The Relationship of Hamstring Length and Chronic Low Back Pain

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THE RELATIONSHIP OF HAMSTRING LENGTH AND CHRONIC LOW BACK PAIN

By

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David Doubblestein

THESIS

Submitted to the Department of Physical Therapy at Grand Valley State University Allendale, Michigan in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN PHYSICAL THERAPY

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THE RELATIONSHIP OF HAMSTRING LENGTH AND CHRONIC LOW BACK PAIN

ABSTRACT

Low back pain (LBP) is one of the most complex dysfunctions facing physical therapists today. There has been some research on the correlation between decreased hamstring length and LBP, but the results have been inconclusive. The purpose of this study was to determine if there is a direct correlation between decreased hamstring length and chronic LBP among males and females aged 20 - 60 years who are non-manual laborers.

Based on responses to a questionnaire thirty-nine volunteer subjects were placed into either the no LBP group or the chronic LBP group. The subjects were then tested bilaterally for hamstring muscle length using the modified passive knee extension test. The multiple linear regression procedure was used to analyze the data. No significant correlation was found ($p = 0.6574$). Therefore, the results of this study indicate that there was no difference in the mean average hamstring length between non-manual laborers aged 20 - 60 years with or without chronic LBP. Limitations of this study along with suggestions for further research are discussed.
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CHAPTER 1
INTRODUCTION

Background to Problem

Low back pain (LBP) is one of the most widespread ailments afflicting the industrialized world. Studies have indicated that approximately 80% of the adult population will experience LBP at some time (Phillips, R. B., Mootz, R. D.; Nyiendo, J., Cooperstein, D. C., Konsler, J., & Mennon, M., 1992). It has been demonstrated that LBP is most common in males aged 20-40 years. Phillips et al. found that 71% of patients experiencing LBP were employed full time, compared to 12% who were part-time and 16% who were unemployed patients. Also, in this study, which involved 141 subjects with LBP, 57% were non-manual laborers, as compared to only 34% who were manual laborers. The remaining 9% of the subjects were unemployed.

LBP profoundly affects daily activities and frequently impairs functional tasks. As a result, 60% of LBP sufferers seek help from health professionals (Phillips et al., 1992). Yet, according to several studies, LBP recurrence is very high (Hultman, G., Saraste, H., & Ohlsen, H., 1992; Biering-Sorensen, 1984; Mellin, 1986). Therefore, LBP is one of the most common orthopedic problems physical therapists are involved in treating today. In fact, it has been shown that patients being treated for LBP may make up as much as 35% of the population in outpatient physical therapy clinics (Nachemson, 1985). However, there is much disagreement among physical therapists about the etiology, treatment, and prevention of LBP. In this area, urgent attention in physical therapy research is needed.

One of the suspected etiologies of LBP is lack of hamstring flexibility. Flexibility of the hamstring muscles has been shown to correlate with LBP in some studies (Hultman...
et al., 1992; Pope, M. H., Bevins, T., Wilder, D. G., & Frymoyer, 1992). Hultman et al. found significant differences in hamstring length between chronic LBP subjects and subjects with no or occasional LBP. Pope et al. (1985) found an analogous trend, although the differences were minimal. Mierau, D., Cassidy, J. D., and Yong-Hing, (1989) reported a direct correlation between a history of LBP and lower extremity straight leg raising (SLR) measurements in adolescent males, although not in adolescent females and male and female children. On the other hand, Kujala et al. (1992) found that only tightness of the hip flexor muscles, and not tightness of the hamstrings, correlated to LBP. Sweetman, B. J., Anderson, J. A. D., and Dalton, E. R. (1974), who studied 500 male post office workers, also found no significant differences in SLR measurements between a no-LBP group and several different LBP groups.

Other research studies appear to indicate a relationship between hamstring muscle tightness and chronic LBP (Wehrenberg and Costello, 1993; Biering-Sorensen, 1984). Biering-Sorensen (1984) found that reduced flexibility of the hamstrings was more pronounced among those who experience recurrence of low back trouble. Biomechanically, it has been emphasized in the literature that tight hamstring muscles have a negative effect on the loading of the lumbar spine (Hultman et al., 1992; Stokes, I. A., & Abery, J. M.; Cyriax, P. J., 1982). In a study by Stokes and Abery, tight hamstrings was shown to decrease the lumbar lordosis in sitting and thus increase the pressure in the lumbar intervertebral discs and the loading on the lumbar spine. This increased stress on the lumbar spine may, according to several authors, highly predispose an individual to low back problems (Cyriax, 1982; Biering-Sorensen, 1984; Nachemson, 1985).

Problem Statement

Wehrenberg and Costello (1993) state that over 100 million work days are lost per year due to LBP, leading to the loss of over 5 billion dollars to companies. With the rise in health care costs and demand for health care reform there is a trend toward
emphasizing preventative care in physical therapy. Thus, evidence about the factors that may lead to LBP is important for preventative education (Mellin, 1986; Biering-Sorensen, 1984). Hamstring tightness has been reported to be one of these factors. The problem is that there is no conclusive evidence of the relationship between hamstring length and chronic LBP in non-manual laborers.

Purpose

The purpose of this study will be to determine if there is a direct correlation between short hamstring length and chronic LBP among males and females aged 20-60 years who are non-manual laborers. Chronic LBP will be defined using a questionnaire (Appendix A) that shows subjects have had a low back pain problem within the last two years that subsides and reappears. Non-manual laborers are those individuals who work in an occupation that requires a low level of physical exertion.
CHAPTER 2
REVIEW OF LITERATURE AND CONCEPTUAL FRAMEWORK

There are three basic topic areas in the literature related to our study. The first area deals with the correlation between hamstring length and LBP. There have been a number of studies that have researched the relationship between these two variables among several different populations. Secondly, the research also discusses the conceptual framework of the relationship between hamstring tightness and LBP. And finally, there have been some studies on the validity of certain techniques to measure hamstring length. The literature review will refer to the above three areas.

Correlation Between Hamstring Length and LBP

It is commonly assumed that patients with low back problems are characterized by tightness of the hamstring muscles (Pope et al., 1985). Several studies have been done on the relationship between hamstring tightness and LBP, although often showing conflicting results. Some studies have shown trends toward hamstring shortness correlating with LBP, but no statistically significant relationships were found (Sweetman, Anderson, & Dalton, 1974; Mellin, 1986). Other studies have shown either a significant correlation or no correlation between the two variables, but serious flaws limit the reliability of the conclusions, such as the methods used to measure the hamstrings and the methods used to classify the subjects (Mierau, Cassidy, & Yong-Hing, 1989; Kujala, Salminen, Taimela, Oksanen, & Jaakkola, 1992). As a result, the relationship between hamstring shortness and LBP remains unclear.
Sweetman, Anderson, and Dalton (1974) conducted one of the earliest studies examining the relationship between the hamstring muscles and LBP. Their research tested 500 post-office workers aged 22 to 63 years. All those tested were fit enough to be working at the time of the study. Their results showed no apparent correlation between straight leg raising (SLR), which is a common measure of hamstring length, and three different groups of back pain subjects, arranged according to their frequency of pain.

However, there were several factors in this study by Sweetman et al. that may have affected the results. First of all, there was potential for error in using the SLR test to measure hamstring length. For example, SLR could have been limited not only by hamstring muscle tightness, but also by nerve root irritation (Mierau, Cassidy, and Yong-Hing, 1989). Also, excessive posterior tilting of the pelvis could have caused the SLR to appear to be longer than it actually was (Kendall, 1993). Sweetman et al. made no mention of taking these factors into account during their testing. Another weakness of their study was that only those postmen who were fit enough to be working were tested. With the epidemic of back pain in the United States and the estimation that 100 million work days were lost per year due to back pain, it was likely that Sweetman et al. failed to do a comprehensive survey of the postal working population (Biering-Sorensen, 1984). Another weakness of the study was that the workers were not categorized by job type. This limits the implications of the study because there were several different jobs in the post office, each with differing levels of stress on the low back.

In a pilot study by Fisk and Baigent (1981), a significant relationship was found between hamstring tightness and Scheuermann's disease. Scheuermann's disease (SD) is characterized by degeneration of the vertebral discs and vertebral end plates during adolescence, often leading to low back problems later in life (Fisk and Baigent, 1981). In testing 20 patients, they found extremely tight hamstrings in all the patients, all of them being limited to 30 degrees or less of SLR (mean = 25.7 degrees). The normal range for the SLR test has been documented as being 80 degrees (Kendall, 1993). Fisk and Baigent
concluded in a pilot study on twenty subjects that short hamstrings "must increase the stress on the spine", leading to low back problems (p.124).

Although the findings of this study were significant, there are some limitations. First of all, it is possible that the spinal posture and relative inactivity due to Scheuermann's disease could have resulted in tight hamstrings. Therefore, the authors need to be cautious in making the conclusion that short hamstrings lead to low back problems. The limitations of the SLR test apply here also, although not to the same extent as the study by Sweetman et al. (mean SLR = 72.3), because the mean hamstring length of the Scheuermann's disease subjects (mean SLR = 37.2) was much shorter than the mean hamstring length of the control subjects (mean SLR = 77.1).

In a follow-up study by Fisk, Baigent, and Hill (1984), the results of their pilot study were further strengthened. They tested 500 seventeen and eighteen year old subjects and found a significant correlation (p<0.05) between tight hamstrings and X-ray evidence of SD among males, and the same trend, although not statistically significant, among females. There was significant evidence that SD in adolescence predisposes one to later disc degeneration of the lumbar spine and, therefore, future low back problems (Fisk et al., 1984). Therefore, the correlation found in this study showed that hamstring tightness may be one of the original predisposing factors to low back problems resulting from SD (Fisk et al., 1984).

A study by Pope, Bevins, Wilder, and Frymoyer (1985) researched the correlation of a number of anthropometric and mobility factors with low back pain among 321 subjects. The anthropometric and mobility factors studied were height, weight, leg length inequality, lumbar flexion and extension strength and flexibility, straight leg raise, and lumbar lordosis. The authors divided the subjects into three groups: 1) those with no LBP, 2) moderate LBP, and 3) severe LBP. In relation to hamstring tightness, the "no pain" and "mild pain" groups were similar, but the differences between these groups and the "severe pain" group were of modest significance (p=0.04). The authors cautioned the
reader on the interpretation of this data, "because there is no way to determine if the observed differences were antecedent to low back symptoms or the result of low back disease" (p.647).

Mellin has studied the relationships between physical measurements of the hip and trunk and chronic LBP. In Mellin's first study (1986), he researched the correlations of nine physical measurements with the degree of chronic LBP and the progress after treatment. The physical measurements studied were lumbar forward flexion, lateral flexion, and rotation; hip extension, flexion, internal and external rotation; hamstring tightness, and trunk flexion and extension strength. The subjects were 151 men, 54-63 years old, who had chronic LBP that interfered with their daily activities. Hamstring muscle tightness was measured by the SLR. The weaknesses of this means of measurement were described above. The measurements were rounded off to increments of 5 degrees, and were tallied by a point system based on 85 degrees being the normal. The results of the study showed no significant correlation between hamstring tightness, as defined by the author, and pretreatment low back trouble or posttreatment progress. Thus, according to this study, hamstring shortness is irrelevant to both the pretreatment status and subsequent progress of the chronic LBP patient. However, there are several weaknesses to this study, the main ones being the method of measuring hamstring length. The wide variability of hamstring length has been reported by many researchers, so it seems inaccurate for Mellin to set the normal hamstring length at 85 degrees (Stokes and Abery,1980). Also, measuring only to every five degrees limits the statistical reliability of the measurements. Finally, the study only looked at men aged 54-63, while statistics have shown the highest incidence of LBP in men to be from the ages of 20 to 40 years (Phillips et al.,1992).

Mellin's second study (1988) looked at correlations of hip and lumbar mobility with the degree of back pain in 301 men and 175 women with chronic LBP, their mean age being approximately 45. In the men, hamstring tightness was shown to correlate with
the degree of LBP ($p<0.001$), but not in the women. Again, hamstring flexibility was measured by the SLR test, but it was measured to the nearest degree. This, along with the sample being more representative of the LBP population, made Mellin's second study more reliable than the first.

More recently, Hultman, Saraste, and Ohlsen (1992) studied the relationships between several characteristics, including hamstring flexibility, and LBP in one hundred and fifty 45-55 year old men. The subjects were divided into three groups: no pain, recurrent pain, and chronic pain. They found no significant differences between the group with healthy backs (mean hamstring length = 67.4 degrees) and those with recurrent (occasional) LBP (mean = 66.3 degrees). But the chronic LBP group showed significantly shorter hamstrings than the two other groups (mean = 57.6 degrees). These results are similar to the trends found by Pope et al. (1985), although more statistically significant. The results of Hultman et al. may be more reliable because they did not just rely on memory-based statements in gathering data about the subjects' LBP status, as Pope et al. did. Instead, they checked the subjects' statements by comparing them with their medical and insurance records.

There have also been some studies on the correlation of these two variables in adolescents. Mierau, Cassidy, and Yong-Hing (1989) examined the relationship between LBP and SLR in 267 children (ages 4-12) and 135 adolescents (ages 12-18). Twenty-three percent of the children and 33% of the adolescents studied had a history of LBP. There was a significant correlation "between a history of LBP and decreased SLR for the adolescent boys ($p<0.01$), but not for adolescent girls or the children of either gender" (p.527).

There are two general weaknesses in this study. First of all, interviewing the children and adolescents was the only method used to gather their LBP history. There are obvious difficulties in eliciting an accurate history of back pain from a child. Secondly, the SLR was the method of measuring hamstring length, and it was only measured to the
nearest five degrees. Also, as the authors admit, they "made no attempt to determine whether the limitation of straight leg raising in some subjects was due to nerve root irritation or to hamstring tightness" (p.528). These factors limit the implications of the study.

Kujala, Salminen, Taimela, Oksanen, and Jaakkola (1992) studied 138 male and female adolescent athletes and nonathletes. Factors associated with LBP were sought by means of a questionnaire and physical measurements of the subjects. Their results showed that only tightness of the hip flexor muscles was associated with LBP. Although their study was well conducted and controlled, it is unlikely that it was representative of the adolescent population because 100 of the 138 subjects were regular competitive athletes. Adolescent athletes have been reported to have a number of thoracolumbar spinal abnormalities and symptoms due to the stress that many sports place on the vulnerable immature spine during adolescence (Comstock, C. P., Carragee, E. J., O'Sullivan, G. S., 1994). Therefore, LBP in adolescent athletes may be due to several other factors.

Sward, Ericksson, and Peterson (1990) studied the correlation of several anthropometric and mobility variables with back pain in 116 top Swedish male athletes aged 16 to 25 years. They found no significant correlation between SLR values and back pain, the only variable that significantly correlated with back pain was the sacral angle. There are obvious limitations of applying these results to the general population, because they only examined highly competitive athletes. For example, the gymnasts had the highest occurrence of severe back pain, and they also had by far the highest SLR values due to the flexibility demands of their sport. This, therefore, influenced the mean SLR value of those with severe back pain, making it remarkably higher than the other groups. Yet, this study showed that severe LBP can exist without tight hamstrings.

Finally, Fairbank, Pynsent, Poortvliet, and Phillips (1984) examined the influence of anthropometry and joint laxity on the incidence of back pain in adolescents. One
hundred and fifteen of the 446 pupils tested had a history of back pain, and 49% of those whose site of pain was identified had pain in the low back area. The lower limb mobility measurements that they tested were hip joint rotation and knee joint rotation. From their results, they concluded that "lower but not upper limb joint mobility is significantly decreased in pupils with a history of back pain" (p.463). Although hamstring mobility was not specifically measured, the conclusions of this study may be significant for all the muscles acting on the hip joint.

Conceptual Framework

Several of the studies reviewed earlier discussed a theoretical basis for the relationship between hamstring shortness and LBP. Hultman, Saraste, and Ohlsen (1992) state that "from a biomechanical point of view, it has been emphasized that short hamstring muscles have a negative effect on the loading of the lumbar spine" (p.251). Also, Fairbank et al. (1984) stated that their results were "consistent with a concept of reduced suppleness in the lower limbs putting an increased strain on the spine during activity" (p.463). Mellin applied this concept to physical therapy: "as it is probable that reduced mobility in the hips causes increased load on the spine, it should, from a therapeutical point of view, be worth paying attention to mobilization of hip restrictions in low back pain patients" (p.670).

Also, Fisk, Baigent, and Hill (1984) observed that tight hamstrings correlated with relative hypermobility of the lumbar spine. This, they theorized, would increase the load on the lumbar spinal joints and lead to an "increased likelihood of later low back problems". Somhegyi and Ratko (1993) tested this theory by comparing 120 patients with Scheuermann's Disease and 120 healthy controls. They found significant increases in both hamstring tightness and lumbar flexion range of motion in the subjects with SD. Thus, their data supports Fisk's theory that hamstring tightness leads to a compensatory
hypermobility of the low back, which, in turn, predisposes people to developing low back problems. However, the answer to the question of which comes first is still not clear.

Research by Biering-Sorensen (1984) may begin to answer this question. He studied 478 women and 442 men and found that hamstring shortness, as measured by the passive knee extension test, was a significant risk factor for the recurrence of LBP in the women, and the same trend, although not statistically significant, was found in the men. The results of this study are opposite to the results of Mellin (1988), in which hamstring tightness was found to correlate with LBP in the men, but not in the women. The study was conducted by measuring the hamstrings and the occurrence of LBP, then, one year later, surveying the participants concerning their low back history during the past year. He found that those women with shorter hamstrings were more at risk to have LBP in the following year (p<0.03). Although the same trend was found in the male subjects, it was not statistically significant. The strength of this study lies in the large number of subjects and the high validity of the method used to measure hamstring length. The author found the passive knee extension (PKE) test to be a more reproducible and valid measure of hamstring length than the SLR test. These findings agree with the results of Gadjodsik's study (1993).

There are two general explanations for the findings of Biering-Sorensen as proposed by the literature. The short hamstrings may have occurred first, leading to increased risk for LBP (Fisk, Baigent, and Hill, 1984; Fairbank et al., 1984). On the other hand, the inactivity and/or impairment due to the LBP may have led to shorter hamstrings, which in turn led to an increased risk for LBP, and the cycle would continue (Biering-Sorensen, 1984). Or, it may have been a combination of both of these.

The theories proposed by the above literature are consistent with the well-recognized theories of Kendall and Cyriax. Kendall (1993) asserts that "shortness of hamstrings does not cause a posterior pelvic tilt, but a posterior pelvic tilt and a flattening of the lumbar spine often are seen in subjects who have hamstring shortness" (p.210).
Kendall identifies two types of LBP patients where this biomechanical chain occurs: those with a sway-back posture and those with a flat-back posture. This biomechanical chain may result in LBP by causing increased stress on the lumbar spine. Therefore, according to Kendall, hamstring shortness is one factor, among others, that may lead to LBP.

Kendall also states that a flattening of the lumbar spine is often found in patients with hamstring shortness. And, according to Cyriax (1982), the normal spinal curves, lumbar lordosis included, act as "shock absorbers" (p.223). He says that sudden vertical stress is absorbed by the spinal curves when the stress is "in part converted into movement increasing the curves" (p.223). However, when there is a flat lumbar spine, the spine has no such protection. And, as a result, these individuals "are more apt to suffer from backache than those with a normal degree of lordosis" (p.223). Therefore, hamstring length may be a factor in the amount of stress the lumbar spine undergoes and, as a result, in how liable the patient is to incur LBP.

There are some research studies that have examined the relationship between hamstring length and lumbar spine curvature. Flint (1963) was one of the first to investigate how short hamstrings affect lumbar posture. Thirty-one female college students age 19 to 22 underwent X-rays to determine their lumbar curves in standing and in a forward trunk flexion test to measure hip-trunk flexion. The results showed no significant relationship between the degrees of lumbar lordosis and hip-trunk flexion. This was by no means a representative sample of the population, since only healthy young women were used as subjects. Also, a very general forward trunk flexion procedure was used to measure both hip and trunk flexibility. And, as discussed before, hypermobility of the trunk often compensates for short hamstrings. Although this test may have been functionally accurate, it was reliable in reflecting hamstring length only if the examiners were consistently accurate in assessing the end-range of the hamstring length and when lumbar spine flexion began. However, Flint did not discuss if hamstring
length was differentiated from lumbar spine flexion during the forward trunk bending test. As a result, the conclusions of this study are very limited.

Stokes and Abery (1980) examined the influence of the hamstring muscles on the curvature of the lumbar spine in different sitting positions. The forward trunk flexion test mentioned above was used to measure hamstring tightness in 38 subjects. The lumbar lordosis was measured in three different positions: standing, sitting with the feet flat on the floor and the knees flexed to 90 degrees, and sitting with the feet on a footrest and the knees flexed to 45 degrees. The results showed that straightening the knees by placing them on the footrest produces a flattening of the lumbar spine "to an extent dependent upon hamstring tightness", even with the knees extended to only 45 degrees (p.527). In other words, tighter hamstrings resulted in a greater loss of the lumbar lordosis in sitting when the knees are straightened from 90 to 45 degrees of flexion. Therefore, tight hamstrings may increase the loading stress on the spine when sitting with the feet elevated. This, in turn, would predispose to low back trouble if one spends a significant amount of time sitting in this position.

Though the results of this study are very important, there are limitations to the reliability of the research. As discussed above, the forward trunk flexion test is not an adequate measure of hamstring length due to the contributions of the trunk, although it does to some extent reflect hamstring tightness. Also, the subjects were instructed to relax and sit comfortably when assuming the sitting and standing postures, and their backs were unsupported by any backrest in sitting. As a result, they could adopt a variety of postures. Despite this lack of control, trying to simulate the normal postures of the subjects by relaxing is also a strength of the study. Also, "the study was limited by not investigating the changes in posture over time" (Stokes and Abery, 1980,p.527). Therefore, the implications of this study are limited in nature.

Gajdosik, Albert, and Mitman (1994) studied the influence of hamstring length, as measured by the SLR test, on the static postures and dynamic range of motion of the
pelvic and spinal angles. Thirty healthy men age 19 to 38 underwent testing of these different angles in standing. The results showed that hamstring length was not significantly related to the pelvic angle or the lumbar lordosis angle in static standing. Thus, the results support Kendall's assertion that hamstring tightness does not cause a flattening of the lumbar spine. However, they conflict with Kendall's statement that "a posterior pelvic tilt and a flattening of the lumbar spine often are seen in patients who have hamstring shortness" (p.210). The results did indicate, however, that hamstring tightness was associated concomitantly with decreased flexion range of motion of the pelvis and increased flexion range of motion of the lumbar spine. Although the subjects were healthy and thus not representative of the LBP population, the study was very well conducted and controlled. And it adds another dimension to the theoretical basis by showing that hamstring tightness may place stress on the lumbar spine during movements by reducing the amount of motion available in the pelvis, and therefore increasing the compensatory motion needed in the lumbar spine.

Gajdosik, Hatcher, and Whitsell (1992) did the same study as above with only twenty subjects, ten without short hamstrings and ten with hamstring shortness, as measured by the SLR test. They also found that hamstring tightness did not influence the pelvic inclination or the lumbar curve in static standing. And, although short hamstrings was significantly correlated with decreased flexion range of motion of the pelvis, it was not correlated with decreased flexion range of motion of the lumbar spine. The small number of subjects was a major limitation of the study and may explain the difference with the above study. However, it also adds a significant dimension to the theoretical basis. Gajdosik et al. concluded that their "results suggest that people with short hamstrings could be more susceptible to low back injury than people without short hamstrings" (p.41). The theory they propose is that the limitation of pelvic flexion would increase the lengthening stress on the lumbar spinal tissues when there is further effort to bend forward beyond the maximal pelvic flexion range. Therefore, people with short
hamstrings who participate in a lot of forward bending may be highly predisposed to low back injury.

Validity of Hamstring Length Measurement Techniques

According to the literature, there were three basic techniques to measure hamstring length: the active knee extension (AKE), the passive knee extension (PKE), and the Straight Leg Raise (SLR) tests. A weakness of the SLR technique is that it could be limited not only by hamstring muscle tightness, but also by nerve root irritation (Mierau, Cassidy, and Yong-Hing, 1989). Also, excessive tilting of the pelvis, as well as the influence of the foot position, could have caused the SLR to appear to be longer or shorter than it actually was (Kendall, 1993, Bohannon et al., 1982, Gajdosik et al., 1985). There have been several limitations to the AKE test. These limitations include: 1) subjects unable to fully extend the knee while maintaining the hip at 90 degrees of flexion, and 2) subjects have difficulty in keeping the knee extended at the end-range of hip flexion due to muscle weakness (Cameron & Bohannon, 1993).

The PKE method of hamstring measurement was shown to be an accurate measurement of maximal length and extensibility of the hamstring muscles (Gajdosik, et. al., 1993). The PKE test has been shown to be a more reproducible and valid measure of hamstring length than the SLR test (Biering-Sorensen, 1984). Gajdosik et al. (1993), suggests that the PKE test and the active knee extension (AKE) test represented significantly different hamstring lengths. This difference was explained in that the AKE test represented a measurement of an initial length due to possible weakness of the quadriceps muscles, whereas the PKE test represented measurements of a more maximal length of the hamstring muscles due to the passive stretch being imposed by an outside source (Gajodsik et al., 1993). Comparatively, the SLR test and the knee extension tests demonstrated a significantly poor correlation (Gajodsik et al., 1993). Gadjodsik et al.,
indicated that the AKE test showed the lowest correlation with the PKE and the passive SLR tests supporting the notion that the AKE test represented a hamstring length that differed significantly from the passive tests (Gajdosik et al., 1993). Worrell et al. (1991) reported that the PKE test was reported to have an intratester Pearson reliability coefficient of 0.98.

Gajdosik et al. (1991), suggested that subjects should be correctly positioned with the pelvis and thigh stabilized to obtain accurate and reliable measurements of the knee angles and hamstring muscle length measurements. Kane and Bernasconi (1992), demonstrated a progressive decrease in the amount of pelvic motion as the contralateral hip was flexed to 45°, 120°, or maximal flexion. A modified AKE test with the contralateral hip flexed maximally demonstrated the least amount of pelvic motion (5.5°) (Kane & Bernasconi, 1992). A hip flexion angle of 45° demonstrated a pelvic motion reduction of 8.9° (Kane & Bernasconi, 1992).

Summary and Implications for the Study

In light of the research cited above, there seems to be a trend in the literature toward a correlation of hamstring tightness and LBP. However, the picture is still unclear. Several of the studies that have shown a positive correlation in one population, have shown no significant correlation in other populations. Also, none of the studies have definitively answered the question of which variable is the cause and which variable is the effect.

Also, there are several theories in the literature that explain how hamstring shortness may predispose an individual to LBP. It may be one factor that influences the loading stress on the lumbar spine by producing a flattening of the lumbar lordosis curve in certain sitting positions, which always increases the stress on the low back. Also, it may place the low back under greater stress during forward bending of the trunk by
limiting the range of the pelvis and increasing the compensatory motion needed in the lumbar spine.

Finally, the literature reveals that the PKE test is a valid and reliable method of measuring hamstring length. Modifications of this method, such as stabilizing the pelvis and contralateral thigh, further strengthen its reliability.

Hypothesis

The hypothesis of this study is that there will be a significant correlation between decreased hamstring length and chronic LBP in subjects who are non-manual laborers aged 20-60 years.
CHAPTER 3
METHODOLOGY

Design of the Study

This chapter discusses the procedures used in conducting this correlational design study on the relationship between hamstring length and chronic low back pain (LBP) in non-manual laborers. The purpose of this study was to determine if there is a direct correlation between short hamstring length and chronic LBP among males and females aged 20-60 years who are non-manual laborers. The methodology employed for this research study was a non-causal correlational method. The advantage in the usage of this method is that it quantitatively describes the strength and the direction of a relationship between two variables (Portney & Watkins, 1993).

Subjects

Voluntary subjects were solicited from clinical rehabilitation sites owned and operated by NovaCare in Grand Rapids, Michigan and from the students and faculty at Grand Valley State University in Allendale, Michigan. A letter (Appendix E) was sent to the clinical site managers of the NovaCare sites informing them of the study and requesting permission to solicit their patients and use their facilities to perform testing. Patients were thus solicited through the help of their therapist. Additional solicitation for volunteers was conducted at Grand Valley State University by means of posting fliers and posters around the campus. The target population of interest had the inclusion criteria of being males and females aged 20-60 years who were non-manual laborers. Exclusion criteria included any lumbar spine surgeries within the last six months from testing date. The method of sampling used was the purposive sampling of the nonprobability type. Nonprobability samples are used when samples are chosen non-randomly (Portney 

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Purposive sampling allows the researcher to pick subjects on the basis of specific criteria (Portney & Watkins, 1993).

Subjects were assigned into either the no LBP group or the chronic LBP group based on responses to a questionnaire (Appendix A). The questionnaire was comprised of ten closed-ended questions which were divided into three categories: six relating to LBP, three to activity level, and one on therapeutic interventions. The questions were designed to categorize subjects into the chronic LBP group, the no LBP group, or exclusion from the study. The appropriate answers marked with an "X" on the questionnaire determined the correct group placement of the subject (see example in Appendix B). The volunteer must have marked all the appropriate answers to be classified as having chronic LBP. For questions involving more than one choice, the subject must have marked one or more of the appropriate answers (see example in Appendix B). In order for the volunteers to be placed in the chronic LBP group, the characteristics of their LBP must have included a previous episode within the last two years that lasted longer than two weeks. This LBP must have been either constant or recurring. In order for the subjects to be considered non-manual laborers, their level of physical exertion at their work must have been low to moderate. But, if they did not consider their level of physical exertion to be low to moderate, then their percentage of time spent sitting at work must have been in the range of 50-100%.

Equipment

A universal goniometer was employed to position the tested hip at 90 degrees and the contralateral hip at 45 degrees. Also, a universal goniometer was used to measure the angle of the knee for hamstring length measurements while the hip was maintained at 90 degrees of flexion. The universal goniometer has been shown to have an excellent intrarater reliability (ICC=.74 - .99) when stabilization of the instrument is employed and when bony landmarks are well defined (Boone, Azen, Lin, Spence, Baron, & Lee, 1978;
Rothstein, Miller, & Roettger, 1983; Elveru, Rothstein, & Lamb, 1988; Gajdosik & Bohanon, 1987). All goniometric measurements were conducted by one tester for the purposes of our study. It is well documented that goniometric measurements have a higher intrarater reliability (ICC=.74 - .99) compared to a lower interrater reliability (ICC=.50 - .88) (Gajdosik & Bohannon, 1987; Boone et al., 1978; Rothstein et al., 1983; Elveru et al., 1988; Hellebrandt, Duvall, & Moore, 194?).

A contact bar (Figure 1) was designed and fabricated for this study to serve as a tactile reminder to help maintain the hip position at 90 degrees of flexion. The concept in the fabrication of the contact bar was to have an adjustable bar that extended horizontally across the patient that would serve the purpose of providing a tactile reminder to keep the thigh of the tested leg in contact with the bar. The contact bar was fabricated from wood and hardware with emphasis placed on maintaining all angles to 90 degrees.

Figure 1. Testing Apparatus - the contact bar
Procedure

After completing the research subject profile form each qualifying volunteer received a phone call from one of the researchers to schedule a time for testing. Researchers met with volunteers on their scheduled date and one researcher read verbatim to each volunteer the consent form (Appendix D). The researcher asked if the volunteer had any questions, and then answered them appropriately. The volunteer was then asked to review and sign the consent form before participating in the study. The subject was asked to change into the appropriate attire, shorts or sweat pants, if needed. A detailed explanation was given of the testing procedures, including specific commands that were going to be used.

The volunteer was asked to lie on his or her back over the base of the contact bar which had been placed on a treatment table. The pelvis of the volunteer was secured to the treatment table by attaching a belt to the treatment table and across his or her anterior superior iliac spines. The non-tested hip of the volunteer was flexed actively to 45 degrees using a universal goniometer for measurement. For this procedure the stationary arm of the goniometer was placed parallel to the mid-axillary line of the thorax and the movable arm was placed parallel to the lateral midline of the femur. The axis of the goniometer was aligned with the greater trochanter of the femur. Subjects were instructed to maintain this hip position. The hip of the tested leg was then flexed passively to 90 degrees using a universal goniometer, as described above, with the knee maintained in a flexed position. The contact bar was positioned to touch the anterior thigh of the subjects to help the subjects and the researcher to maintain 90 degrees of hip flexion during the testing procedure. The volunteer was instructed to relax while one researcher maintained the position of the flexed thigh and then passively extended his or her knee to maximal muscular resistance as felt by the researcher and to a level that was within the subject's pain tolerance. The second researcher then used a universal goniometer to measure the degrees of knee flexion by placing the axis of the goniometer
at the center of the joint, the stationary arm was placed along the midline of the femur, and the movable arm along the midline of the fibula. Measurements were repeated three times on each lower extremity with intervals of rest lasting approximately 3 minutes, during which time the opposite extremity was measured. Please refer to figure 2 below for a pictorial view of subject set up and testing procedure.

Figure 2. Test set up and goniometric measurement of a subject.
CHAPTER 4
DATA ANALYSIS

The total sample size (n) used in this study was computed by using a power analysis, with \( \alpha = .05 \). Based on this analysis, the total sample size was determined to be 35 subjects, approximately 17 subjects in each group (Portney & Watkins, 1993). The effect size (d), an estimate of the effect of the independent variable, was estimated to be .80 based on previous research that has examined the same variables (Portney & Watkins, 1993). For the purposes of this study the researchers were interested in a strong relationship between variables, leading to a choice of power or sensitivity of a true difference between variables equal to .95 (Portney & Watkins, 1993). This study was one tailed and had the risk of a Type I error (Portney and Watkins, 1993).

A total of thirty-nine subjects participated in the study. Twenty-One subjects were placed in the chronic LBP group based on their responses to the questionnaire. Eighteen subjects were placed in the no LBP group in the same manner. The mean age of all the subjects who participated in the study was 27 years, with a range of 20 to 58 years of age. Twenty-five subjects (64%) were females and fourteen were males (36%) . Of all the subjects who participated, 77% were students at Grand Valley State University. The data was tabulated by calculating the average of the three measurements of each lower extremity. The average of the right and left lower extremity was recorded and were analyzed for statistical significance. The mean group average of left and right hamstring lengths, measured in degrees of knee range of motion, were 14.83 degrees short of full knee extension for the chronic LBP group (figure 1) and 16.28 degrees short of full knee extension for the no LBP group (figure 2). None of the subjects reported LBP after the testing procedure.
Figure 3. Distribution of average ROM in degrees short of full knee extension of right and left knees for subjects in the chronic LBP group.

Figure 4. Distribution of average ROM in degrees short of full knee extension of right and left knees for subjects in the no-LBP group.
The method of data analysis was the multiple linear regression statistical procedure. Multiple linear regression was the appropriate statistical method to analyze our data because it is used clinically to establish criteria for groups by showing strong or weak correlations between variables (Portney & Watkins, 1993). The ANOVA table from the regression analysis (table 1) was used to describe the relationship between hamstring length and chronic LBP. Using a degree of freedom (df) of one (1), the table shows a p value of 0.6574, demonstrating a lack of correlation between hamstring length and chronic LBP.

Table 1. ANOVA Table from Regressional Analysis

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F Value</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>0.05209</td>
<td>1</td>
<td>0.05209</td>
<td>0.199</td>
<td>0.6574</td>
</tr>
<tr>
<td>Within</td>
<td>9.64022</td>
<td>37</td>
<td>0.26055</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The null hypothesis \((H_0)\) stated that there is no positive correlation between chronic LBP and decreased hamstring length \((H_0: R^2 = 0)\). The alternative hypothesis \((H_a)\) stated that there would be a positive correlation between chronic LBP and decreased hamstring length \((H_a: R^2 > 0)\).

The study failed to reject the null hypothesis \((F_{(1,37)} = 0.199, p = 0.6574)\) meaning that no significant relationship was found between low back pain and hamstring length. Using the coefficient of determination \((R^2)\), only 0.54% of the variability in low back pain can be explained by the average range of motion of hamstring length. Basically, this means that the two variables are separate and have nothing in common or any practical significance with each other.

Intraexaminer reliability was examined by using the intraclass correlation coefficient. The intraclass correlation coefficient is an analysis of variance used to reflect
the degree of correspondence and agreement among ratings (Portney & Watkins, 1993). The model used for the intraclass correlation coefficient was

\[ ICC = \frac{BMS - WMS}{BMS + (k - 1) WMS} \]

where BMS is the between subjects mean square from the analysis of variance (.05209), WMS is the within groups mean square (.26055), and k is the number of rating for each subject. A significantly high intrarater reliability was attained (ICC = .9727) from using only one clinician for all ROM measurements.

In the course of conducting various analysis additional points of interest became evident. Of those who had LBP only 38% were participating in a regular leg stretching exercises compared to 50% in subjects without LBP. Figure 3 presents graphically the finding that males overall presented to have shorter hamstring lengths (17.20) than females (14.54). When the percentage of those who were participating in a regular leg stretching program within the groups and the different overall hamstring lengths between genders were factored into the data analysis as covariants, there was no significant change in the correlation.

Figure 5. Overall mean averages of right and left hamstring length in degrees short of full knee extension in males (17.20) and females (14.54).
CHAPTER 5
DISCUSSION AND IMPLICATIONS

Discussion

The hypothesis of this study that there would be a significant relationship between decreased hamstring muscle length and chronic LBP was not confirmed. Our results showed no difference in the mean hamstring length between subjects with or without LBP. Our findings agree with several other researchers such as Sweetman et al. (1974), who performed the largest study to date with 500 subjects, Mellin (1986), Kujala et al (1992), and Sward et al. (1990), who found no correlation between LBP and hamstring length. There are other researchers who have found a correlation between one group, but not other groups. Pope et al. (1985) found a relationship of modest significance between "severe" LBP and decreased hamstring length, but there was no correlation between the "mild" LBP and no-LBP groups and decreased hamstring length. In addition, Hultman et al. (1992) showed no correlation between the recurrent (occasional) LBP and no-LBP groups and decreased hamstring length, but did find a positive correlation between the more severe LBP group and decreased hamstring length.

There have been other studies that have shown a significant correlation between LBP and decreased hamstring length for one gender, but not the other. Mellin (1988) found a significant correlation among males, but not among females. Also, Mierau et al. (1989) found a significant correlation for adolescent boys, but not for adolescent girls or children of either gender.

Our results, along with the results of previous studies, seem to indicate that there may not be a significant relationship between hamstring tightness and chronic LBP in non-manual laborers. Although this lack of correlation may be contrary to popular clinical opinion, there may be several reasons for these findings.
First of all, hamstring length, if it influences LBP at all, is only one of many factors that may lead to or exacerbate LBP. For example, other studies have shown correlations between decreased hip internal and external rotation and LBP and hip flexor tightness and LBP (Fairbank et al., 1984; Kujala et al., 1992). Other factors that may theoretically be related to LBP include flexibility and functional mobility of the hip abductors, hip adductors, and back extensor muscles (Kendall, 1993). Also, muscular strength and endurance of the abdominal obliques, back extensors, and gluteal muscles may be factors influencing LBP. Therefore, hamstring muscle tightness may be only one of the many pieces that make up the complex puzzle of LBP.

Secondly, another aspect of this study that may have significantly influenced the results was that we limited our inclusion criteria to include only non-manual laborers, the majority of whom reported that they spent at least 50% of their occupational time sitting. It may be that hamstring length is a more important factor in LBP for manual laborers, especially those who perform a large amount of bending and lifting. As explained in chapter 2, two studies have shown a significant positive relationship between hamstring tightness and decreased pelvic range of motion during forward trunk flexion, but not pelvic inclination during static standing (Gajdosik, Albert, and Mitman, 1994; Gajdosik, Hatcher, and Whitsell, 1992). This suggests that those who have tight hamstrings and do a large amount of bending at the waist, especially during lifting, produce increased stress on their low back by requiring more motion in their lumbar spine to compensate for the decreased pelvic motion. On the other hand, those who do a large amount of static standing and sitting may not be impacted by tight hamstrings to the same extent.

Thirdly, hamstring tightness may be more a result of LBP, instead of an initiating factor of LBP. The research studies by Pope et al. and Hultman et al., as cited above, seem to suggest this. Both studies found no significant hamstring tightness in the "mild" or "occasional" LBP groups as compared to the groups with no LBP, yet there was significant tightness in the "severe" LBP groups. It may be that the mild or occasional
LBP led to hamstring tightness over time. If hamstring tightness was an original causative factor in the LBP, then it would seem that those with mild or occasional LBP would have notable hamstring tightness as compared to the group without LBP. This could also mean that hamstring tightness is more an "exacerbator" than an "initiator" of LBP. For example, the hamstring tightness which resulted from relative inactivity due to the mild, occasional LBP may have precipitated the more severe LBP.

There are certain aspects of our research that seem to support this theory. For example, the majority of our subjects in the LBP group were college students who were not significantly debilitated by their chronic LBP. Therefore, it could be said that they did not suffer from "severe" LBP, although it was recurrent. This study appears to support the research studies that found that there was no significant difference between those with no LBP and those with "mild" or "moderate" recurrent LBP.

It is important to note that a significant number of the LBP group subjects in our study (nine) reported that they were involved in regular lower extremity stretching exercises, which included the hamstrings. This may have influenced the results, leading to a lower mean hamstring length for the LBP group. But it also may indicate that the regular stretching decreased the hamstrings' "exacerbation" effect on their LBP, preventing it from becoming more severe and debilitating.

Implications

Hamstring stretching is often prescribed by Physical Therapists as a part of a home exercise program for those who have chronic LBP. However, the results of this study suggest that there may not be a positive correlation between hamstring length and chronic low back pain. Therefore, hamstring stretching may not benefit those who have chronic low back pain. As a result, therapists must not treat every LBP patient with a
standard protocol of treatment, while failing to thoroughly investigate their individual muscular, arthrokineatic, and biomechanical deficits.

Where hamstring stretching is indicated, we need to analyze what is the biomechanically optimal method of hamstring stretching for each LBP patient. If, as previous research has shown, forward trunk bending can increase the stress on the lumbar spine in those with shorter hamstrings by limiting the amount of anterior pelvic tilt, then perhaps the traditional long-sitting or standing methods of stretching the hamstrings is not optimal (Gajdosik, Albert, and Mitman, 1994; Gajdosik, Hatcher, and Whitsell, 1992). When the patient with short hamstrings is in the long-sitting position and forward flexes with the trunk, the compensatory motion required of the lumbar spine may actually exacerbate the low back problem. The same is true of forward trunk flexion in standing. Biomechanically better and more direct ways of stretching the hamstrings may include flexing from the lower extremities rather than from the trunk or maintaining a neutral spine position while performing a long-sitting hamstring stretch (Gajdosik, Albert, and Mitman, 1994).

Also, the question needs to be asked as to if the traditional static stretching of the hamstrings is the most effective way. Guissard et al (1988) found that reciprocal inhibition stretching leads to increased inhibition of the muscle being stretched as indicated by a greater decrease in the H-reflex when compared to static stretching. In addition, Vujnovich (1994) found that ballistic stretching, or several repetitions of quick stretches led to a greater decrease in the muscle H-reflex compared to static stretching. These studies may imply that there may be biomechanically better ways of stretching the hamstrings than the conventional static stretch.
Limitations

There are some limitations in applying the results of this study. First of all, the size of our sample was relatively small. The fact that only 39 subjects were tested, makes it difficult to draw definite conclusions from our data. Also, the fact that the majority of the subjects were full-time college students (77%) makes it difficult to apply the data to other populations besides those whose occupation requires merely a low to moderate level of physical exertion and spend a significant amount of their time sitting.

A second limitation of our study was that we grouped our subjects into the no-LBP or chronic LBP group based solely on their self-report in a written questionnaire. Although most of the subjects were very well educated college students, their recall of their LBP may have been deficient in certain aspects.

Also, our method of testing hamstring length may have certain limitations. We sought to maximize our testing validity by having the same researcher perform the passive knee extension test on all the subjects and the same researcher goniometrically measure the knee angle. However, we sought to test the maximal amount of hamstring length, while still being within the subjects pain tolerance. This method may have limitations due to the difference in subjective levels of stretch and pain tolerances between volunteers. Therefore, we could have stopped at the first sensation of hamstring muscle tension and then measured, thus avoiding possible differences in pain tolerance between volunteers.

Finally, the non-probability sampling method has certain limitations. Because we used volunteers instead of randomly selecting subjects, this sample was biased, causing it not to be a true representation of the normal population.
Suggestions for Further Research

Research is greatly needed in regards to the etiology and treatment of LBP, including the relationship between hamstring length and LBP. Specifically, there is a need to clarify this relationship in non-manual laborers as compared to manual laborers. Theoretically, it seems that short hamstring length may be more of a causative factor in LBP for those workers who are doing a significant amount of bending and lifting as compared to those who do a lot of static standing and/or sitting. Research is needed to further substantiate and clarify this theory so we know the importance of addressing tight hamstrings in treatment or for prophylactic reasons.

Also, it should be considered that there are certain limitations to retrospective studies such as this study, where the subjects' hamstring length is being measured after they already have chronic LBP. A significantly stronger research study would be a prospective study of the relationship between hamstring length and chronic LBP. For example, no-LBP volunteers could be tested periodically for hamstring length, while being monitored for any occurrence of LBP over several years. The data could then be analyzed to see if there is any correlation between hamstring tightness and the occurrence of acute and/or chronic LBP. Another important prospective study would be to research if regular hamstring stretching has any effect on the recurrence of LBP in subjects with chronic low back problems.

Another question that needs to be clarified by further research is the most effective and biomechanically safe method of stretching the hamstrings. Two methods have been proposed here based on the existing research, reciprocal-inhibition and ballistic stretch, but additional research comparing the different methods is needed to further attest these claims.

In addition, there needs to be research into how each of the different components of the hamstring complex affect the biomechanics of the pelvis and lumbar spine, and therefore how they may contribute to LBP. Clarification is also needed about the most
effective way to stretch the lateral and medial hamstrings. Anatomically, it seems evident that simply a sagittal plane stretch is not adequate in increasing the flexibility of all the components of the hamstrings. Specific techniques, such as rotating the foot, knee, and trunk, should be compared to determine their efficacy. No studies to date have investigated these questions.

Conclusion

Because of the high incidence of chronic LBP in the Western world and the increasing emphasis to deliver more effective treatment for back pain, it is important to investigate the relationship of good versus poor flexibility of different muscles on LBP. The results of this study indicate that there is no difference in the mean average hamstring muscle length between non-manual laborers age 20-60 with or without chronic LBP. Further research is needed to substantiate these findings and to help answer questions related to this possible relationship.
REFERENCES


Appendix A

Research Subject Profile

Subject Number:_______________
Age:_______

PLEASE CIRCLE OR CHECK THE APPROPRIATE ANSWERS.
1. Would you consider yourself as having a generally healthy back? Y/N

2. Any previous low back or leg injuries? Y/N
   If yes, please explain:

3. Have you had any low back pain in the last two years? Y/N
   If yes, when was your last episode of low back pain?

4. How long does the low back pain last?
   Minutes _____ One Hour _____ Several Hours _____ One Day _____
   Several Days _____ Several Weeks _____ One Month _____ Several Months _____
   Other ______________

5. Does your current low back pain fully diminish? Y/N

6. Does your current low back pain come and go? Y/N
   If so, how often?
   Never _____ Seldom _____ Occasionally _____ Often _____

7. How do you rate your physical activity level?
   Very active _____ Moderately active _____ Minimally active _____
   Not active _____

8. What is the general percentage you spend sitting while at work?
   75-100% _____ 50-74% _____ 25-49% _____ 1-24% _____

9. What level of physical exertion does your occupation require?
   Low _____ Medium _____ High _____

10. Do you participate in any regular leg stretching exercises? Y/N
    If yes, please explain:

FOR RESEARCHERS USE ONLY
Acute Recurring Low Back Pain? Y/N
Non-Manual Laborer? Y/N
Appendix B

Research Subject Profile

Subject Number: _______________
Age: ______

PLEASE CIRCLE OR CHECK THE APPROPRIATE ANSWERS.
1. Would you consider yourself as having a generally healthy back?  Y/N

2. Any previous low back or leg injuries? Y/N
   If yes, please explain:

3. Have you had any low back pain in the last two years? Y/N
   If yes, when was your last episode of low back pain?

4. How long does the low back pain last?
   Minutes _____ One Hour _____ Several Hours _____ One Day _____
   Several Days X Several Weeks X One Month X Several Months X
   Other________________

5. Does your current low back pain fully diminish? Y/N

6. Does your current low back pain come and go? Y/N
   If so, how often?
   Never _____ Seldom _____ Occasionally _____ Often _____

7. How do you rate your physical activity level?
   Very active _____ Moderately active _____ Minimally active _____
   Not active _____

8. What is the general percentage you spend sitting while at work?
   75-100% X 50-74% X 25-49% ____ 1-24%____

9. What level of physical exertion does your occupation require?
   Low X Medium _____ High _____

10. Do you participate in any regular leg stretching exercises? Y/N
    If yes, please explain:

FOR RESEARCHERS USE ONLY
Acute Recurring Low Back Pain? Y/N
Non-Manual Laborer? Y/N
Appendix C

DATA COLLECTION FORM

Subject number

**RIGHT LEG**

Trial 1 ______ degrees
  2 _____ deg.
  3 _____ deg.

**LEFT LEG**

Trial 1 ______ degrees
  2 _____ deg.
  3 _____ deg.
Appendix D

Consent Form

I understand that this is a study of how hamstring muscle length affects low back pain and that the knowledge attained for this study will be used to help physical therapists better treat the needs of low back pain patients.

I also understand that:

1. participation in this study will involve a confidential questionnaire concerning any low back pain symptoms and activity level.

2. participation in this study will involve three measurements of hamstring length for each leg.

3. the study will involve one 30 minute session for all data gathering.

4. it is not anticipated that this study will lead to physical or emotional risk to myself.

5. the information I provide will be kept strictly confidential and the data will be coded so that identification of individual participant will not be possible.

6. a summary of the results will be made available to me upon my request.

I acknowledge that:

"I have been given an opportunity to ask questions regarding this research study, and that these questions have been answered to my satisfaction."

"In giving my consent, I understand that my participation in this study is voluntary and that I may withdraw at any time without penalty.

"I hereby authorize the investigator to release the information obtained in this study to scientific literature. I understand that I will not be identified by name."

"I have been given Aaron Deline's and David Doublestein's phone numbers so that I may contact them at any time if I have questions or concerns."

"I acknowledge that I have read and understand the above information, and that I agree to participate in this study."

_________________________       _____________________________
Witness                                (Participant Signature)

_________________________       _____________________________
Date                                (Date)

I am interested in receiving a summary of the study results.
APPENDIX E

Letter to Data Collection Sites

David Doubblestein
Aaron Deline
4330 Curwood SE
Grand Rapids, MI 49508

Mr.

We are third year Grand Valley State University Physical Therapy students. Currently we are in the midst of formulating a research project in order to meet the graduating requirements and to better the field of physical therapy. The purpose of our study is to determine if there is a direct correlation between hamstring length and chronic LBP among males aged 20-40 years who are non-manual laborers. The plan is to look for a correlative, rather than a cause and effect relationship, between hamstring length and low back pain. Thus, the results of our study would apply to two areas of physical therapy: prevention and treatment. Low back pain (LBP) is one of the most widespread ailments afflicting the industrialized world. Studies have indicated that approximately 80% of the adult population will experience LBP at some time (Phillips et al., 1992). It has been demonstrated that LBP is most common in males aged 20-40 years. From the research there appears to be a relationship between hamstring muscle tightness and chronic LBP. The problem is that there is no conclusive evidence of the relationship between hamstring length and LBP in non-manual laborers. The hypothesis of this study is that the mean hamstring length will be significantly shorter among subjects who are non-manual laborers with a history of chronic LBP than among subjects without a history of chronic LBP.

We are in need of your services and clinical site. We would need volunteer referrals for this study. These volunteers would need to be male patients aged 20-40 years, who are non-manual laborers and suffer from chronic low back pain. Definitions are as follows.....

Non-manual laborers: Working individuals whose occupation requires a low level of physical exertion.

Chronic Low Back Pain: Low back pain that has occurred within the last year that is characterized by coming and going occasionally to often but never fully diminishes.
Appendix E cont.

If you have a patient that meets these requirements we would appreciate if you would submit to him, within the first couple of visits, the "Volunteer for Research" form included in this letter for your viewing. We will obtain the completed forms and schedule them for data collection.

The use of your clinical site for data collection is optimal for this study due to the treatment rooms, plinths, familiarity and locality for the patient.

If you are interested in helping us in this research project please fill out the attached form titled "Consent for Patient and Clinical Site Usage". We have also included the volunteer consent form, questionnaire, data collection form, and testing procedures of our thesis proposal. Any questions can be directed to Aaron Deline 361-0051, David Doubbleston 531-3590, or Arthur Schwarcz (Chair Member) 895-6611.

David Doubbleston, SPT

Aaron Deline, SPT
VOLUNTEER FOR RESEARCH

Grand Valley State University Physical Therapy students are required to conduct a research project to meet the requirement of a master of science degree. Currently we (Aaron Deline and David Doubblestein) are in the midst of formulating a research project in order to meet those graduating requirements and to better the field of physical therapy. The purpose of our research study is to determine if there is a direct correlation between hamstring length and chronic LBP among males aged 20-40 years who are non-manual laborers. The plan is to look for a correlative, rather than a cause and effect relationship, between hamstring length and low back pain. Thus, the results of our study would apply to two areas of physical therapy: prevention and treatment. It has been demonstrated that LBP is most common in males aged 20-40 years. From the research there appears to be a relationship between hamstring muscle tightness and chronic LBP. The problem is that there is no conclusive evidence of the relationship between hamstring length and LBP in non-manual laborers. We are in need of volunteers for our research project and we hope that you will be able to help us out. If you are interested in participating in this study please read and sign below. This will require only 30 to 45 minutes of your time.

I would be interested in helping further the research on low back pain by volunteering for data collection involving range of motion measurements. To schedule an appointment you can reach me at this phone number: __________

Patient Signature __________________________ Date __________

Therapist Signature __________________________ Date __________
Appendix E cont.

CONSENT FOR PATIENT AND CLINICAL SITE USAGE

I agree to help Aaron Deline and David Doubblestein who are current third year physical therapy students in ......

Please mark the appropriate response.

_______ Initially obtaining volunteers as stated in the letter.

_______ Giving permission to use this clinical site for data collection.