“Lumbar lordosis and low back pain in professional show jumping riders”

Professional assignment of Maaret Auvala and Swantje Klein

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Some people love to know all the parts involved in moving the body; some like to be aware of where it is they are experiencing a "feeling"; others just ride without ever needing (or wanting) to know.

Sue Morris
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Maaret Auvala & Swantje Klein
Abstract

**Background:**
The professional assignment ‘*Lumbar Lordosis and low back pain in show jumping riders*’ focuses in hamstring shortening and its effects in muscle imbalance and changes in pelvic tilt; its consequences as vertebral disc compression causes possible increased risk of disc herniation.

**Objectives:**
Our goal of the professional assignment is to determine the main factors of muscular dysbalance and their effects contributing to lumbar lordosis as ell as the influences in low back in professional show jumping riders.

**Methods:**
A *Pilot study*, Low Back Pain questionnaire designed for Professional Show jumping riders and literature research were used to conclude our findings.
A Randomized controlled clinical trial investigated the effect of a daily home training program for hamstring stretching in professional show jumping riders with unspecific low back pain. Seven male and three female participants were included.
Aberdeen Low Back Pain Questionnaire was used to asses the level of back pain. SPSS was used for statistical analysis.
*Low Back Pain Questionnaire* (Auvala M, Klein S) was distributed to 40 SJ riders to asses the percentage of riders affected with unspecific low back pain and if they are receiving physiotherapy treatment or manual therapy.
*Literature research* was used to compare our findings whereby 21 articles were reviewed out of which 6 were rejected due to low quality. Criteria list was used to asses the scientific level and external validity of the articles.

**Results:**
Out of 40 riders questioned 35 presented with Low Back Pain. During the pilot study hamstring stretch had a positive effect in reduction of Low back pain.

**Conclusion:**
The incidence of Low Back Pain amongst professional show jumping riders is high. It may be caused by muscular dysbalance and further randomized controlled trials are recommended.

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Chapter 1  Introduction

1.1 Definition of Low Back Pain

In the guidelines by KNGF, the term ‘Low Back Pain’ refers to ‘non-specific Low Back Pain’, which is defined as low back pain that does not have a specified physical cause, such as nerve root compression (the radicular syndrome), trauma, infection or the presence of a tumor. This is the case in about 90% of all low back pain patients as stated in the KNGF guidelines ‘Low Back Pain’. (1)

1.2 Show jumping

Jumping is undoubtedly the best known of the equestrian disciplines recognized by the FEI, the international governing body for all Olympic equestrian disciplines (2) where men and women compete as equals in both individual and team events. No less than 737 International Jumping events were organized in 2005. It is one of the three disciplines in competition at the Olympic Games, the other two being Dressage and Eventing.

A lot of progress has been achieved in show jumping and demands on the rider and the horse have remarkably increased since the 1895 World championships. The height and technicality of the tracks has increased, the riders are training harder and a lot less attention is paid to the rider’s welfare compared to the horse. One of the common complaints amongst riders is unspecific Low Back Pain. In this paper we are focusing for possible cause behind it; muscular dysbalance and its effect on Low Back Pain.
“The good rider must be able to lay claim to an education. Then he also feels the need to analyze his actions. He will try to deduce them from nature by scientific means, and form a system that can serve as a foundation for all his individual actions.”

Louis Seeger (1844)

It is known that due to muscular shortening tears to the hamstring group in show jumping riders are not uncommon. The current Individual World Champion 2006 at the World Games in Aachen, Jos Lansink was a victim to a hamstring tear last year and sidelined from action for months(3). He can no longer take the risk of this injury reoccurring and is maintaining a regular stretching program designed by his physiotherapist to eliminate the imbalance between hip extensors and flexors.
Jos Lansink withdraws from the competition in Lummen 20/05/2005

The Belgian quartet that crammed for the EC will be jumping one last time on home soil, during the national in Lummen. Federation coach Somers chose the same riders, but on other horses. The team for Lummen consists of Ludo Philippaerts (Chatman), Dirk Demeersman (Orlando vd Heffinck) and Jean-Claude Vangeenberghe (Osta Rugs Quintus). Jos Lansink, fourth man for the EK, is the big name in Lummen. Last weekend Jos jumped with Cumano in the national competition in Rotterdam. His sporting test was successful (4 + 0), the wound to his hamstring, dating back to the BC, is still a problem. The doctor ordered two week’s rest. Lansink has bet his shirt on the EC and has no intention of taking any more unnecessary risks. (7) Press cut 20/05/2005

A major problem with hamstring strains is the high incidence of reinjury. Muscle injuries can be classified as direct or indirect and are typically grouped into three categories according to severity. A number of potential risk factors have been proposed for hamstring strains. Only a few are evidence based and some are mainly based on theoretical assumptions. There is a lack of clinical research on the effectiveness of rehabilitation programmes for hamstring strains. Although the initial treatment of rest, ice, compression, and elevation is accepted for muscle strains, no consensus exists for their rehabilitation. Not much evidence based research has been carried out on prevention of hamstring strain. To our knowledge only two prospective studies have so far been published. As the injuries are common in football and other sports involving sprinting and jumping, there is a need for further research preferably in the form of randomized controlled trials.

1.3 Muscular dysbalance

Our professional assignment focuses on the effects of muscle dysbalance and its relation to unspecific Low Back Pain in Professional Show jumping riders. Articles in Low back pain in athletes are to be found in literature Bono, 2004 (4). Reid and Mc Nair discuss the effects of hamstring shortening and the relation to low back pain in rowers (5), but there is lack of research and scientific literature in the area of show jumping riders where they spend long training sessions in the saddle with their knee in ‘locked’ flexion position. Other literature and related injuries within equestrian activities can be found on medical databases (6, 7, and 8) but we found it a high importance to increase awareness and knowledge of the area in jumping riders. The physiotherapist treating professional show jumping riders needs to be aware of the specific problems as well as the demands of the sport.

To be able to answer our research question; “Influence and effect of muscular dysbalance on low back pain in show jumping riders” we found it of interest to carry out an experiment on low back pain in show jumping riders and to investigate whether there is an influence of a shortened hamstring muscle group. There are scientific studies in low back pain on cyclist and athletes in general (4), but need for research in show jumping riders at international level exists as they are subject to severe force alterations during the obstacle jumping and the effect in the differences of the forces of the horses gait to the lumbar spine.

Professional show jumping riders who fulfilled the inclusion criteria were recruited for the study. Each subject was evaluated at the beginning for baseline evaluation and at the end of the intervention. Patients were divided into two groups (A & B). The subjects of Group A (n=5) underwent a daily home training program of 3-week duration. The control group, Group B (n = 5) received a modified treatment. Aberdeen Low Back Pain Questionnaire was filled out by the subject at the beginning of the intervention and at the end of the intervention.
Patient outcomes were measured with the aid of Aberdeen Low Back Pain Questionnaire (ALBPQ) at trial entry and at the end of the trial (3 weeks).

Ruta et al all used a questionnaire to measure outcome in patients with low back pain. This can be used for initial evaluation of the patient and to monitor the effectiveness of any interventions. The authors are from the University of Aberdeen and the Aberdeen Royal Infirmary in Scotland. The Aberdeen instrument has been found to be the most powerful at discriminating between different groups of patients on variables relating to activity limitations, medication, and co morbidity compared to the discriminatory power and responsiveness of the Roland Disability Questionnaire (RDQ), and the EuroQol in patients with low back pain. (9)

An external questionnaire was carried out and distributed to professional show jumping riders to assess the number and frequency of nonspecific back pain occurring. They were also questioned on the location of the pain, the type of pain, the frequency and time of the day the pain occurred. Additionally they were asked if they did strengthening or stretching exercises and if they received physiotherapy or manual therapy and the outcome of the treatments.

### 1.4 The physiological differences between male and female riders

Women have a wide pelvis, wide set seat bones and hip sockets that face outward, and a tailbone set out behind the spine. A woman's legs tend to be knock-kneed, making it harder to relax the thighs so they hang down along the horse's side. The thighs often point outward at the knee and come forward and upward when riding. Because the tailbone is behind the lumbar vertebrae, women have a naturally hollow lower back. Young female riders especially, tend to tip forward on the pubic bone, ahead of the center of balance, creating an exaggerated hollow back. It requires proper instruction and effort to bring the seat bones under, tuck the tailbone, and achieve a flat lower back.

Men have a narrow, upright pelvis, nearly parallel seat bones, hip sockets that face forward, a tail bone that is more vertical, and a tendency toward bow-leggedness. This allows the legs of the male rider to conform to the horse's barrel. The upright pelvis results in a flatter back and a more naturally stable position. The male's near-parallel seat bones and near-vertical tailbone are perfectly suited for a deep seat. The seat bones are able to rock freely backward and forward in contrast to the muscular effort required for a female rider to do the same. The naturally tucked tail bone of the male rider allows him to sit down more effortlessly on a jogging or loping horse than a female rider who must constantly exert muscular energy to tuck the tail bone and flatten the lower back. (10)
Chapter 2 Background

The unspecific Low Back Pain continues to puzzle the experts and despite the enormous amount of literature available it is impossible to come to definitive diagnosis. (11) De Rosa and Portfield state that “…at present, identifying with any certainty the exact tissues involved in most low back pain is virtually impossible”. (12)

We are therefore not trying to come to definite statements but want to look closely into muscle imbalance and its influence on low back pain on show jumping riders.

2.1 The Importance of Muscular Strength

Much emphasis has been placed on muscular strengthening exercises to add stabilization and support to the trunk area. Several arguments can be made to justify this rationale for the treatment and prevention of low back pain. For instance, the degree of stability and support of the trunk area is largely dependent on the strength of the supporting structures, the muscles. Improper vertebral alignment can result from weak back extensor muscles which may lead to undue loading on the spine. Stronger muscles can enhance the spine's ability to withstand various degrees of external loads. The fact that patients with low back pain exhibit decreased levels of trunk extension, trunk flexion, and lateral flexion strength, when compared to non-suffering persons, suggests a need to alleviate this dissimilarity. In industry, workers with high levels of muscular strength are less prone to back injury. It should be emphasized that the greatest losses in strength have been found in the trunk extensor muscles. (13) In healthy normal persons, a natural imbalance is expected to exist with the lumbar extensors being stronger than the lumbar flexors. The trunk extensors in a healthy person are approximately 30% stronger than the trunk flexors. (14)

2.2 Pelvis and Low Back

The relationship of the pelvis to the line of reference is determined to the great extent by the relationship of the pelvis and hip joints. It is necessary to define the neutral position of the pelvis in the standard posture. The neutral position is described by Kendall as one in which the anterior superior spines are in the same horizontal plane, and the anterior superior spines and the symphises pubis are in the same vertical plane. In neutral position of the pelvis, there is a normal anterior curve in the low back; in anterior tilt, a lordosis; and in posterior tilt, a flat back. (11)
2.3 Muscular dysbalance

The human body functions as a whole. The main reason people experience these problems are because certain muscles are pulling their body out of proper alignment. Muscles are connected to bones in two places, the insertion and the origin. In order for movement to occur the muscles must contract or shorten, which pulls on one end or attachment.

Two things can cause a muscle to pull too much when it is not being asked to contract. The most common cause is poor posture or positioning. An example of this would be how the hip flexor muscles (the muscles in the top front of your thigh that bring your leg forward) shorten while sitting. The more time you spend sitting the more the hip flexor muscles will tighten due to poor positioning. What's worse is most of us spend a lot of time sitting! Whether it's while driving, while at work, at home watching television, or at home on the computer! This sets you up for a big problem!

The other cause is a corresponding weakness, or lack of use in the opposing muscle groups. For example, the hamstring and gluteus muscles don't get worked nearly as often as the hip flexors and quadriceps, unless of course one walked backwards. The pull of these muscles directly affects the positioning of the pelvis.

Think of a muscle imbalance as a tug of war. If one side is stronger it will over power the other muscle group. The tightening of the hip flexors pulls the front of the pelvis downward causing the lower back to arch excessively. Serious problem... This puts unnecessary pressure on the discs and also the muscles of the lower back! This is the number one cause of low back pain and injury!

Not only do muscle imbalances affect every joint of your body; they also affect your internal organs! For example, what do you think happens to the space between your internal organs when your low back muscles are pulling you to right? Your overall health is affected by muscle imbalances! (15)

2.4 Lumbar lordosis

Fahmi and Trueman have emphasized the common association of increased lumbar lordosis and low back pain (16). Kendall points out that the best index regard to painful low back is not the degree of lordosis or other mechanical defect visible in examination of alignment but the extent of muscle tightness that maintains a fixed anteroposterior alignment, and the extent of muscle weakness that allows the faulty position to occur and to persist. (11)

Cailliet in his ‘soft tissue pain and disability ‘ remarks that excessive lordosis, or abnormal lumbosacral angle, has been advocated as the major cause of postural pain, whether it is discogenic, facetal, or radicular. The sacral angle implies the concept of pelvic tilt, because the sacrum is firmly attached to the pelvis, which rotates around the hip joints. (24)
2.5 Weak abdominals leading to lumbar lordosis and LBP

Based on Kendall the trunk muscles consists of the back extensors (m. eractor trunci), lateral flexors, and anterior abdominals. All these muscles move the trunk in extension (bending backward), flexion (bending forward), lateral flexion (bending sideward), and rotation or tilt anteriorly or posteriorly. They also play a role in stabilizing the trunk.(11)

The term “weak back” is frequently used in connection with low back pain and is according to Kendall associated with a faulty alignment the body assumes, and is of caused by weakness of the abdominal muscles and not necessarily of the back muscles.

If the hip extensors (m. gluteus maximus and the hamstrings) are weak, an anterior tilt is the result, especially in combination with hip flexor shortness or abdominal weakness. With extreme weakness the only stable position of the hips is obtained by displacing the pelvis forward whereas the upper trunk is displaced backward (“sway-back posture”). Stretched hamstrings appear to be the reason for lordosis and hyperextended knees. With short hamstrings there will be a sway-back position or flat-back position. A position of hyperflexion of the lumbar spine may be more likely due to tight hamstrings than to weak back extensor muscles.

In the cross-sectional study of Kim et al. (17) it was hypo sized “…that imbalance of trunk muscles due to weakness of abdominal muscles, can increase the lordotic curvature of the lumbar spine, which can be an important factor of LBP”. They concluded that “An imbalance in trunk muscle strength can influence significantly lordotic curve of lumbar spine and might be one risk factor for potential low back pain”.

Lee et al. (18) did a 5-year prospective study to investigate “…trunk muscle weakness as a risk factor for low back pain in asymptomatic volunteers”. They concluded “…that the imbalance of trunk muscle strength, i.e., lower extensor muscle strength than flexor muscle strength, is one of the risk factors of LBP incidence.

In the study of Goldby et al. (19) “…the efficiency of musculoskeletal physiotherapy on chronic low back disorder” was investigated. The authors came to the conclusion that the spinal stabilization program is significantly more effective than manual therapy at reducing pain, disability, dysfunction, medication intake, and improving the quality of life. It is suggested that manual therapy is appropriate to be used on patients with low back pain, but should not be used as an isolated modality.
2.6 Anterior pelvic tilt

Kendall points out that when there is a good muscle balance, the pelvis is maintained in a good alignment. With imbalance, the pelvis tilts anteriorly or posteriorly. With anterior pelvic tilt, the low back arches forward into a position of lordosis.

He continues describing weakness of anterior abdominals allows the pelvis to tilt forward, because they are incapable of exerting the upward pull on the pelvis to maintain good alignment. This causes the low back to draw in a position of lordosis. If this happens to an individual he/she usually complains of low back pain. Tight low back muscles cause an anterior tilt of the pelvis, and cause the low back to draw in a position of lordosis .(11)

There is undue compression posteriorly on the vertebrae and articulating facets, and there is undue tension on the anterior longitudinal ligament in the lumbar area .(11)

2.7 Iliopsoas the ‘riders muscle’

The main contributor to anterior pelvic tilt is usually the psoas major. Dr. Vladimir Janda states that if the psoas major is tight, it can disrupt the muscle balance relationships of the entire postural chain. When the psoas is tight, it pulls the pelvis into anterior tilt, thereby increasing hip flexion and shortening all hip flexor muscles. Since the psoas has its origin on the lumbar spine vertebrae, when it shortens, it pulls the spine into extension. This causes the lumbar erectors and quadratus lumborum to shorten. The short/tight muscles will inhibit their antagonists. The gluteals, which contribute strongly to hip extension, will be inhibited by the psoas, causing the hamstrings to pick up the extra force. The deep abdominal wall will be inhibited by the lumbar erectors, and their synergist, the psoas major. Due to the neurological connection, other muscles in the deep stabilization mechanism may become dysfunctional. This may include the pelvic floor and lumbar multifidus.(20)

Through the years many doctors within chiropractic and medicine have stressed the importance of the iliopsoas in relation to low back pain and viscera of the human body.

Michele A wrote a 550 page textbook, Iliopsoas, in which he relates psoas spasm to pelvic tilt, exaggerated lumbar lordosis, compensatory dorsal kyphosis, back pain, sacroiliac dysfunction, degenerative hip arthrosis, degenerative disc disease, spondylolysis, spondylolisthesis, scoliosis, malposture, and meralgia paraesthetica, among others. He stated, "Any and all defects of the spine and the hip joint structures should be evaluated in terms of disturbance of function of the iliopsoas.”(21)

Are we missing a link with often overlooked muscle in m. Iliopsoas?.Iliopsoas shortening causes anterior pelvic tilt increasing lumbar lordosis and therefore main contributing factor to low back pain.
2.8 Thoracolumbar Fascia

The fascia thoracolumbalis is of special interest because it covers the autochthone muscles of the back. It consists of a lamina posterior (superficialis) and lamina anterior (profunda/deep).

According to Vleeming et al.: The superficial lamina is continuous with the m. latissimus dorsi, m. gluteus maximus, partly the m. obliquis externus abdominis, and partly the m. trapezius. Its fibers are oriented from cranio-lateral to caudo-medial. The m. latissimus dorsi is a significant part of the superficial lamina because most of the fibers derive from the apponeurosis of the latissimus dorsi and attach to the lig. supraspinale and proc. spinosi cranial to L4. Caudal to L4 it is attached to lig. supraspinale, spinous process, and crista sacralis mediana. (22)

The deep lamina is continuous with the fascia of m. gluteus med., m. erector spinae, m. obliquis internus, m. serratus posterior inferior, and partly m. transversus abdominis. There is also a connection to the m. biceps femoris which is attached to the sacrotuberous ligament. At lower lumbar and sacral levels the fiber are orientated from cranio-medial to caudo-lateral and at sacral level they are fused with fibers from the superficial lamina. Fibers of the deep lamina are continuous with lig. sacrotuberale. (22)

Both laminae are connected with each other lateral to the m. iliocostalis. The firmness (stability) of the fascia thoracolumbalis decreases from caudal to cranial – in the thoracic region it is very thin. (23)

Through the thoracolumbar fascia there exists a connection between the muscles of the back and muscles of the abdomen. This connection can influence the posture of a human and can avoid back pain if it is strong and stable. A strong abdominal musculature can compensate an increased lumbar lordosis. (23)

Because of its multiple connections the strong thoracolumbar fascia can be used for load transfer, and traction of these muscles can cause a displacement of the posterior layer. In experiments on human specimens Vleeming et al. investigated the role of the posterior layer of the thoracolumbar fascia in load transfer between spine, pelvis, legs, and arms. It has been determined whether muscles such as the gluteus maximus, latissimus dorsi, erector muscle, and biceps femoris are functionally coupled via the thoracolumbar fascia. To simulate tension they loaded the various muscles with traction on their tendons and measured by studying the displacement in the posterior layer. For the superficial lamina there occurred displacement for all muscles to the homolateral side with the caudal part of the m. latissimus dorsi showed the most displacement. Either m. gluteus maximus or caudal part of the m. latissimus dorsi also showed displacement to the contralateral side. For the deep lamina traction was applied to the tendon of m. biceps femoris into lateral direction and resulted in displacement of the deep lamina up to level of L5-S1 by load transfer which was conducted through the lig. sacrotuberale. When applying traction to the biceps tendon in medial direction also displacement occurred. (22)

Vleeming concluded that especially the m. gluteus maximus and the m. latissimus dorsi can conduct forces contralaterally via the posterior layer of the fascia thoracolumbalis and that further studies are required to reveal whether m. gluteus maximus and contralateral m. latissimus dorsi are functionally coupled and whether muscles like these need to be emphasized in training programs. They pointed out that because of this coupling via the fascia thoracolumbalis, caution is needed in categorizing structures as belonging exclusively to arms, spine, or legs.
2.9 Pelvic cross syndrome

Based on the theory by Jull and Janda :”Pelvic cross syndrome” where they hypothesized that there is a combination of weak, long muscles and short, strong muscles resulting in an imbalance pattern leading to low back pain. An imbalance in the ‘lower cross’ will lead to postural changes such as excavated lumbar lordosis, forward tilting of the pelvis and flexion in the hips.(20)

Janda’s views were based on the observation that in case of a pathology of the motor system, some muscles respond with hypertonia and shortening, while other ones consistently display weakening and hypotonia. In his view, this was due to difference between fiber types of which thee muscles are composed: muscles which are predominantly slow –twitch or so called tonic muscle fibers respond with a tone increase and shortening, while muscles composed mainly of fast- twitch or so called phasic muscle fibers respond with tone decrease and weakening.

Modern theories don’t any longer promote the importance of muscle fiber types but rather the motor behavior of muscles and motor units that participate in posture or movement. This outlook gives clear implications for the therapeutic possibilities to treat myogenic limitations of motor function.

Cailliet illustrates in his 5th edition of *Low back pain syndrome*, p, 34 how tight hamstrings restrict pelvic rotation and thereby cause excessive stretch of low back resulting in pain (24). Cailliet is also paying attention how inflexibility of hamstring muscles causes impairment in the trunk flexion. If the limited straight leg raising is considered exclusively muscular and fascial and not from nerve root tension, pain will be considered muscular and there will be no negative dural signs.

The above means that the pain will be unilateral and not significantly aggravated by ankle dorsiflexion and simultaneous nuchal flexion. Readers interested more in this matter may find the section of Neurological examination in his 5th edition *Low Back Pain Syndrome* of interest. (24)
2.10 Disc compression

The intervertebral discs are located between each of the vertebra that makes up the spinal column. These discs consist of a tough outer fibrous layer that surrounds a gel-like nucleus centre. Repeated over-use during prolonged sitting, bending, lifting, and sporting activities can lead to degeneration of the outer layer of the disc. If this degeneration is sufficient, the nucleus material is liable to prolapse out of the disc.

As the nucleus material leaks out of the disc, the onset of pain can be sudden and severe. If the direction of the prolapse is back and to the side, it may press on what is called a 'nerve root'. Most commonly, the nerve roots affected produce pain in the Sciatic nerve, resulting in Sciatica. This can produce pain in the buttock, the hamstrings, back of the knee, the calf or the heel.

Mr. Brooks states:” When the spine is hyper extended the lumbosacral angle becomes open and the axial pressure is distributed to the facet joint and sacroiliac joint in the posterior margin of the intervertebral disc. The center of gravity is posterior. This position tends to lessen the security of the rider and be associated with low back pain related to compression of the joints and posterior margin of the intervertebral disc”.(25)

Brooks continues to explain that: when the spine is slightly flexed, the lumbosacral angle is closed and the axial pressure is in the anterior portion of the intervertebral disc. This tends to aggravate any bulge of the intervertebral disc thereby associated with pain in the back which will then radiate into either lower extremity. The center of gravity in this position tends to be more anterior thereby giving the rider a greater sense of security. And finally: the muscles most important for horseback riding include the strong erector muscles which attach to the lamina and facet joints of the vertebra, the flexor group of muscles in the abdomen and the strong iliopsoas. It is the relationship of the flexor and extensor groups in association with the iliopsoas that determines the angle of the lumbar spine with the pelvis through its sacroiliac junction. In non-pathological conditions this angle determines whether a rider is more or less prone to low back pain. (25)
2.11 Anterior translated posture

Compression of the disc has been shown to be greater in anterior translated posture. Compressive loads on the anterior and posterior L5-S1 disc nearly doubled in the anterior translated posture. Anterior translation of the thorax resulted in significantly increased loads and stresses acting on the thoracolumbar spine. This posture is common in lumbar spinal disorders and could contribute to lumbar disc pathologies, progression of L5-S1 spondylolisthesis deformities, and poor outcomes after lumbar spine surgery. In conclusion, anterior trunk translation in the standing subject increases extensor muscle activity and loads and stresses acting on the intervertebral disc in the lower thoracic and lumbar regions.

Show jumping riders are a group of athletes that are strongly affected by anterior translated posture and the compression of the vertebral discs is greater. (25)

Tight hamstrings syndrome (THS) has been attributed to a number of disorders. Most authors argue that tight hamstring syndrome is determined in the majority of cases by a protruding or slipped vertebral disc. The term "disc related tight hamstring syndrome" is usually used to describe the condition. Tight hamstring syndrome and extra- or intraspinal diseases in childhood: a multicenter study.(29)

2.12 Adolescent Lumbar Disc Herniation and Hamstring Tightness

The incidence of hamstring tightness in adolescent lumbar disc herniation is high. The physical examination findings and prognoses of patients with hamstring tightness are different from those of simple disc herniation patients. The hamstring tightness appeared to have developed from a different mechanism.(28)

There is a need for larger, controlled studies to be carried out in adult population to assess a possible link between lumbar disc herniation and hamstring tightness.

2.13 Sacroiliac Joint

The sacroiliac joint is the ‘bete noire’ of low back pain, with enthusiastic proponents and equally vociferous opponents.(24)
To discuss this interesting pathology is unfortunately beyond the scope of this paper.
Chapter 3 Methods

3.1 Pilot study; Effects of Hamstring stretch on Low Back Pain

The purpose of this pilot study was to create a baseline study in order to investigate if a daily home training program in hamstring stretching has a short term effect on the unspecific low back pain in professional show jumping riders. With our significant findings we hope to set a baseline for further research and studies with a larger sample sizes to reach higher internal and external validity and in order to create more evidence based data in regards to our research question.

3.1.a Research Question

“What is the short term effect of a daily home training program for hamstring stretching in professional show jumping riders with unspecific low back pain versus the effect of no home training program?”

3.1.b Abstract

Background: Many professional show jumping riders suffer from low back pain. This is also seen in professional athletes for example cyclists, tennis player and others. The riding position of professional show jumping riders puts an increased load on the hamstring musculature which can cause increased tension. This is due to the constantly flexed position of the hip and knee. Literature states that tight or shortened hamstrings can cause lower back problems like pain or even pathologies. Physiotherapy methods for loosening the hamstrings are beyond others stretching of the musculature which can also have an influence on low back pain.

Objective: To investigate the effect of a daily home training program for hamstring stretching in professional show jumping riders with unspecific low back pain.

Design: A randomized controlled trial (single blinded)

Setting: The Hogeschool van Amsterdam and various testing locations

Subjects: 10 professional show jumping riders with unspecific low back pain

Intervention: Professional show jumping riders who fulfilled the inclusion criteria were recruited for the study. Each subject was evaluated at the beginning for baseline evaluation and at the end of the intervention. Patients were divided into two groups (A & B). The subjects of Group A (n=5) underwent a daily home training program of 3-week duration. The control group, Group B (n = 5) received a modified treatment.

Measures: Aberdeen Low Back Pain Questionnaire was filled out by the subject at the beginning of the intervention and at the end of the intervention.

Results: In the intervention group the low back pain was reduced significantly (p< 0,005) after three weeks of training whereas no changes could be recognized in the control group.

Conclusion: Hamstring stretching has a positive effect on the low back pain of professional horse jumping riders but it needs to be researched which kind of stretching is the most effective one.

Keywords: Tight hamstring syndrome, Muscle Imbalance, Hamstring shortening, Lumbar Lordosis, Low Back Pain, Disc herniation, Pelvic tilt, (Horse Back) Riding, Lumbrosacral angle

Abbreviations: Aberdeen Low Back Pain scale (ALBP), Hogeschool van Amsterdam (HvA),
3.1.c Introduction

Since the first championships in Show Jumping in 1895, the demands on the riders and the horses have increased immensely. A lot less attention is paid to the rider’s well-being in comparison to the horses. Low back pain is a common complaint among horseback riders regardless of their age, sex, or particular interest. It is frequently a problem amongst show jumping riders at the top level.

Reasons for low back pain have a large variety of origins: It is at times caused by herniated discs. Another common cause is the presence of muscle imbalance and specifically the shortening of the hamstring muscles causing excessive lumbar lordosis which leads to compression of the lumbar spine and the interspinal discs.(25)
This is the case in about 90% of all low back pain patients as stated in the KNGF guidelines ‘Low Back Pain’.(1)

There are some theories about muscular imbalance concerning the pelvis and lower back pain. Kendall points out that the pelvis remains in a natural position when the surrounding musculature is in balance. With muscular imbalance, the pelvis can tilt anteriorly or posteriorly.(11) With an anterior pelvic tilt, the low back arches forward into a position of lordosis and can cause low back pain. He also points out that the best index with regards to painful low back is not the degree of lordosis or other mechanical defect visible in examination of alignment but the extent of muscle tightness that maintains a fixed anteroposterior alignment, and the extent of muscle weakness that allows the faulty position to occur and to persist.(11)

Furthermore Cailliet illustrates in his study ‘low back pain syndrome’, how tight hamstrings restrict pelvic rotation and thereby cause excessive stretch of the low back resulting in pain.(24)
The article ‘Low Back Pain during horseback riding’ by Brooks states that the lumbosacral angle and the interspinous line are vital to balanced riding and the avoidance of low back pain.(25) In the normal erect position the lumbosacral angle is approximately 30 degrees. In this position the vertical forces are absorbed through the individual intervertebral disc, facet joint and supporting musculature. The back is relatively flattened with the centre of gravity in the mid-thoracic region over the vertebral body (T-9). Tightening and fatigue of the hamstring muscle can cause backward pelvic tilt and functional leg length shortening.(24)

Scientific studies on low back pain in cyclists and athletes in general exist (4) but there is a specific need for research in show jumping riders at international level. In riders, low back pain is mainly subject to severe force alterations during the obstacle jumping and the different horse gaits, forces which transfer to the lumbar spine.

The purpose of this pilot study is to create a baseline study in order to investigate whether a daily home training program in hamstring stretching has a short term effect on the unspecific low back pain in professional show jumping riders. Our findings throughout this pilot were significant.
3.1.d Methods

Ten show jumping riders were selected to participate in the study and were randomized into two groups. The study was set to be carried out during ‘normal’ training rather than competitive setting to exclude the confounding factors that are apparent in a competitive setting. The subjects were recruited by a letter which explained the purpose of the study, its procedures and methods as well as confidentiality aspects to the possible subjects. The subjects had to respond whether they would join the study or not.

Inclusion criteria were: professional show jumping riders (at least 6hrs/day 6 days a week riding/training horses), male/female, unspecific Low back pain and of all ages.

Exclusion criteria were positive Lasegue’s test ie.Straight Leg Raising Test (30), undergone surgery for herniated disc, undergoing a medical treatment for any kind of back/pelvic pain and/or receiving medication for Low Back Pain. (30)

An Informed Consent Form was distributed before the study and signed by the participants. This form waves any liability on the part of any group members or the HvA.

Randomization was done with neutral envelopes containing either a red (n = 5) or a green (n = 5) card. Each subject chose 1 envelope thereof, without knowing whether it would contain a red or a green card. The red cards stood for Group A (intervention group) and green cards for Group B (control group).

Group A received a daily home training program consisting of a static exercise for hamstring stretching as well as a relaxation exercise; detailed training information see appendix .(31,32)

In order to explain thoroughly the correct and exact execution of the exercises all subjects were invited to an introduction meeting was organized. In addition, the subjects received clear and simple instructions in writing including visualized and verbal explanation of the exercises. The home training program was executed for twenty-one days two times a day (morning and evening). Furthermore, the subjects received a personal diary in which the each training unit had to be reported (see appendix ).

Group B received a modified training which consisted of the relaxation exercise only (see appendix ).

The procedure was controlled by external expert and client Patrick Molenaers, PhD. A logbook was maintained by the researchers.

The Aberdeen Low Back Pain scale (ALBP, see appendix 4) was used to assess changes in pain levels .(33) This scale was invented by a research team from the University of Aberdeen and the Aberdeen Royal Infirmary in Scotland, U.K. It has been used extensively in clinical trials and shows strong evidence of validity and reliability.(9)

All subjects of both groups (A and B) completed the form at the beginning (baseline) and at the end of the trial.

In order to compare the outcome of the Aberdeen score both groups before and after the intervention, the repeated ANOVA test was used in order to determine the outcome (significance) of the scale (ratio). An alpha-value of 5 %, (p< 0,05), was seen as significant.
3.1.e Results

Randomization
The age levels in both groups were similar with an average of 31 years (range 21 to 48 years) in Group A and an average of 31 years (20 to 40 years) in Group B. Group A consisted of one female and 4 male subjects; Group B consisted of 2 female and 3 male subjects (see Table 1).

Table 1: characteristics of subjects

<table>
<thead>
<tr>
<th>Group</th>
<th>Male</th>
<th>Female</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>4</td>
<td>1</td>
<td>Mean 30.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(range 21 to 48)</td>
</tr>
<tr>
<td>Group B</td>
<td>3</td>
<td>2</td>
<td>Mean 31</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(range 20 to 40)</td>
</tr>
</tbody>
</table>

Logbook for home exercises
Three logbooks out of ten were returned. Two of the three were filled out correctly and one partly.

The ALBP score
Comparing the ALBP scores that were measured before and after the intervention, a significant difference (p<0.005) could be found in Group A. In comparison with Group B (intervention), Group A showed a considerable reduction of low back pain, whereas no significant change in Group B (control) (see also Table 2).

Table 2: ALBP score before and after intervention of the tested subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
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<td>14</td>
<td>7</td>
</tr>
<tr>
<td>A2</td>
<td>21</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>A3</td>
<td>28</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>A4</td>
<td>48</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>A5</td>
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<td>B6</td>
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</tr>
<tr>
<td>B10</td>
<td>40</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Graph 1: ALBP score before and after intervention of Group A and B in total
3.1.f Discussion

The purpose of this study was to find out whether hamstring stretching has an influence on low back pain in professional show jumping riders.

The results of this study imply that hamstring stretching can reduce low back pain. The total reduction of low back pain throughout Group A was as high as 40%. Despite the internationality of the subjects, our study has, due to the small sample size of subjects (n = 10) a low external validity. Nevertheless, due to the significantly positive result, this pilot study can be regarded as a baseline for further (empirical) studies in the field, including a larger sample size for a higher external validity.

The most considerable reduction in low back pain was evident with the oldest subject in Group A (see table 2). In depth investigation of the interrelation between age and low back pain in professional riders and other athletes, could build the base for another interesting research. Equal distribution of male and female through the randomization was not met but differences in outcome compared to age and sex were not the original goal of this study.

Due to the fact that we opted for a home exercise program, the internal validity is fairly low since the treatment intervention could not be controlled optimally. Neither the quality nor the quantity of the subject’s exercise execution could be controlled. In order to minimize the loss of control some measures were taken. Quality: exercises were chosen which were simple in execution and the procedure was described precisely in the beginning of the study (see methods). Quantity: All subjects were reminded of their exercises via short text messages, phone calls and/or visits. Additionally, with the help of a home diary, that the riders were asked to fill out on a daily basis, we tried to create an increased sense of responsibility of the subjects.

Unfortunately, seven out of ten diaries were not filled in or were lost. The low return of the diaries makes unclear to what extend the exercises were executed per day. This might be a reason for biased results. Due to the fact that professional show jumping riders underlie a high amount of travelling (frequent competitions in different countries throughout Europe), it was not possible to see the riders on a regular basis throughout this study. To follow the riders individually and keep track of their exercise program was beyond the possibilities of this project.

Literature about the “best” stretching exercise for hamstring muscles does not exist until now as described in the article “The effects of hamstring stretching on range of motion: a systematic literature review” by Decosta et al.(34) For this reason, we chose a stretching exercise in our study, that could be easily conducted and is commonly used (see appendix ) It remains unclear which set (amounts of repetition) of stretching exercises has the best outcome on the reduction of low back pain and is therefore additionally advised for further research.
3.1.g Conclusion

Hamstring stretching in professional show jumping riders has a positive effect on their low back pain. Due to the small number of study subjects it remains unclear whether the positive effect relates strictly to the hamstring stretches. Other influences, for example changed stress level; other psychological and/or physiological changes could have influenced the outcome of the study.
In order to receive a higher validation of the outcome, it would be useful to repeat the study with a larger amount of subjects, to be tested for a longer period of time as well as with an improved method for the control of quality and quantity of the exercises.

3.1.h Acknowledgments

The group would like to thank Jesse Aarden for continuous support and enthusiasm throughout the whole project and we want to thank Bas Moed for his great help with the statistics.

Our gratitude goes out to the external expert Mr. Molenaers who helped us with scientific advice since the beginning stages of this project. Of course we want to thank all the riders for participation as without them it would not have been possible to conduct this study.
3.2 Low Back Pain Questionnaire on Professional Show jumping riders

Due to lack of data in unspecific Low Back Pain in Show jumping riders a questionnaire was designed to assess the severity of the problem and athletes affected.

3.2.a Number of riders affected

A questionnaire was anonymously distributed to 40 professional jumping riders (32 male, 8 female) during national competitions in the Netherlands and Belgium. Out of 40 participants 35 reported with unspecific LBP.

Graph 3: Participants with Back Pain v. No pain

3.2.b Receiving physiotherapy treatment and its benefit

Out of 40 participants 31 received physiotherapy/manual therapy (Graph 4), out of which 25 replied as treatments having a positive contribution to their recovery. Five of the participants quoted to be carrying out a home stretching program, 4 participants carried out strengthening exercises and 2 of the participants replied running/jogging as an additional exercise. All of the affected participants replied to receive physiotherapy/manual therapy only when they have pain.

Graph 4: Total participants v ones receiving Physiotherapy / Manual therapy
Low Back Pain Questionnaire
Show jumping Riders

The purpose of this questionnaire is to provide additional information regarding the low back pain on show jumping riders and whether muscular imbalance is a contributing factor to unspecific low back pain.
The questionnaire is a part of the Thesis; *Lumbar Lordosis and Low back pain in show jumping riders* with the following research question:

“Influence and effect of muscular dysbalance on low back pain in show jumping riders”
Authors: Maaret Auvala and Swantje Klein

Final Year students for Bachelors degree in Physiotherapy, any comments or questions regarding the questionnaire to be forwarded to maaretauvala@msn.com or swantje_klein@hotmail.com

We are grateful for your time to fill in the following short questionnaire!

1) Female O Male O Height _______cm Weight _____kg.


3) Riding on a professional level

   1-5yrs O 5-10yrs. O 10-15yrs. O 15-25yrs O 25yrs + O

4) Do you have Low Back Pain?

   Yes O some pain O bad pain O Severe pain O
   No O

Other pain? Please describe:_____________________________________________________

5) Pain is ; Sharp& burning O Dull& aching O Deep & boring O

6) I receive medication for my pain Yes O No O

7) Pain occurs in the
Morning  O  Afternoon  O
Evening  O  At night  O

During flat work;  Trot  O  Canter  O  Jumping  O
During competition  O  Only with some horses  O

Competition stress increases my pain  Yes  O  No  O
Pain is worse after competition  Yes  O  No  O

8) Do you have pain in any of the following?
   Buttocks  O  Calf  O  Foot or ankle  O
   Thigh front of leg  O  Thigh back of leg  O
   Thigh inside  O  Thigh outside  O

9) Have you undergone a surgery for herniated disc?
   Yes  O  year of surgery  ______  No  O

11) Do you have loss of feeling in your legs?
   Yes  O  No  O  Sometimes  O

12) Low Back pain increases
   Walking  O
   Riding  O
   Driving car  O
   Sitting for long periods  O
   Standing for long periods  O
   Lying  O

13) I receive physiotherapy treatment for my pain
   Yes  O  No  O
   Weekly  O  Monthly  O  Only when I have pain  O
   Stretching  O  Manual therapy  O
   Electric current (TENS)  O  Massage  O
   Laser therapy  O  Ultrasound  O  Other  ____________

14) I maintain home exercise program
   Stretching  O  Strengthening  O
   Fitness  O  Other  ____________

15) Treatment has
   Reduced my back pain  O  I no longer have pain  O
   Worsened my back pain  O  I feel no difference  O

We Thank You for your participation!! Please fill in name & address if you are interested in the final paper (Jan 2007) Name: ____________________________
Address: ____________________________

27
3.3 Literature Research

3.3.a Databases
Searches were conducted using Cochrane library; Pubmed; PEDro (Physical therapy database); CEBP; AMED; Picarta and Google Scholar

3.3.b Keywords used
The following keywords were used; Tight hamstring syndrome; Hamstring shortening; Disc herniation; Iliopsoas tightening; Lumbar Lordosis; Low Back Pain; Disc compression; Disc herniation and Equestrian.

3.3.c Assessment of validity
In order to assess the quality of an article each article had to be judged for its quality. The CONSORT statement states that ‘to comprehend the results of an RCT, readers must understand its design, conduct, analysis and interpretation. That goal can be achieved only through transparency from authors’ (26). Unfortunately, not all published articles are transparent and it can be difficult to fully assess whether an article is of good quality or not. What is required is a list of pertinent criteria that can be used to interpret and judge research articles.

3.3.d Criteria List
Criteria list was used to assess the quality of the articles (see Appendix I). The Criteria List mirrors the structure required for scientific research articles:

- Abstract and title
- Introduction
- Methods
- Instruments
- Procedure
- Results
- Discussion/conclusion
- References
- General Information

In addition to providing tick boxes the Criteria List includes a grading system. The PEDro scale gives an equal point to each criterion that is ticked. For our grading system each criteria was given a maximum possible score (between one and three). This approach was designed to reflect that sometimes an incomplete answer is given rather than no answer. Each criterion was also labelled high, medium or low importance; however, this does not always mean to state the level of importance but the number of reasonable points that we want to apply. The maximum possible points an article could score is 47. To be labelled high quality an article must score over 70 percent (plus 33 points), between 40 to 70 percent (19 to 33 points) an article is labelled as medium quality and below 40 percent (below 19 points) of low quality. Any article that does not have external validity is labelled as low quality. Two articles were scored differently due to the fact that they were studies rather than clinical trials. The criteria randomisation and blindfolding were not applicable to these articles and we therefore gave them a maximum score of 42 and applied the same 70 percent grading.
Chapter 4 Results

4.1 EBP pilot study

Randomization
The age levels in both groups were similar with an average of 31 years (range 21 to 48 years) in Group A and an average of 31 years (20 to 40 years) in Group B. Group A consisted of one female and 4 male subjects; Group B consisted of 2 female and 3 male subjects (see also table 1).

Table 1: characteristics of subjects

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Three logbooks out of ten were returned. Two of the three were filled out correctly and one partly.

The ALBP score Comparing the ALBP scores that were measured before and after the intervention, a significant difference (p<0.005) could be found in Group A. In comparison with Group B (intervention), Group A showed a considerable reduction of low back pain, whereas no significant change in Group B (control) (see also Table 2).

Table 2: ALBP score before and after intervention of the tested subjects

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<tr>
<td>B10</td>
<td>40</td>
<td>10</td>
<td>10</td>
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</tbody>
</table>
4.2 Questionnaire

A questionnaire was anonymously distributed to 40 professional jumping riders (32 male, 8 Female) during national competitions in the Netherlands and Belgium. Out of 40 participants 35 reported with low back pain of variable degree. 31 of the participants received physiotherapy/manual therapy out of which 25 replied as treatments having a positive contribution to their recovery. 10 of the participants quoted to be carrying a home stretching program, 4 participants carried out strengthening exercises and 2 of the participants replied running/jogging as an additional exercise. All of the affected participants replied to receive physiotherapy/manual therapy only when they have pain.

4.3 Table of articles

4.3 a Analysis of data

Table 1: Scoring of articles:

<table>
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<th>Type</th>
<th>Ext. Validity</th>
<th>Score</th>
<th>Quality/Importance</th>
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<tr>
<td>2. Goldby et al. (2005)</td>
<td>RCT</td>
<td>YES</td>
<td>S.K 45/47 M.A 44/47</td>
<td>High</td>
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<tr>
<td>5. Vleeming et al. (1994)</td>
<td>Investigation</td>
<td>YES</td>
<td>S.K 37/39*a</td>
<td>High</td>
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<tr>
<td>7. van Wingerden et al. (1997)</td>
<td>Chapter</td>
<td>YES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Decoster et al. (2005)</td>
<td>Systematic review</td>
<td>YES</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Authors</td>
<td>Study Type</td>
<td>YES/NO</td>
<td>Rating</td>
</tr>
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<tr>
<td>12.</td>
<td>Liebenson et al. (1996)</td>
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<td></td>
</tr>
<tr>
<td>15.</td>
<td>Qingsan et al. (2006)</td>
<td>Retrospective Review</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Virgin (1951)</td>
<td>Experimental Investigation</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Dyrek et al. (1996)</td>
<td>Review</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Lee et al. (1998)</td>
<td>Prospective study</td>
<td>YES</td>
<td>33/39* High</td>
</tr>
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*a due to in vitro investigation, no randomization, blindfolding, no measurement/treating therapist
*b this study there was just one intervention-group, thus they were all in one group – no randomization, no blinding, no measurement/treating
*c no randomization, no blindfolding, no measurement/treating therapist
*d like *c
*e like *c

Detailed table of articles in Appendix I, articles Appendix II, criteria list in Appendix III
Chapter 5 Discussion

Many professional show jumping riders suffer from low back pain. This is also seen in professional athletes for example cyclists, tennis player and rowers. The riding position of professional show jumping riders puts an increased load on the hamstring musculature which can cause increased tension. This is due to the constantly flexed position of the hip and knee. Literature states that tight or shortened hamstrings can cause lower back problems like pain or even pathologies. Physiotherapy methods for loosening the hamstrings are beyond others stretching of the musculature which can also have an influence on low back pain.

There is still much that is unknown concerning Muscle Dysbalance and its effect on Low Back Pain. None of the reported studies compared the effects of lumbar lordosis and muscular dysbalance on professional show jumping riders.

In general our results showed that short term stretching of hamstring musculature had a positive effect in reduction of Low Back Pain compared to the control group.

In our experimental study the effect of short term hamstring stretch was assessed and it gave positive outcomes in our results but we were only looking at one muscle group. When a rider is sitting on a horse there are several muscles functioning. Do we need to look more closely m. iliopsoas or other musculature discussed within this paper.

Chapter 6 Conclusion

Unspecific Low Back Pain, acute or chronic remains ambiguous of nature despite numerous researches that have been carried out as well as all the current knowledge and literature available. It also remains as one of the most common pathologies that we as physiotherapist daily face.

Could muscle imbalance be one of often overlooked factors at today’s practice? Does the treatment plan correct your condition, or did they just treat the symptom? The major problem is that large amount of medical professionals don't look at the body as a whole. They often focus in on problem area (symptom), in our example the low back.

An extensive physical evaluation can be performed, which includes testing of muscular strength, flexibility, and function. Gait (walking) and biomechanics should also be assessed to note any deviations that are the result of current muscle imbalances and ones that may cause future problems. Once you know which muscles are too tight and which are too weak you can then begin correcting those imbalances.
Chapter 7 Advice for further research

The causes of unspecific low back pain and its link to hamstring shortening and muscular imbalance has been widely accepted by physical therapists, but there is lack of scientific evidence to support this view.

Hamstring stretching in professional show jumping riders has a positive effect on their low back pain. Due to the small number of study subjects it remains unclear whether the positive effect relates strictly to the hamstring stretches. Other influences, for example changed stress level; other psychological and/or physiological changes could have influenced the outcome of the study. In order to receive a higher validation of the outcome, it would be useful to repeat the study with a larger amount of subjects, to be tested for a longer period of time as well as with an improved method for the control of quality and quantity of the exercises.

The experimental study and Questionnaire used for the purpose of this paper were carried out within short time frame and limited resources. Hamstring stretching in professional show jumping riders had a positive effect on their low back pain. Due to the small number of study subjects it remains unclear whether the positive effect relates strictly to the hamstring stretches. Other influences, for example changed stress level; other psychological and/or physiological changes could have influenced the outcome of the study.

In order to receive a higher validation of the outcome, it would be useful to repeat the study with a larger amount of subjects (min.200), to be tested for a longer period of time with improved method for the control of quality and quantity of the exercises. To carry out a double blinded, randomized trial as randomization eliminates selection bias and is the crucial component of high-quality RCTs as stated in ‘Consort’(35). Physiotherapists treating and measuring the patients should remain unchanged during the study with a follow up study that is carried out in identical format.

Measurements of hamstring, iliopsoas and adductor tightness should be recorded at pre-and post testing to able to reason a possible link as a cause of unspecific Low Back Pain. A follow up study needs to be carried out 3 months and 6 months after the initial study to be able to follow the changes in muscle function. In this manner higher quality experimental results would be achievable.
References


3) www.lummen-horses.be/jumping


9) Garratt AM. (2001), *Responsiveness of generic and specific measures of health outcome in low back pain*, Lippincott, Hagerstown


19) Goldby L.J, PhD,* Ann P. Moore, PhD,† Jo Doust, PhD,† and Marion E. Trew, MSc†(2006)*A Randomized Controlled Trial Investigating the Efficiency of Musculoskeletal Physiotherapy on ChronicLow Back Disorder* SPINE Volume 31, Number 10, pp 1083–1093 , Lippincott Williams & Wilkins, Inc


32) http://orthoinfoaaos.org/booklet/view_report.com


Appendix

I  Detailed table of articles
II List of Articles
III Criteria List for Articles
IV Stretching program for Pilot study
V Patient diary used during pilot study
VI Relaxation exercise for Control group
VII Intake form for participants
VIII Aberdeen Low Back Pain Questionnaire
## I Detailed table of articles

<table>
<thead>
<tr>
<th>Article 1</th>
<th>Mills et al. (2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subjects + Status</strong></td>
<td>30, high-functioning athletes</td>
</tr>
<tr>
<td><strong>Age + Sex</strong></td>
<td>Aged 18-23, 30 females</td>
</tr>
<tr>
<td><strong>Clinical Relevance</strong></td>
<td>2/3</td>
</tr>
<tr>
<td><strong>Therapy/ Intervention/ Investigation</strong></td>
<td></td>
</tr>
<tr>
<td>T group:</td>
<td>Activating local stability muscles TrA,LM,PF</td>
</tr>
<tr>
<td>PT group:</td>
<td>Global mobility mm,RA,OE</td>
</tr>
<tr>
<td>Control gr.:</td>
<td>Nothing</td>
</tr>
<tr>
<td><strong>Time/ Time-period</strong></td>
<td>10 weeks, 1 supervised, session per week 3 unsupervised, sessions per week</td>
</tr>
<tr>
<td><strong>Results/ Relevant Outcome Measurement/ Observation</strong></td>
<td>Pre-test LPS Level</td>
</tr>
<tr>
<td>T group:</td>
<td>1.3±1.3</td>
</tr>
<tr>
<td>PT group:</td>
<td>0.6±0.7</td>
</tr>
<tr>
<td>C group:</td>
<td>1.8±1.4</td>
</tr>
<tr>
<td><strong>Post-test:</strong></td>
<td></td>
</tr>
<tr>
<td>T group:</td>
<td>2.8±1.5</td>
</tr>
<tr>
<td>PT group:</td>
<td>2.3±1.4</td>
</tr>
<tr>
<td>C group:</td>
<td>2.4±1.3</td>
</tr>
<tr>
<td>Agility(s): T: pre-test 8.8±0.7</td>
<td></td>
</tr>
<tr>
<td>Post-test 8.5±0.6</td>
<td>No differences found in PT &amp; C</td>
</tr>
<tr>
<td>Leg power (cm):</td>
<td>No difference found between pre- &amp; post-test heights of C,T,PT</td>
</tr>
<tr>
<td>Static balance (s):</td>
<td>Improvement in all groups from pre- to post-test</td>
</tr>
<tr>
<td><strong>Conclusion/ Key Points</strong></td>
<td>There is evidence that LPS training enhances LPS. But there is no evidence that the muscle group exercised differentially results in improved LPS. No correlation exist between changes in LPS scores &amp; changes in athleticism in this study.</td>
</tr>
<tr>
<td>Article 2</td>
<td>Goldby et al. (2005)</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Subjects + Status</td>
<td>213, with mechanic, chronic LBD, with current episode lasting a min. of 12 weeks</td>
</tr>
<tr>
<td>Age + Sex</td>
<td>Aged 18-65 (mean age 42), Females 146, Males 67</td>
</tr>
<tr>
<td>Clinical Relevance</td>
<td>3/3</td>
</tr>
</tbody>
</table>
| Therapy/ Intervention/ Investigation | A group = Spinal stabilization group (40%), following Panjabi’s theories. Exercise class, selective training of TrA, M, PF, D.  
B group = Manual Therapy (40%), Th. Ave individ. Treatment, without exercise for TrA, M, PF, D.  
C group = Education, minimal intervention control (20%) Th. explained educ. Book “Back in Action”. A+B+C(all) Did Back School |
| Time/ Time-period | 10 weeks,  
A: 10x1hr classes + 1x3hr Back School  
B: 10x intervention + 1x3hr Back School  
C: Booklet + 1x3hr Back School  
Follow up study after 3/12, 6/12, 12/12, 24/12 months. |
| Results/ Relevant Outcome Measurement/ Observation | BackPain:  
All groups showed reduction, with highest reduction in B, between entry & 3 mos.  
LegPain:  
A benefit was evident in A at each stage. Not for B & C.  
Clin. Site of pain: improved at each stage for A & B. No improvement for C.  
Disability  
A & B showed reduction between entry and each follow up stage. C did not.  
Handicap  
Impairment showed consistent reduction in all groups with similar trend.  
Quality of Life (total)  
A had a higher % improvement than B & C, but it was not significant.  
Medication taking  
A&B had red. in nr. Of days of medic. A had largest red. of medic. At 12mos. stage. C had red. at 6mos. stage. |
<p>| Conclusion/ Key Points | Spinal stabilization (A) is more effective over time in red. of pain, disability, dysfunction, medic. intake &amp; improving quality of life in these patients than B or C. Manual therapy (B) is better than C at reducing pain in these patients. Manual therapy can be used as pain red. modality, but should not be used as an isolated modality. |</p>
<table>
<thead>
<tr>
<th>Article 3</th>
<th>Ong et al (2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subjects + Status/</strong></td>
<td>31 athletes at the Olympic Games (from several kinds of sports)</td>
</tr>
<tr>
<td><strong>Age + Sex</strong></td>
<td>Aged 19-46; 14 female, 17 male</td>
</tr>
<tr>
<td><strong>Clinical Relevance</strong></td>
<td>2/3</td>
</tr>
<tr>
<td><strong>Therapy/ Intervention/ Investigation</strong></td>
<td>Lumbar spines of the athletes were imaged by MRI examination and were analyzed independently by 3 examiners. LD of L1–S1 was examined for presence &amp; degree of degeneration.</td>
</tr>
<tr>
<td></td>
<td><strong>Degeneration:</strong> Disc was graded as normal (1) or mild (2) or severe (3) degeneration.</td>
</tr>
<tr>
<td></td>
<td><strong>Height</strong> of disc were regarded as normal (1) or reduced (2)</td>
</tr>
<tr>
<td></td>
<td><strong>Disc displacement</strong> was described as normal, bulging, prolapsed.</td>
</tr>
<tr>
<td><strong>Time/ Time-period</strong></td>
<td>4 weeks (2 weeks before &amp; 2 week duration of the Sydney Games)</td>
</tr>
<tr>
<td><strong>Results/ Relevant Outcome Measurement/ Observation</strong></td>
<td><strong>Disc signal intensity:</strong> Were reduced most common in L5/S1, only 12 discs were normal, the largest proportion (11) of abnormal group of disc degeneration was grade 3. Normal signal at L1/2 &amp; L2/3 in 25 athletes. The more caudal the disc space, the higher proportion of abnormal discs. Only 4 athletes had normal disc signal in all lumbar discs</td>
</tr>
<tr>
<td></td>
<td><strong>Disc Height</strong> Reduced disc height was more common distally. L1/2 level was normal in all discs. The most common height reduction found was grade 1. 6 athletes had normal height in all levels.</td>
</tr>
<tr>
<td></td>
<td><strong>Disc Displacement</strong> total prevalence at one or more levels = 58% No displacement at L1/2, L2/3. Bulges at L5/S1 level = 58% have displacement (most bulges).</td>
</tr>
<tr>
<td><strong>Conclusion/ Key Points</strong></td>
<td>Due to the lack of a control group none of the results can be interpreted meaningful. Although the study was limited, the results suggest that elite athletes have a greater prevalence and greater degree of lumbar disc degeneration than the normal population.</td>
</tr>
</tbody>
</table>
### Article 4
Li et al. (1995)

**Subjects + Status/**
39 volunteers, without known musculoskeletal impairment of spine or lower extremities, with tight hamstring mm. on right side (SLR ≤70°)

**Age + Sex**
Aged 22-37; 22 female, 17 male

**Clinical Relevance**
3/3

**Therapy/ Intervention/ Investigation**
- Stretching group:
  - Slow static stretching for 15s, followed by a 15s rest in supine position
- Control group:
  - Performed no stretching program.

**Time/ Time-period**
3 weeks of daily stretching.

**Results/ Relevant Outcome Measurement/ Observation**
- SLR and hip motion during late and total forward bending were increased after stretching.
- No changes in standing posture or lumbar motion during forward bending.

**Conclusion/ Key Points**
There is no relationship between hamstring muscle length and lumbo-pelvic posture. There was no indication that stretching of hamstring muscles may affect motion during forward bending.

### Article 5
Vleeming et al. (1994)

**Subjects + Status/**
10 human cadavers

**Age + Sex**
Aged 65-90; 4 female, 6 male

**Clinical Relevance**
3/3

**Therapy/ Intervention/ Investigation**
Investigation during dissection of the posterior layer of thoraco-lumbar fascia, studied by visual inspection & raster photography.
- Tension was simulated by applying traction to various muscles and measured by studying the displacement.

**Time/ Time-period**
No time period

**Results/ Relevant Outcome Measurement/ Observation**
- Traction to a variety of muscles caused displacement of the posterior layer.
- Caudal to the level of L4 (L2/L3) tension in posterior layer was transmitted to the contra-lateral side.

**Conclusion/ Key Points**
The results implies that in vivo the superficial lamina will be tensed by contraction of various muscles such as LaJ, GM, ES, BF.
- In transferring forces between spine, pelvis, and legs, the post layer of the thoraco-lumbar fascia may play an important role in rotation of trunk & stabilization of the lower lumbar spine.

### Article 6
Orchard et al. (2004)

**Subjects + Status/**
Athletes of Australien Football League

**Age + Sex**
Discusses the theory that subtle lumbosacral canal impingement of the L5 nerve root may be a relatively common occurrence in older footballers and may in fact be a common underlying basis for the age related predisposition towards hamstring and calf strains.
<table>
<thead>
<tr>
<th>Article 7</th>
<th>van Wingerden et al.(1997)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects + Status/</td>
<td>1. There is a functional anatomic connection between BF and the LST.</td>
</tr>
<tr>
<td>Age + Sex</td>
<td>2. The BF plays a role in the intrinsic and extrinsic stability of the pelvis.</td>
</tr>
<tr>
<td>Clinical Relevance</td>
<td>3. When healthy subjects bend forward a coupled motion exists between pelvis and lumbar spine : LPR</td>
</tr>
<tr>
<td>Therapy/ Intervention/ Investigation</td>
<td>4. In low back pain pat’s this LPR seems different from that of healthy subjects</td>
</tr>
<tr>
<td>Time/ Time-period</td>
<td>5. Normalizing the LPR might be beneficial in low back pain pat’s</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Article 8</th>
<th>Bachrach(1997)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects + Status/</td>
<td>1. Lumbo-sacral &amp; SI ligamentous laxity with ant. wight bearing postural mechanics related to aging-gravity-assist dysfunctional posture and/or repeated injury might be a source of progressive spinal disease.</td>
</tr>
<tr>
<td>Age + Sex</td>
<td>2. This is perpetuated through chronic shortening, asymmetric, of the m.psoas association with weakness of that muscle+of the abdominals+gluteals+hamstring tightness</td>
</tr>
<tr>
<td>Clinical Relevance</td>
<td>3. Anterolat. disc extrusion at L1,2,3 may be a component of initiating and/or perpetuating cause of psoas maj. Shortening through pressure on the muscle belly/ reflex excitation of motor nerves</td>
</tr>
<tr>
<td>Therapy/ Intervention/ Investigation</td>
<td>4. Low back pain due to ES strain &amp; SI dysfunction may be an early consequence of PDIS-related muscle imbalance</td>
</tr>
<tr>
<td>Time/ Time-period</td>
<td>5. The increased shearing forces on annulus fibrosus resulting from PDIS-generated hyperlordosis may then produce intervertebral disc degeneration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Article 9</th>
<th>Decoster et al.(2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects + Status/</td>
<td>Investigate the literature regarding the most effective positions, techniques, and durations of stretching to improve hamstring muscle flexibility.</td>
</tr>
<tr>
<td>Age + Sex</td>
<td>Overall, methodological quality was poor, with only 21.4% (6/28) of studies achieving a score between 6 and 8. Thus it was difficult to confidently identify most effective hamstring stretching method. Instead, the evidence appears to indicate that hamstring stretching increases range of motion with a variety of stretching techniques, positions, and durations.</td>
</tr>
<tr>
<td>Clinical Relevance</td>
<td></td>
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<tr>
<td>Therapy/ Intervention/ Investigation</td>
<td></td>
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<tr>
<td>Time/ Time-period</td>
<td></td>
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<tr>
<td>Results/ Relevant Outcome</td>
<td></td>
</tr>
<tr>
<td>Measurement/ Observation</td>
<td></td>
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<tr>
<td>Conclusion/ Key Points</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Article 10</th>
<th>Bono (2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects + Status/</td>
<td>Several possibilities and factors that can cause or can influence low back pain in athletes in different types of sports are discussed and certain studies are compared. It was stated that the prevalence of radiographic evidence of disc degeneration is higher in athletes than in non-athletes but it is still unclear whether this correlates with a higher rate of low back pain.</td>
</tr>
<tr>
<td>Age + Sex</td>
<td></td>
</tr>
<tr>
<td>Clinical Relevance</td>
<td></td>
</tr>
<tr>
<td>Therapy/ Intervention/ Investigation</td>
<td></td>
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<tr>
<td>Time/ Time-period</td>
<td></td>
</tr>
<tr>
<td>Results/ Relevant Outcome</td>
<td></td>
</tr>
<tr>
<td>Measurement/ Observation</td>
<td></td>
</tr>
<tr>
<td>Conclusion/ Key Points</td>
<td></td>
</tr>
</tbody>
</table>
### Article 11

**Raid et al. (2000)**

**Subjects + Status/ Age + Sex**

In summary, the large forces combined with the repetitive nature of the activity create the potential for injury to the lumbar spine structures during rowing. The warming up activities of the rower, the time at which they train during the day, the control of lumbar motion by specific muscle activation patterns, and the flexibility of the hamstring muscles can influence these forces.

### Article 12

**Liebenson et al. (1996)**

**Subjects + Status/ Age + Sex**

The m. iliopsoas plays a primary role in determining postural faults and may have a profound effect on the stresses placed on the lumbar spine, resulting in facet imbrication and discopathy.

### Article 13

**Fahrni et al. (1965)**

**Subjects + Status/ Age + Sex**

<table>
<thead>
<tr>
<th>Clinical Relevance</th>
<th>Therapy/ Intervention/ Investigation</th>
<th>Time/ Time-period</th>
<th>Results/ Relevant Outcome Measurement/ Observation</th>
<th>Conclusion/ Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>175, &quot;Civilized&quot; and &quot;Primitives&quot;</td>
<td>Radiographic studies of <strong>civilized</strong> (American &amp; Swedish, 2 studies) and of <strong>primitives</strong> (squatting tribe in West Central India) were investigated concerning <strong>Hypertrophic Lipping</strong> and <strong>Disc Narrowing</strong></td>
<td>2/3</td>
<td>Incidence of transitional vertebrae: 14%, Incidence of Spondylolisthesis: 5%; Hypertrophic lipping: <strong>Civilized</strong>: Hard working group: 85% at the age of 47, Not heavy working group: 80%, Age 47; <strong>Primitives</strong>: 65% at the age of 47; Disc Narrowing: <strong>Civilized</strong>: Hard working group: 65%, age 47, Not heavy working group: 75%, Age 47; <strong>Primitives</strong>: 6-10%</td>
<td>On the basis of radiographic studies the incidence of degenerative change in the intervertebral disc in primitive squatting populations is considerably less than that found in civilized people. In the primitive group, while the hypertrophic change rose at a similar rate to the civilized, the incidence of disc narrowing rose very slowly, suggesting that a different cause is involved. The suggestion is made that lordosis is implicated in the pathogenesis of degeneration, but further studies are required.</td>
</tr>
</tbody>
</table>
### Article 14
Micheli et al. (1994)

<table>
<thead>
<tr>
<th>Subjects + Status/</th>
<th>Several possibilities, factors, and syndromes and their influences to affect the lumbar spine of athletes were discussed in this article. The authors stated that repetitive extension, flexion, or rotation, particularly in the lumbar spine of athletes in different types of sports, play an important role and increase the risk of injury to the structures of the lumbar spine.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age + Sex</td>
<td></td>
</tr>
<tr>
<td>Clinical Relevance</td>
<td></td>
</tr>
<tr>
<td>Therapy/ Intervention/ Investigation</td>
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</tr>
<tr>
<td>Time/ Time-period</td>
<td></td>
</tr>
<tr>
<td>Results/ Relevant Outcome Measurement/ Observation</td>
<td></td>
</tr>
<tr>
<td>Conclusion/ Key Points</td>
<td></td>
</tr>
</tbody>
</table>

### Article 15
Qingsan et al. (2006)

<table>
<thead>
<tr>
<th>Subjects + Status/</th>
<th>16 adolescent lumbar disc herniation patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age + Sex</td>
<td>Aged 11-18 years (mean age 15.8); 13 male, 3 female</td>
</tr>
<tr>
<td>Clinical Relevance</td>
<td>2/3</td>
</tr>
</tbody>
</table>
| Therapy/ Intervention/ Investigation | All cases underwent ant-post & lat radiograph and CT, MRI in 7 cases;  
A group: 10 cases: Hamstring tightness (mean deficit angle 59°)  
B group: 6 cases; no hamstring tightness (mean deficit angle 23.7°) – tested with bilat. SLR  
A & B group received conservative treatment =>6 cases (A:5,B:1)  
B group improved in other symptoms than ham-tightness, =>10 cases (A:5,B:5) had no improvement and therefore underwent discectomy; 3 of the 10 (A:1,B:2) still had problems 3 weeks after conservative treatment post-op,  
7 (A:4,B:3) had improvement in neurol. problems after conserve. treatment post-op but recurred 2-7 months later,  
1 case of A underwent shortening osteotomy of femur bilat. 10 months post discectomy because of continued ham-tightness. |
| Results/ Relevant Outcome Measurement/ Observation | After discectomy all pat’s had immediate relief of the neurologic defects, but the bilat. SLR test remained positive in all pat’s A. Pat’s were discharged after 10 days without further special treatment.  
Ham-tightness relieved from 6months to 11months after discectomy in 4 cases, all had ham. shortening with ham-deficite angle 37°-58° one year after surgery, 2 pat’s had symptoms 27&42 months after discectomy. One case showed no improvement => shortening osteotomy. After surgery ham-tightness was relieved.  
6 cases respond well to conservative treatment – 4 complained of continuing low back pain. Mean decrease of the ham. deficit angle:13° in 4 pat’s 1 year after treatment; 1 pat had 11° decrease in both sides 8months later. |
| Conclusion/ Key Points | In adolescent lumbar disc herniation with hamstring tightness, the neurologic defects were improved shortly after discectomy, but the hamstring tightness continued and remained even after 1 year.  
A high incidence of hamstring tightness is a characteristic of adolescent lumbar disc herniation.  
Hamstring tightness in adolescent lumbar disc herniation might develop from different mechanism than disc herniation. |
**Subjects + Status**
8 volunteers, neither spine injuries nor low back pain,
Mean body height 170±10cm, mean weight 67±6kg

**Age + Sex**
Aged 22-36; 1 female, 7 male

**Clinical Relevance**
2/3

**Therapy/ Intervention/ Investigation**
The bodies were compressed axially in supine posture with knees extended between the shoulder (shoulder harness) and the foot (footplate) by a MRI-compatible compression device. MRI was taken without axial compression and during compression of 50% body weight. Axial compression was readjusted after 5 minutes.

**Time/ Time-period**

**Results/ Relevant Outcome Measurement/ Observation**
MRI during compression took 11±3 minutes, and compression force was 48.1±0.8% of the body weight.

**Vertebral angle before & during compression:**
- T12-L1 (-0.8°±2.5° and -1.5±2.6°)
- L1-L2 (0.7°±1.4° and 3.3°±2.9°)
- L2-L3 (4.7°±3.5° and 7.3°±6°)
- L3-L4 (7.9°±2.4° and 11.1°±4.6°)
- L4-L5 (14.3°±3.3° and 14.9±1.7°)
- L5-S1 (25.8°±5.2° and 20.8°±6°),

L1-S1 (53.4°±11.9° and 57.3°±16.7°), no significant changes T12-L1 to L2-L3, L3-L4 increased significantly during compression. L4-L5 was not altered, L5-S1 decreased during compression. No significant change L1-S1.

**Decrease in disc height:**
Significant decrease was observed at L4-L5: 10.1±1.1mm before compression and 9.3±1.3mm during compression. Decrease in lumbar spine length: average 2.5±1.4mm and 1.3±0.8mm of total length.

No correlations between change in spine length and overall lumbar intervertebral angle (T12-S1, P=0.23) or in cumulative disc height (T12-S1 to L5-S1, P=0.13).

**Conclusion/ Key Points**
The axial force of 50% of body weight in supine position applied by a compression force device simulates the upright lumbar spine morphologically. No change in intervertebral angle occurred at L4-L5. Disc height at level L4-L5 decreased significantly during compression.
### Therapy/ Intervention/ Investigation

An intervertebral disc was removed at autopsy; a thin slice of bone at each end of the disc was included. The disc was kept in Ringer’s Solution before and during the tests. It was compressed by successive increments of 50 lb. (≈22.68 kg).

**Experiment: group:**
1. The loading was continued until the disc began to lose height.
2. The disc were loaded up to 500 lb. and then unloaded to zero.
3. Two successive tests were made on one disc with a time interval between the tests.
4. After 2 successive tests an incision was made with a scalpel into the centre of the disc through post-lat part of the annulus fibrosus, then a 3. test was carried out.
5. In this group there were 2 tests, then an incision, then 2 more tests. Disc was then allowed to remain in Ringer for ≈20 hrs.
6. The preceding tests were carried out on sections of the spine containing 4 lumbar vertebral bodies & 3 complete discs.
7. A series of discs were placed under constant load of 50 lb. for periods up to 48 hrs. Continuous measurements of the deflections during this period were recorded.

### Time/ Time-period

Results/ Relevant Outcome Measurement/ Observation

Can be divided into 2 groups: 1. concerning the elastic properties of the discs (Elasticity), 2. concerning the compression of the discs (Hysteresis):

#### Elastic properties

1) **Deflection/Elastic limit of 6 different discs:**
   - **Disc 1:** with a load=1000 lbs. (≈453.6 kg) the deflection is 0.05 inch (=1.27 mm)
   - **Disc 2:** load=700 lbs. (317.52 kg), deflection is 0.06 inch (1.524 mm)
   - **Disc 3:** load=850 lbs (385.56 kg), deflection is 0.075 inch (1.905 mm)
   - **Disc 5:** load 800 lbs (362.88 kg), deflection is 0.075 inch (1.905 mm)
   - **Disc 6:** load≈500 lbs (226.8 kg), deflection is 0.075 inch (1.905 mm).

   The power of recover was greater when the discs were immersed in a physiological fluid than when they tested dry.

2) **Effect of loading to 500lbs. & unloading:**
   - The curves rose sharply and then fell during unloading at a slower rate.
   - The hysteresis varied, being smaller in the upper lumbar and lower dorsal discs, and larger in the lowest lumbar disc. It was greatly exaggerated in pat’s who had suffered from chronic passive congestion of the circulatory system, and in cases where Schnorr’s nodes were marked. In very young subjects it was very large, in aged people where discs showed degeneration it was moderately large. It was least in people of middle decade of life, and in subjects of seventh decade with no degenerative changes in the discs.

3) **Two successive tests on each disc: Effect of repeated loading & unloading**
   - It was demonstrated that the hysteresis during the 2. test was always less than that during the first test. The mechanical efficiency of the disc improved with use, and the energy lost during recovery became less. During the interval (1 minute) the disc partly regained its sickness. The role of fluid exchange during compression and expansion needs further investigation.

### Effects of compression on the structure of the discs 3),4),5),6),7)Experiments into the effects of incision into the centre of the disc:

Incision through post-lat part of annulus f. & deepened into central part: linear incision or a split caused no loss of its elastic properties & no tendency for disc-content to herniate U-shaped or Z-shaped incision: herniations were not easily produced, there was interference with recovery of the disc, the hysteresis was increased.

### Conclusion/ Key Points

1. Intervertebral disc is an organic viscous elastic structure capable of maintaining very g
2. Recovery of the disc reat loads without disintegration. after deforming depends upon: the imbibitions of tissue fluid by the disc & --the removal of the deforming force. Complete recovery is modified by the duration of the force.
3. Factors that interfere with the elasticity of the disc are extreme youth (immaturity of disc), chronic wasting diseases (general nutrition disturbance), and local pathological changes in the vertebral bodies which interrupt /damage its blood supply. The intervertebral disc reaches its greatest state of efficiency in adult life – when the ncl. pulposus has disappeared as an entity.
4. The highly resilient elastic nature of the vertebral column is provided by the intervertebral discs, which constitute 1/3 of the whole length of the column.
5. The imbibition of fluid requires further investigation. It appears that from lacunae in the adjacent bodies finger-like pockets dip into the disc and that fluid passes through the lining membrane of these pockets.
Because the thoracolubopelvic region is such a major component of the human kinetic chain as it used in sport, training and competition can be quickly interrupted by the presence of an injury in this area. Some sports with certain loads and motions can have a higher potential for causing spinal injury by microtrauma or macrotrauma. In equestrian sport for example there are higher than normal vertical loads on the spine. Also extensive flexion-extension loads, like in football or gymnastics, can affect the spine, particularly the lumbar spine. It was stated by some authors that increased lordosis is an indication of potential low back pain.

**Article 19**

**Subjects + Status/ Age + Sex**
31 with back pain between L1 and the gluteal folds within the previous 3 months
Mean age: 35 years (range 31-61); 11 males, 20 females

**Clinical Relevance**
2/3

**Therapy/ Intervention/ Investigation**
Radiography to define sacral angle and to measure lordotic angle.
Investigation of trunk muscle strength by Isostation B-200 for the category isometric maximum torque:
Subjects were placed in an upright neutral position with maximum resistance and mechanical locks placed on all 3 axes. Subjects performed max. isometric contraction of lateral-flexion, flex.-ext., and rotation. The tests were repeated twice.

**Time/ Time-period**
Same day.

**Results/ Relevant Outcome Measurement/ Observation**

<table>
<thead>
<tr>
<th>Isometric max. strength:</th>
<th>Male:</th>
<th>Rot.: 50.60±16.56; L-rot: 50.10±13.60; Flex.: 79.11±26.08; Ext.: 99.56±32.46; R-lat-rot.: 101.42±31.35; L-lat-rot.: 98.87±30.51</th>
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</thead>
<tbody>
<tr>
<td>Female:</td>
<td>R-rot.: 29.75±7.32; L-rot.: 26.45±6.37; Flex.: 45.78±11.20; Ext.: 60.46±16.59; R-lat-rot.: 58.07±13.03; L-lat-rot.: 55.94±17.52</td>
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<tr>
<td>Total:</td>
<td>Rot.: 37.55±15.11; L-rot.: 34.84±14.82; Flex.: 57.61±23.85; Ext.: 74.33±29.79; R-lat-rot.: 73.45±29.66; L-lat-rot.: 71.17±30.67</td>
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</table>

Lumbar lordosis obtained: 27.19
Sacral angle: 31.77

Lumbar flexion and extension muscle strength were not related significantly with lordotic angle in males/females.
Ratio of extension to flexion showed a moderate significant relationship with lordotic angle, not with sacral angle.
No significant correlation in R/L ratio of rotation or lateral-flexion with both angles.
Extension maximum torque was significant related with sacral angle only in male.

**Conclusion/ Key Points**
An imbalance between trunk muscle strength can cause excessive lordosis, possibly a major reason for chronic LBP. Further study is needed with more subjects combined with assessment of LBP or activities of daily life.
### Article 20

**Lee et al., (1999)**

**Subjects + Status/**
67 volunteers who neither reported nor had been treated for low back pain.

**Age + Sex**
Mean age: 17 (13-26); 30 males, 37 females

**Clinical Relevance**
3/3

**Therapy/ Intervention/ Investigation**
Trunk muscle strength was measured with isokinetically, using Cybex Trunk Extension/Flexion Unit and Torso-Rotation Unit. Test was performed at a speed of 60 degrees/second, with 5 repetitions, maximal muscle strength was measured as peak torque. ROM during measurement was preset from 0° to 60° flex., and from 60° R-rot. to 60° L-rot.

Subjects were observed for 5 years to determine the incidence of LBP, and were classified to a non-LBP group and LBP group.

Measurements of their trunk muscle strength were compared between non-LBP gr. And LBP gr.

**Time/ Time-period**
5 years (1992-1997)

**Results/ Relevant Outcome Measurement/ Observation**
LBP in 18 cases out of 67 (male 8/30), female (10/37).

No significant differences regarding age, height, weight, smoking habits.

Among the men were statistically significant differences regarding only their daily sports activities – non-LBP were more engaged in sports.

**Peak torque values of the male (both LBP & non-LBP gr.)**
230.2±59.0 N · m in extension, 203.6±46.0 N · min flexion, 128.6±28.0 N · m in L-rot, 126.4±25. N · min R-rot.

**Peak torque values of the female (both LBP & non-LBP gr.)**
113.1±30.5 N · m in Flex., 121.6±24.9 N · m in Ext., 60.0±18.9 N · m in L-rot., 58.4±19.2 N · m in R-rot.

A comparison of peak torque between the non-LBP and LBP gr. showed no significant differences.

The E/F ratio of the LBP gr. Demonstrated a significant lower value than that of the non-LBP gr. In both male and female.

**Conclusion/ Key Points**
An imbalance in trunk muscle strength, i.e., lower back extensor muscle strength than flexor strength, might a risk factor for low back pain.

---

### Article 21

**Kayser et al (2006)**

**Subjects + Status/**
102 children with tight hamstring syndrome (THS) presented to the clinics

**Age + Sex**
Mean age: 10.5 years (3-17); 54 females, 48 males

**Clinical Relevance**
3/3

**Therapy/ Intervention/ Investigation**
All patients were diagnosed clinically with help of standardized evaluation to the criteria:

1. fixed contraction of the lumbar, ischiocrural and gluteal musculature
2. fixed lumbar vertebral column & hip joints when full extended leg is lifted up
3. typical waddling gait (shifting gait)
4. fixed scoliosis

**Time/ Time-period**
Every case of the past 22 years was retrospectively reviewed

**Results/ Relevant Outcome Measurement/ Observation**
-74 (73%) suffered from a severe or disabling underlying disease.
-15 (15%) cases a tumor or tumor-like lesion was observed.
-7 (7%) children suffered from a spinal Langerhans cell histiocytosis.
-4 (4%) children with Ewing’s sarcoma.
-Amongst 27 cases they observed:
  5 (5%) cases with an osteoidoostoma of the vertebral body, 5 with a spinal ependymoma of the filium terminale, 4 (4%) with an epidural lipoma, 4 (4%) an leukemia focus, 3 (3%) with a fibrous bone dysplasia, 3 with arachnoidal cyst, 3 with an aneurysmal bone cyst
-15 (15%) with local osteomyelitis or spondyloodontis
-14 (14%) with a slipped disc
-14 (14%) with a high-grade spondylolisthesis of the last lumbar segment

**Conclusion/ Key Points**
The results suggest that THS in childhood can be an initial symptom of an associated, usually severe disease. It was concluded that therefore further diagnostic evaluation is required when THS is observed. A rapid initiation of an adequate primary therapy could be indicated.
Abbreviations

T = Treatment group
PT = Pseudo-treatment group
TrA = m. transversus abdominis
LM = mm. multifidii lumbales
M = mm. multifidii
PF = pelvic floor muscles
RD = m. rectus abdominis
OE = m. obliquus externus
D = diaphragm muscles
LPS = lumbo-pelvic stability
LPR = lumbo-pelvic rhythm
LBD = low back disorders
Th = Physiotherapists
MRI = Magnet Resonance Imaging
LD = Lumbar Disc
LaD = m. latissimus dorsi
GM = m. gluteus maximus
ES = m. erector spinae
BF = m. biceps femoris
LST = lig. sacrotuberale
PDIS = psoas dysfunction/insufficiency
SLR = straight leg raise
II  List of Articles

The effect of a 10-week training regimen on lumbo-pelvic stability and athletic performance in female athletes, a randomized controlled trial

2. Lucy Jane Goldby, PhD,* Ann P. Moore, PhD, Jo Doust, PhD, and Marion E. Trew, MSc†
A Randomized Controlled Trial Investigating the Efficiency of Musculoskeletal Physiotherapy on Chronic Low Back Disorder
SPINE Volume 31, Number 10, pp 1083–1093
©2006, Lippincott Williams & Wilkins, Inc

3. A. Ong, J.Andersen, J. Roche
A pilot study of the prevalence of lumbar disc degeneration in elite athletes with lower back pain at the Sydney 2000 Olympic Games
© 2003 BMJ Publishing Group & British Association of Sport and Exercise Medicine

4. Yenchen Li, Philip W. McClure, Neal Pratt
The Effect of Hamstring Muscle Stretching on Standing Posture and on Lumbar and Hip Motions During Forward Bending
Physical Therapy, Volume 76, November 8, August 1996

5. A. Vleeming PhD, A. L. Pool-Goudzwaard bSc, RPT, R.StoeckartPhD, J.-P.van Wingerden BSc, RPT, C. J. Snijders PhD
The Posterior Layer of the Thoracolumbar Fascia
Its Function in Load Transfer From Spine to Legs
Second Interdisciplinary World Congress on Low Back Pain;
The Integrated Function of the Lumbar Spine and Sacroiliac Joints
San Diego, November 9-11, 1995/Andry Vleeming et al.
Rotterdam: ECO; ISBN90-802551-1-Y
Subject heading: Back Pain

6. J.W. Orchard, P. Farhart, C Leopold
Lumbar spine region pathology and hamstring and calf injury in athletes: is there a connection?
Br J Sports Med 2004;38;502-504
www.bjssportmed.com

7. J.-P. van Wingerden, A. Vleeming, G.-J. Kleinrensink, R. Stoeckart
The role of the hamstrings in pelvic and spinal function
Movement, Stability and Low Back Pain – The essential role of the pelvis
Edited by: A. Vleeming, V. Mooney, T. Dorman, C. Snijders, R. Stoeckart
Page 207-209

8. R.M. Bachrach
Psoas dysfunction/insufficiency, sacroiliac dysfunction and low back pain
Edited by: A. Vleeming, V. Mooney, T. Dorman, C. Snijders, R. Stoeckart
Page 309-317

9. LC Decoster , J Cleland , C Altieri , P Russell.
The effects of hamstring stretching on range of motion: a systematic literature review.
PMID: 16001909 [PubMed - indexed for MEDLINE]
10. CM Bono  
*Low Back pain in athletes*  

11. D.A. Raid, P.J McNair  
*Factors contributing to low back pain in rowers*  
Br J Med 2000;34;321-325  
www.bjsportmed.com

12. C. Liebenson DC, J. Cimino DC  
*The Missing Link in Low Back Pain Syndrome: The Iliopsoas Connection?*  
Dynamic Chiropractic – May 6, 1996, Volume 14, Issue 10  
www.chiroweb.com

13. W.Fahrni, G.E. Trueman  
*Comparative Radiological Study Of The Spines Of Population With North Americans And Northern Europeans*  
The Journal of Bone and Joint Surgery, Inc.

14. (59c)LJ Micheli , RA Yancey  
Chapter 5.5: *Overuse Injuries of the Spine*  
In: Harries M, Williams C, Stanish WD, Micheli LJ, eds.  
www.lylemichelimd.com/bookchapters.htm

15. Qingsan Zhu MD, Rui Gu MD, Xiaoyu Yang MD, Ye Lin MD, Zhongli Gao MD, Yasuhisa Tanaka MD  
*Adolescent Lumbar Disc Herniation and Hamstring Tightness: A Review of 16 Cases*  
SPINE Volume 31, Number 16, pp1810-1814  
©2006, Lippincott Williams & Wilkins, Inc.

16. Shinji Kimura MD PhD, Gregory C. Steinbach PhD, Donald E: Watenpaugh PhD, Alan R. Hargens PhD  
*Lumbar Spine Disc Height and Curvature Response to an Axial Load Generated by a Compression Device Compatible with Magnetic Resonance Imaging*  
SPINE Volume 26, Number 23, pp 2596-2600  
©2001, Lippincott Williams &bWilkins, Inc.

17. W.J. Virgin, Ludhiana, Punjab, India  
*Experimental Investigation into the physical properties of the intervertebral disc*  
The Journal Of Bone And Joint Surgery, Vol. 33B, No.4, November 1951, page 607-611  
The Journal of Bone and Joint Surgery, Inc.

18. (77c)Dyrek D.A., Micheli L.J., Magee D.J  
Chapter 24: *Injuries to the thoracolumbar spine and pelvis*  
In: Zachazewski J.E., Magee D.J., Quillen W.S., eds. Athletic Injuries and Rehabilitation.  
www.lylemichelimd.com/bookchapters.htm

*Influence of trunk muscles on lumbar lordosis and sacral angle*  
DOI 10.1007/s00586-005-0976-5

*Trunc Muscle Weakness as a Risk Factor for Low Back Pain: A Prospective Study*  
Spine, Volume 24 (1). January 1, 1999.54-57

*Tight hamstring syndrome and extra- or intraspinal diseases in childhood: A multicenter study*  
DOI 10.1007/s00586-005-0886-6
III Criteria List for Articles

Scoring system:

<table>
<thead>
<tr>
<th>Importance of the question</th>
<th>Max points possible</th>
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<tbody>
<tr>
<td>Low</td>
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<td>Medium</td>
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<td>High</td>
<td>3 points (complete)</td>
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<td>2 points (incomplete)</td>
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Gradingbox

After reading the article please use this form to fill in the points the article scored.

Max points possible: 47

After having read and graded the article this additional question has to be answered positively to meet the criteria:

- Is there external validity? (see bottom of explanation document)
### Abstract & Title
- Summary of the article (introduction [why this research has been conducted], essence of the study, method, etc.) *(low importance)* /1

### Introduction
- Background information on the topic *(medium importance)* /2
- References to other literature or researches and their results, mistakes or facts that have been proven *(medium importance)* /2
- Clarifies the essence and purpose of the study *(high importance)* /3

### Method
#### Subjects
- Criteria for including certain subjects (eg.: how are subjects chosen to participate, etc) *(high importance – complete/incomplete)* /3
- Adequate number of subjects *(medium importance – complete/incomplete)* /2
- Randomization:
  - Criteria for putting those subjects into different groups *(high importance – complete/incomplete)* /3
  - randomization [3 points, but only if the groups were compared on at least one variable if they are similar, otherwise 2 points]
  - paired or distributed based on other criteria [2 points only if motivated, otherwise 0]

#### Instruments
- Description of how the results (data) were collected (it must be stated who [1 point], when [1] and how [1] collected the results) *(high importance – complete/incomplete)* /3
- Were measurement PT and treating PT different people [2 /2]
Points? Otherwise nothing. *(medium importance)*

- Reliability of the instruments *(medium importance)*
- Validity of the instruments *(medium importance)*

### Procedure

- Every step of the research must be stated (reproducibility) *(high importance – complete/incomplete)*
- Subjects and PT should be blindfolded regarding the knowledge of the group the subject is in all through the study. *(high importance – complete/incomplete)*

### Results

- Report data (findings) in detail (facts) *(high importance – complete/incomplete)*
- Report about subject participation (drop out rate, exclusion, were exercises done as planned) *(medium importance – complete/incomplete)*
- Clear statistical analysis (P-value) *(low importance – complete/incomplete)*

### Conclusion/Discussion

- Interpretation of the results must be logic and understandable *(medium importance – complete/incomplete)*
- All arguments for or against outcomes of the study *(high importance – complete/incomplete)*
- Clinical relevance/significance *(high importance – complete/incomplete)*

### References *(low importance)*

- Author’s names, titles of the works, publishers of the works, date of publication, volume number and page number
### General Information

- Contact information of the author *(low importance)*
IV  Stretching program for Pilot study

Name: ______________________________

The exercises only take 2 x 8 minutes per day. Perform it every day in the morning and in the evening for a consecutive duration of 3 weeks (21 days). Please follow as closely as possible the following description in order maintain clear result at the end of the trial:

1. Hamstring Stretch

![Hamstring Stretch Image]

Step by Step:

Lie flat on your back with one leg bent and one leg straight on the mat (keep mat contact with the straight leg & knee during the entire exercise!). Make sure that your shoulders stay firmly on the ground. Lift the bent leg until you can hold the thigh behind the knee with your hands. Slowly straighten the knee until a stretch is felt in the back of the thigh. If you cannot feel a stretch yet, increase the bend at the hip (while maintaining the leg straight) until a stretch is felt. Hold the stretch for 15 sec.. Relax for 5 sec. Change legs. Repeat 5 times on each side.

2. Relaxation:

- Sit quietly and comfortably.
- Close your eyes.
- Start by relaxing the muscles of your feet and work up your body relaxing muscles.
- Focus your attention on your breathing.
- Breathe in deeply and then let your breath out. Count your breaths, and say the number of the breath as you let it out (this gives you something to do with your mind, helping you to avoid distraction).
- Do this for five minutes.
**Patient diary used during pilot study**

**Diary**

Fill in the diary below with as much precision as possible.

**ATTENTION:** If for any reason you are not be able to perform the exercises, please **DO NOT** fill in false information, for the study it is important to have accurate information.

<table>
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<tr>
<th>Day</th>
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<th>Time 1</th>
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VI  Relaxation exercise for Control group

Exercise Name: ______________________________

The exercises only take 2 x 5 minutes per day. Perform it every day in the morning and in the evening for a consecutive duration of 3 weeks (21 days). Please follow as closely as possible the following description in order maintain clear result at the end of the trial:

• Sit quietly and comfortably.
• Close your eyes.
• Start by relaxing the muscles of your feet and work up your body relaxing muscles.
• Focus your attention on your breathing.
• Breathe in deeply and then let your breath out. Count your breaths, and say the number of the breath as you let it out (this gives you something to do with your mind, helping you to avoid distraction).

Diary
After doing the exercise, please fill in the diary below as precise as possible.

ATTENTION: If for any reason you are not be able to perform the exercise, please DO NOT fill in false information, for the study it is important to have accurate information.

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<th>Day</th>
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### Intake form for participants

**Intake form of participants**  
Pilot study  
Low back Pain

Date:________ (intake)                        Date:________(end of study)

**Group A, Intervention group**

Aberdeen Low Back Pain Questionnaire  
Hamstring stretch instructions

<table>
<thead>
<tr>
<th>Name &amp; Age</th>
<th>Remarks (drop out/other)</th>
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<tbody>
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</table>

**Group B, Control Group**

Aberdeen Low Back Pain Questionnaire  
Relaxation instructions

<table>
<thead>
<tr>
<th>Name &amp; Age</th>
<th>Remarks (drop out, other)</th>
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</table>
Aberdeen Low Back Pain Scale

Overview:

Ruta et al all used a questionnaire to measure outcome in patients with low back pain. This can be used for initial evaluation of the patient and to monitor the effectiveness of any interventions. The authors are from the University of Aberdeen and the Aberdeen Royal Infirmary in Scotland.

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the past 2 weeks how many days did you suffer pain in the back or leg(s)?</td>
<td>none at all</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>between 1 and 5 days</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>between 6 and 10 days</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>for more than 10 days</td>
<td>3</td>
</tr>
<tr>
<td>On the worst day during the past 2 weeks how many painkilling tablets did you take?</td>
<td>none at all</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>less than 4 tablets</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>between 4 and 8 tablets</td>
<td>2</td>
</tr>
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<td></td>
<td>between 9 and 12 tablets</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>more than 12 tablets</td>
<td>4</td>
</tr>
<tr>
<td>Is the pain made worse by any of the following?</td>
<td>coughing</td>
<td>+1</td>
</tr>
<tr>
<td></td>
<td>sneezing</td>
<td>+1</td>
</tr>
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<td></td>
<td>sitting</td>
<td>+1</td>
</tr>
<tr>
<td></td>
<td>standing</td>
<td>+1</td>
</tr>
<tr>
<td></td>
<td>bending</td>
<td>+1</td>
</tr>
<tr>
<td></td>
<td>walking</td>
<td>+1</td>
</tr>
<tr>
<td>Do any of the following movements ease the pain?</td>
<td>lying down</td>
<td>see below</td>
</tr>
<tr>
<td></td>
<td>sitting down</td>
<td>see below</td>
</tr>
<tr>
<td></td>
<td>standing</td>
<td>see below</td>
</tr>
<tr>
<td></td>
<td>walking</td>
<td>see below</td>
</tr>
<tr>
<td>In your right leg do you have any pain in the following areas?</td>
<td>pain in the buttock</td>
<td>+1</td>
</tr>
<tr>
<td>Question</td>
<td>Option</td>
<td>Score</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>On the worst night during the last 2 weeks how badly was your sleep affected by the pain?</td>
<td>not affected at all</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>I didn’t lose any sleep but needed tablets</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>it prevented me from sleeping but I slept for more than 4 hours</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>I only had 2-4 hours of sleep</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>I had less than 2 hours of sleep</td>
<td>4</td>
</tr>
<tr>
<td>On the worst day during the last 2 weeks did the pain interfere with your ability to sit down?</td>
<td>I was able to sit in any chair for as long as I liked</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>I could only sit in my favorite chair as long as I liked</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pain prevented me from sitting more than 1 hour</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>pain prevented me from sitting more than 30 minutes</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>pain prevented me from sitting more than 15 minutes</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>pain prevented me from sitting at all</td>
<td>5</td>
</tr>
<tr>
<td>On the worst day during the last 2 weeks did the pain interfere with your ability to stand?</td>
<td>I could stand as long as I wanted without extra pain</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>I could stand as long as I wanted but it gave me extra pain</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pain prevented me from standing more than 1 hour</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>pain prevented me from standing more than 30 minutes</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>pain prevented me from standing more than 15 minutes</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>pain prevented me from standing at all</td>
<td>5</td>
</tr>
<tr>
<td>On the worst day during the last 2 weeks did the pain interfere with your ability to walk?</td>
<td>pain did not prevent me walking any distance</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>pain prevents me walking more than 1 mile</td>
<td>1</td>
</tr>
<tr>
<td>Pain Question</td>
<td>Response</td>
<td>Score</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Pain prevents me walking more than 1/2 mile</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Pain prevents me walking more than 1/4 mile</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>I can walk but less than 1/4 mile</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>I was unable to walk at all</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>In the last 2 weeks did the pain prevent you from carrying out your work, housework, and other daily activities?</td>
<td>no not at all</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>I could continue with my work but my work suffered</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>yes for one day</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>yes for 2-6 days</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>yes for 7 days or more</td>
<td>4</td>
</tr>
<tr>
<td>In the last 2 weeks for how many days have you had to stay in bed because of the pain?</td>
<td>none at all</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>between 1 and 5 days</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>between 6 and 10 days</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>for more than 10 days</td>
<td>3</td>
</tr>
<tr>
<td>In the last 2 weeks has your sex life been affected by your pain?</td>
<td>not affected by the pain</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>mildly affected by the pain</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>moderately affected by the pain</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>pain prevents any sex life at all</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>does not apply</td>
<td>NA</td>
</tr>
<tr>
<td>In the last 2 weeks have your leisure activities been affected by your pain?</td>
<td>not affected by the pain</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>mildly affected by the pain</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>moderately affected by the pain</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>severely affected by the pain</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>pain prevents any social life at all</td>
<td>4</td>
</tr>
<tr>
<td>In the last 2 weeks has the pain</td>
<td>not at all</td>
<td>0</td>
</tr>
<tr>
<td>interfered with your ability to look after yourself (e.g. washing dressing etc.)</td>
<td>because of the pain I needed some help looking after myself</td>
<td>1</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>because of the pain I needed a lot of help looking after myself</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>because of the pain I could not look after myself at all</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

where:

- Point assignments is discussed on page 1889 first column.
- Some point assignments may need review. For example pain in the foot or ankle without pain higher up strikes me as unusual to be due to back pain.
- The point assignment for actions that relieve the pain is unclear to me. According to the text it could be scored as +1 for each activity. But it would seem that the pain is worse if no activity relieves the pain. So I scored it as (4 – (number of actions relieving the pain)).
- Many scores of pain relief distinguish between different types of "painkillers".

**total number of points = SUM(points for all questions answered)**

**back pain severity score = (SUM(points for all questions answered) / SUM(maximum points for questions answered)) * 100**

**Interpretation:**
- minimum back pain severity scale: 0
- maximum back pain severity scale: 100
- The higher the score the greater the severity of the back pain.

**Performance:**

- The authors found the instrument valid and reliable.
- It was compared to the Oswestry Waddell and Greenough indices.
- It correlated with the SF-36 as a general measure of health status. It was able to detect significant changes in patients and was more responsive than the SF-36.
- It shows good internal consistency and test-retest reliability.
- The instrument shows construct validity.

**References:**