lordosis	inc
2	1	3		pain at end range			hamstrings	min		
5	0	8	dec	dec	dec					
5	1	5								
6	0	3							rounded shoulders	min
6	1	1								
9	0	6	dec		dec	L dec	lumbar	R	lordosis	inc
9	1	3								
9	2	0	full in lumbar							
11	0	0								
11	1	0								
15	0	0	dec				hamstrings		lordosis	dec
15	1	0					hamstrings			
15	2	0					hamstrings		lordosis	min dec
29	0	3	dec	WNL	dec	dec	hamstrings	B min		
29	1	1								
29	2	0					hamstrings	min		

Patient Number	Treatment Number	Pain Level	Flexion	Extension	Side bend	Rotation	Tightness	Tightness Detail	Curvature	Curvature Detail
31	0	4					hamstrings	hips		
31	1	3					hamstrings	min		
31	2	3					lumbar			
33	0	4	dec						lordosis	inc
33	1	2							lordosis	inc
37	0	2	dec	dec	dec	dec			lordosis	dec
37	1	2					hamstrings	min		
38	0	4	dec	dec			hamstrings	mod		
38	1	1	min dec							
38	2	0	min dec				hamstrings	improved		
40	0	0								
40	1	0								
50	0	3					piriformis			
50	1	3					hamstrings	min		

APPENDIX E

Treatment Subjective Notes for All Patients

Patient Number	Post-Eval Treatment Number	Subjective Progress
1	1	a little better
1	2	ran day before, felt fine but woke up sore. Stretches helped.
1	3	only on L side, longer distance, no pain going down legs
1	4	L side
1	5	MVA but has not worsened symptoms in LB, some pain in UB
1	6	feels good
1	7	feeling better
1	8	feeling better, run and play tennis but sore after
1	9	feeling much better
1	10	feeling good
1	11	occasional discomfort sit to stand, supine to stand
2	1	better, little increase in pain with extension
5	1	about the same, doing exercises
6	1	much better, doing exercises
8	1	more sore, doing exercises
8	2	little soreness, does not prevent activity
8	3	feeling better, doing exercises
8	4	feels good, no pain in upper back (slight in lower)
9	1	stretching aggravated back
9	2	much better
11	1	no pain, doing activity

12	1	upper back sore, doing exercises; xrays WNL, no fxs
12	2	worse yesterday, better today
12	3	sore today
12	4	a little better
12	5	a little better, doing exercises
12	6	pain with prolonged sitting, but doing better
12.1	1	still sore, stretching regularly
12.1	2	a little better, doing exercises
12.1	3	feeling better, doing exercises, a little sore
12.1	4	sore
12.1	5	sore, doing exercises
12.1	6	sore from a LE workout
14	1	feeling okay, sore over weekend, did not do exercises
14	2	feeling better
14	3	improving
14	4	feeling better, pain with work
14	5	feeling good
14	6	feeling good, occasional pain with prolonged studying or work
14	7	feeling better, sore from work
15	1	tightness, but feeling okay
15	2	feeling better, doing exercises, not limited
16	1	some better some more sore, doing exercises
16	2	increasing, going to hips and upper back
16	3	still sore especially after work, doing exercises
16	4	better
20	1	doing better, some tightness
20	2	feeling better, exercise without pain
20	3	feeling better, full activity, just tightness but no pain
21	1	feeling better
21	2	seeing a chiropractor so stopped PT
21	3	worse with frisbee tournaments, more in the mid-upper back now
21	4	when on meds, not much pain

21	5	improving, doing exercises
21	6	had surgery, stopped seeing PT, 3 weeks later now
21	7	feeling better, threw frisbee
23	1	feeling better, exercises are helping
23	2	continues to improve, sore in R SI, doing exercises
23	3	R SI more sore
23	4	feeing better
28	1	feeling better, doing exercises
28	2	about the same, doing exercises, jogging, taking breaks
28	3	less soreness, can sit for longer
28	4	started to plateau, worsens with sitting
28	5	doing better, just to an annoyance
29	1	better, doing exercises
29	2	doing better, doing exercises
31	1	feeling better, doing exercises
31	2	a little sore, doing exercises
33	1	feeling better, x-rays WNL
34	1	feeling better, doing exercises, some discomfort
34	2	still some pain, sore after last treatment
34	3	feeling good, stiffness with studying
34	4	sore after studying, exercises help
37	1	feeling better, still tight
38	1	doing better, pain moved up a little
38	2	doing much better, doing exercises
40	1	no pain, able to do activity
41	1	about the same, doing exercises
41	2	doing okay
41	3	feeling better, tight still, less pain with exercises
41	4	more sore today
41	5	feeling good, can run some

44	1	back feeling better, walking without crutches
44	2	still sore
44	3	improving, doing exercises, swimming, located centrally in L5-S1
44	4	still sore, trying to lift is painful
44	5	feeling better, doing exercises
45	1	feeling okay, still sore
45	2	improving
45	3	min soreness, doing a lot of studying
45	4	min tightness, doing exercises
45	5	still sore, studying a lot
45	6	pain with prolonged studying, massage helped
46	1	feeling better, doing exercises
46	2	much better, still sore in am
46	3	little looser, pain with extension
46	4	much improvement, just occasional soreness
47	1	good but still sore
47	2	some spasms
47	3	getting better, doing exercises
47	4	feeling good, massage was helpful
47	5	cervical and lumbar improved, thoracic worse
47	6	upper back painful, stressful week
47	7	feeling better, doing exercises
47	8	feeling better, soreness
47	9	doing better, just a little tightness
47	10	soreness, still some discomfort
47	11	feeling better, can take deeper breaths, can workout
48	1	better with activity, only min tightness after
48	2	more sore after activity
48	3	doing better, pain with carrying backpack, stretching helps
48	4	feeling better, usually no pain unless bending forward
48	5	got worse after leg workout, but now just stiff
48	6	just stiff, min pain
48	7	much better, doing exercises and light activity
48	8	pretty good, doing exercises
50	1	feeling much better, low back still sore

APPENDIX F

Treatment Exercises for All Patients

Patient Number	1	1	1	1	1	1	1	1	1	1	1	1	2	2	5	5	6	6
Post-Eval Treatment Number	0	1	2	3	4	5	6	7	8	9	10	11	0	1	0	1	0	1
Pain Level	6	3	3	6	0		3	2	2	2	1	0	3	3	8	5	3	1
Lumbosacral Mobilization			x				x	x	x	x		x			x			
DKC	x	x	x	x	x		x	x	x	x	x		x	x	x	x		
SKC															x	x		
Lumbar Rotations	x	x	x	x	x		x	x	x	x	x				x	x		
Pelvic Tilts	x	x	x	x	x		x	x	x	x	x		x	x		x		
Hamstring Stretches	x	x	x	x	x		x	x	x	x	x		x	x				
Hip Flexor Stretches																		
Mid Back Stretch												x						
Low Back Stretch												x						
Crunches		x	x	x	x		x	x	x	x	x	x	x	x		x		
Diagonal Crunches		x	x	x	x		x		x	x	x	x		x		x		
Prone opposite arm/leg		x		x	x		x	x	x	x				x				

Patient Number	8	8	8	8	8	9	9	9	11	11	12	12	12	12	12	12	12
Post-Eval Treatment Number	0	1	2	3	4	0	1	2	0	1	0	1	2	3	4	5	6
Pain Level	5	3		0	2	6	3	0	0	0	7	6	6	5	4	4	3
Lumbosacral Mobilization																	
DKC	x				x												
SKC											x						
Lumbar Rotations	x				x												
Pelvic Tilts	x				x	x	x	x	x		x						
Hamstring Stretches	x																
Hip Flexor Stretches											x						
Mid Back Stretch						x	x	x									
Low Back Stretch											x						
Crunches	x				x	x	x	x	x								
Diagonal Crunches					x	x	x	x	x		x						
Prone opposite arm/leg							x	x									

Patient Number	12.1	12.1	12.1	12.1	12.1	12.1	12	14	14	14	14	14	14	14	14
Post-Eval Treatment Number	0	1	2	3	4	5	6	0	1	2	3	4	5	6	7
Pain Level	6	6	0	1	2		2	8	0	0	1	0	0	0	0
Lumbosacral Mobilization		x		x	x	x	x								
DKC	x	x	x	x		x	x		x	x	x	x	x	x	x
SKC						x	x	x							
Lumbar Rotations	x	x	x	x	x	x									
Pelvic Tilts	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hamstring Stretches		x	x	x						x					
Hip Flexor Stretches	x	x	x		x	x	x								
Mid Back Stretch				x											
Low Back Stretch															
Crunches	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Diagonal Crunches					x				x	x	x	x	x	x	x
Prone opposite arm/leg									x	x			x	x	x

Patient Number	15	15	15	16	16	16	16	16	20	20	20	20	21	21	21	21	21	21	21	21
Post-Eval Treatment Number	0	1	2	0	1	2	3	4	0	1	2	3	0	1	2	3	4	5	6	7
Pain Level	0	0	0	6	3	6	3	0	7	5	2	0	6	0		2	4	3	2	0
Lumbosacral Mobilization							x		x	x	x	x	x							
DKC		x	x	x	x					x		x	x	x						
SKC		x																		
Lumbar Rotations	x			x	x		x		x	x		x								
Pelvic Tilts	x	x	x	x	x															
Hamstring Stretches		x	x						x	x	x	x	x	x						
Hip Flexor Stretches																				
Mid Back Stretch																				
Low Back Stretch								x												
Crunches		x	x											x						
Diagonal Crunches			x											x						
Prone opposite arm/leg		x	x																	

Patient Number	23	23	23	23	23	28	28	28	28	28	28	29	29	29	31	31	31	33	33
Post-Eval Treatment Number	0	1	2	3	4	0	1	2	3	4	5	0	1	2	0	1	2	0	1
Pain Level	6	4	0	4	2	7		4	4	2	1	3	1	0	4	3	3	4	2
Lumbosacral Mobilization		x								B	B					x	x		
DKC	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
SKC						x	x	x	x									x	x
Lumbar Rotations			x			x	x	x	x	x	x				x	x	x		
Pelvic Tilts	x	x	x	x								x	x	x				x	x
Hamstring Stretches						x	x	x	x	x	x	x	x	x		x	x		
Hip Flexor Stretches	x	x	x	x	x										x				x
Mid Back Stretch																x	x		
Low Back Stretch																			
Crunches		x	x	x	x		x	x	x			x	x	x					x
Diagonal Crunches			x	x	x							x	x						
Prone opposite arm/leg				x			x	x	x			x	x	x					

Patient Number	34	34	34	34	34	37	37	38	38	38	40	40	41	41	41	41	41	41
Post-Eval Treatment Number	0	1	2	3	4	0	1	0	1	2	0	1	0	1	2	3	4	5
Pain Level	7	3	3	0	0	2	2	4	1	0	0	0	6	6	5	0	2	2
Lumbosacral Mobilization	x		x			x	x		R				x	R		x	x	x
DKC	x	x	x	x		x	x	x	x	x			x	x		x	x	x
SKC	x	x	x	x				x	x	x			x	x		x	x	x
Lumbar Rotations						x	x											
Pelvic Tilts											x			x	x	x	x	x
Hamstring Stretches	x	x	x	x		x	x	x	x	x			x	x	x	x		x
Hip Flexor Stretches																		
Mid Back Stretch																		
Low Back Stretch																		
Crunches		x	x	x			x				x		x	x	x	x	x	x
Diagonal Crunches			x	x							x				x	x	x	x
Prone opposite arm/leg		x												x	x			

Patient Number	44	44	44	44	44	44	45	45	45	45	45	45	45	46	46	46	46	46
Post-Eval Treatment Number	0	1	2	3	4	5	0	1	2	3	4	5	6	0	1	2	3	4
Pain Level	6	2	3	2	3	0	5	3	1	3	2		4	5	0	2	1	0
Lumbosacral Mobilization			x		x	x								L	B	B	x	x
DKC		x	x	x		x								x	x	x		x
SKC																		
Lumbar Rotations		x	x	x		x									x	x		x
Pelvic Tilts														x	x		x	x
Hamstring Stretches			x	x	x	x								x	x	x	x	x
Hip Flexor Stretches																		
Mid Back Stretch																		
Low Back Stretch	x																	
Crunches															x	x	x	x
Diagonal Crunches																		
Prone opposite arm/leg																		

Patient Number	47	47	47	47	47	47	47	47	47	47	47	47	48	48	48	48	48	48	48	48	48	50	50
Post-Eval Treatment Number	0	1	2	3	4	5	6	7	8	9	10	11	0	1	2	3	4	5	6	7	8	0	1
Pain Level	2		3	2	2	2		2	2	3	2	1	2	0	2	1	1	1	2	0	0	3	3
Lumbosacral Mobilization													x	x	x		x	x		x			
DKC					x								x	x	x	x	x	x	x	x	x		
SKC																							
Lumbar Rotations					x								x	x	x	x	x	x	x	x	x		
Pelvic Tilts		x	x	x	x								x	x	x	x	x						x
Hamstring Stretches														x	x	x	x	x	x	x	x		x
Hip Flexor Stretches																							
Mid Back Stretch																		x					x
Low Back Stretch																							
Crunches		x	x	x	x							x	x		x	x							x
Diagonal Crunches		x		x	x																		x
Prone opposite arm/leg		x		x																			

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