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# A discussion on How Hamstring Dysfunction leads to Low Back Pain (LBP) Through its Effects on the Pelvis

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**Abstract.** Background: Low back pain represents a significant and growing cause of pain and disability, affecting both athletes and the general population. Given its high prevalence and recurrence, it can be considered a global health burden. The prevailing approach in traditional studies is to focus on the localized aspects of the low back. This has led to a considerable body of work on the underlying mechanisms and treatments for this condition. Purpose: This article aims to contribute to the study of low back pain by examining the role of indirect muscles, such as the hamstrings, and their functional connection with the pelvis in the context of this condition. Conclusion: The findings indicate a direct correlation between hamstring dysfunction, including tightness and weakness, and low back pain. This is due to the excessive pelvic tilt that is caused by the aforementioned hamstring issues. Furthermore, asymmetries in length and strength between the left and right sides can also contribute to the development of low back pain. Nevertheless, it remains unclear whether the pelvis plays a role in this process.

**Keywords:** Low back pain, Hamstring, Pelvic tilt, Muscle imbalance.

## 1. Introduction

The low back refers to the region between the 12th rib and the posterior superior iliac spine, serving as a crucial connection between the upper and lower parts of the body. The skeletal structure of the low back consists of five lumbar vertebrae, the sacrum, and the intervertebral discs in between. Multiple muscles surround the low back, contributing to its extension, stabilization, and lateral flexion.

Low back pain (LBP) is a prevalent musculoskeletal condition worldwide, affecting approximately 577 million people in 2017 [1]. By 2020, the number of individuals suffering from LBP had risen to 619 million, with the trend continuing to increase rapidly [2]. LBP exhibits a particularly high prevalence among athletes, with an average rate of 42%, though this varies widely between 18% and 80% depending on the type of sport [3]. The lifetime incidence of LBP is estimated to be around 80% [4]. As a leading cause of years lived with disability and absenteeism from work, LBP represents a significant public health challenge.

A one-year follow-up study reported that 65% of patients with acute low back pain experienced recurrent pain at least once during that period [5]. Given the high prevalence and recurrence rate, many individuals struggle to achieve full recovery, underscoring the chronic nature of LBP.

Historically, research on LBP has focused on the relationship between the condition and the tissues of the low back. However, recent studies have increasingly considered the spine and pelvis as a functional unit, given their coordinated role in movement and stability during activities such as bending and twisting. Consequently, lower back pain may not only be associated with the lumbar region itself but also with adjacent structures, including the thoracic vertebrae and pelvis.

The lumbar vertebrae are connected to the pelvis via the lumbosacral joint, which transmits forces and movements from the legs to the lower back. Pelvic stiffness, malposition, or weakness can potentially impact the lower back. This raises several important questions: Does pelvic malposition increase the incidence of LBP? Which muscles contribute to improper pelvic alignment? Can targeted exercises for these muscles improve pelvic and lumbar posture, thereby alleviating LBP? Addressing these questions is crucial for advancing our understanding of LBP prevention and treatment. Moreover, it may open new research avenues in the field of physical therapy for LBP.

## 2. Pelvic malposition as a contributing factor to LBP

The pelvis serves as the anatomical bridge between the abdomen and lower extremities. Structurally, the bony pelvis forms an approximately circular framework composed of the hip bones, sacrum, and coccyx. Within its cavity, the pelvis houses vital organs such as the colon, bladder, and reproductive organs. The pelvis connects to the lumbar spine through the lumbosacral joint, formed between the sacrum and the fifth lumbar vertebra (L5), allowing limited motion. Additionally, the pelvis articulates with the femur via the hip joint, a key ball-and-socket joint responsible for limb coordination and maintaining body balance.

Through the lumbosacral joint, the pelvis can execute slight extension, flexion, and lateral flexion relative to the lumbar spine. In anatomical terms, "pelvic tilt" refers to the orientation of the pelvis compared to its neutral anatomical alignment (Figure 1). Assessment of pelvic tilt is more accurately performed using a handheld inclinometer or caliper, which offers superior precision compared to visual evaluation.

A neutral pelvic tilt typically ranges between 6 and 10 degrees. Posterior pelvic tilt occurs when the angle is less than 6 degrees, while anterior pelvic tilt is characterized by an angle greater than 10 degrees [6]. The orientation of the pelvis is closely associated with the development of hip musculature and skeletal alignment. An anterior pelvic tilt, in particular, has been linked to musculoskeletal disorders, as it can significantly affect the surrounding musculature and joint function [7].

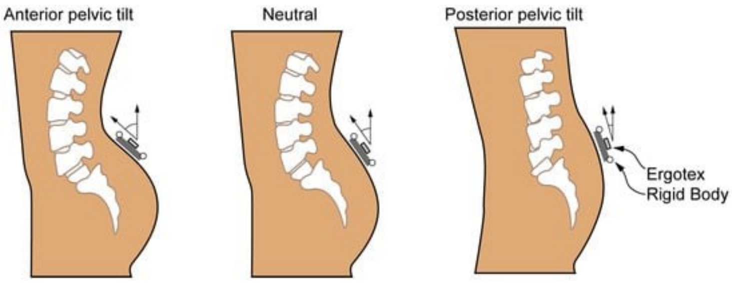


**Figure 1.** The pelvic tilts and lumbar curves in the sagittal plane [8].

## 3. Hamstring and LBP

### *3.1. Anatomy and function of the hamstring*

The hamstring group comprises three muscles located on the posterior aspect of the thigh: the semimembranosus, semitendinosus, and biceps femoris, arranged from medial to lateral. These muscles attach to the pelvis at the ischial tuberosity and extend to the tibia and fibula.

The hamstrings cross both the hip and knee joints, enabling them to facilitate thigh extension and calf flexion when contracting. Additionally, the hamstrings participate in pelvic movements in conjunction with other muscle groups, including the back and abdominal muscles. They contribute to posterior pelvic tilt (PPT), a counterclockwise rotation around the horizontal axis of the hip joint in the sagittal plane, which results in the pelvis tilting backward and a reduction in lumbar lordosis [9].

*3.2. Hamstring tightness and its association with LBP*

Deshmukh et al. identified a correlation between LBP and hamstring tightness in college students using the 90-90 hamstring test [10]. Similarly, Dubon et al. reported a similar correlation among adolescents [11]. These studies suggest that hamstring tightness may be relevant to discussions on LBP. Radwan et al. further quantified the severity of LBP using the Oswestry Disability Index (ODI) and found a positive relationship between LBP severity and hamstring tightness, establishing hamstring tightness as a contributor to LBP [12] (Figure 2).

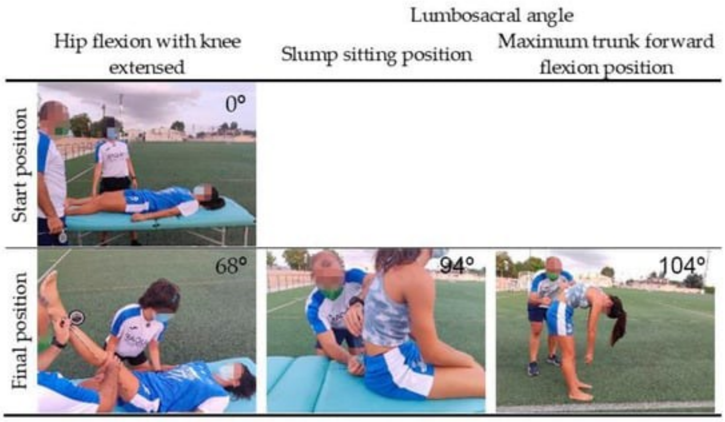


**Figure 2.** Evaluations of hamstring flexibility and sagittal pelvic tilt [13].

*3.2.1. Impact of posterior pelvic tilt.* Hamstring tightness is prevalent in modern populations, where prolonged static activities like sitting and standing can lead to the muscles being maintained in a shortened state. This extended shortening can result in reduced elasticity over time, increasing the likelihood of hamstring tightness and posterior pelvic tilt. PPT can flatten the lumbar curve, exacerbating stress on muscles, ligaments, and discs, and contributing to LBP.

*3.2.2. Impact of Anterior Pelvic Tilt.* Conversely, hamstring weakness can lead to anterior pelvic tilt (APT) and increased lumbar lordosis. Król et al. analyzed 60 female students with and without LBP and observed a significant correlation between APT and LBP ($R^2 = 0.07$, $p = 0.049$) as well as lumbar lordosis ($R^2 = 0.13$, $p = 0.02$) [14].

*3.3. Treatment*

*3.3.1. Effectiveness of hamstring stretching.* Gou et al. reviewed 344 trials and found that hamstring stretching is effective in treating various types of LBP, as measured by ODI. Additionally, hamstring exercises can alleviate radiating pain in LBP patients during the straight leg raise test [15]. However, Park et al.'s findings present some divergence.

*3.3.2. Stretching and pelvic tilt.* Park et al. investigated the effects of hamstring stretching with a Pilates ring in LBP samples with APT, PPT, and neutral pelvic tilt. The study found a modest reduction in Quick Visual Analog Scale (QVAS), ODI, and Fear-Avoidance Beliefs Questionnaire (FABQ) scores across all groups. Notably, hamstring stretching significantly improved pelvic mobility in LBP individuals with PPT, but similar improvements were not observed in the APT group. This suggests that hamstring stretching is more effective for LBP associated with PPT. The study supports the notion that hamstring tightness contributes to PPT, and stretching can help alleviate it. However, APT is associated with strong quadriceps and weak hamstrings, which may explain the limited effectiveness of stretching in patients with APT.

*3.3.3. Hamstring-quadriceps imbalance.* APT can be attributed to an imbalance between the hamstrings and quadriceps. The quadriceps, being antagonistic to the hamstrings, are typically stronger and larger. Leong's study demonstrated that an 8-week program of hip extensor and abdominal anti-resistance exercises improved APT and the hamstring-to-quadriceps strength ratio [16]. This supports the role of the H/Q strength ratio in APT and highlights hamstring resistance training as a beneficial exercise for preventing and managing LBP by addressing excessive APT caused by stronger quadriceps.

*3.3.4. Other treatments.* Despite these findings, some studies suggest that stretching and exercises primarily improve flexibility without significantly altering pelvic tilt angles. Cai et al. found that both dynamic and static stretching sessions yielded similar short-term improvements in hamstring range of motion (ROM) and tightness, with long-term benefits from continuous static stretching [17]. Shamsi et al. compared static hamstring stretching and strengthening exercises among 45 LBP patients and found both to be effective in dynamic balance and lumbopelvic rhythm, although stretching showed slightly better results [18]. However, no changes in pelvic tilt angles were observed in these two modes of exercise [19], a finding corroborated by Rossa et al. [20].

*3.4. Hamstring Length Asymmetry*

A negative correlation between hamstring shortening and LBP was reported by Sassonker et al., who measured LBP using ODI, Roland-Morris Disability Questionnaire (RMDQ), and passive straight leg raise (PSLR) tests among 109 women. They noted greater flexibility in the left leg compared to the right [21]. Kamalakannan et al. also observed tighter right legs in female college students [22], raising questions about whether hamstring imbalance may also contribute to LBP.

*3.4.1. Hamstring strength imbalance.* Moon et al. investigated the relationship between hamstring asymmetry and LBP severity, measuring LBP extent using the Modified Pain Rating Scale (MPRS) and ODI. The study found that hamstring asymmetry and shortness were associated with compensatory flexion movements and LBP severity [23]. A prospective study by Nalder et al. indicated that muscle imbalances between left and right hamstrings are effective predictors of LBP occurrence in the following year among females [24]. Kim et al. found that hip extension asymmetry was linked to pain and disability levels in LBP patients, with a strong correlation between limited hip extension and compensatory lumbar rotation [25]. This suggests that limitations in hip extension can lead to compensatory movements in the lumbar spine, contributing to LBP. However, this study did not address asymmetries in hip abduction and adduction.

Al-Eisa's research noted that trunk asymmetry in pelvic movements was seen in LBP patients, but no direct correlation between LBP and pelvic asymmetry was found [26]. Yoo et al. reported an association between left-right pelvic imbalance and LBP based on a review of 24 studies [27].

Overall, evidence supports that asymmetries in hamstring, hip ROM, and pelvic alignment contribute to LBP. However, direct evidence linking hamstring asymmetry to pelvic asymmetry and the specific mechanisms by which hamstring asymmetry may lead to LBP remain lacking.

*3.4.2. Incomplete improvement of asymmetry with stretching.* Riaz et al. conducted a four-week static stretching program and observed a 15-degree improvement in passive SLR. Nonetheless, a 5-degree difference between sides persisted, indicating challenges in fully resolving hamstring asymmetry [28]. Similarly, Shamsi et al. found that neither core exercises nor general exercise effectively corrected muscle imbalances, with participants retaining stronger trunk muscles on the left side after six weeks [29].

## 4. Discussion

LBP presents as a multifaceted issue, often extending beyond the realm of back muscle dysfunction. While conventional treatments typically focus on strengthening and rehabilitating the back muscles, this approach may not address the underlying causes of LBP, particularly when pelvic malposition is a

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contributing factor. The interconnected nature of the lumbar spine and pelvis means that dysfunction in one area can affect the other. For instance, strength imbalances between the anterior and posterior thigh muscles can exacerbate pelvic tilt, leading to further low back dysfunction. Hamstring exercises and stretches may offer relief by addressing these imbalances and improving pelvic alignment.

A critical aspect of managing LBP is understanding the role of left-right hamstring imbalances. Such imbalances can lead to pelvic asymmetry, which might worsen LBP if not addressed with targeted interventions. Current research indicates that generic exercise programs may not be sufficient for correcting these imbalances. Therefore, there is a pressing need for targeted training plans and additional studies to develop and validate these approaches.

Despite existing research on pelvic tilt asymmetry and its association with LBP, significant gaps remain in our understanding of effective treatments. Most guidelines on rehabilitation methods remain broad and lack specificity regarding the exact exercises, loads, and repetitions required for optimal outcomes. This underscores the need for more detailed and practical recommendations for physical therapy.

Furthermore, asymmetry in hamstring length has been found to correlate positively with compensatory lumbar rotation, posing a potential risk for LBP. This relationship suggests that further research is needed to explore how hamstring length asymmetry affects LBP and to determine effective treatment strategies.

In clinical practice, it is essential for physical therapists and rehabilitation clinicians to consider assessing pelvic tilt as part of a comprehensive evaluation. Excessive pelvic stiffness can lead to abnormal compensatory movements in the lumbar spine, potentially aggravating LBP. Conversely, pelvic displacement may sometimes compensate for lost lumbar function, which could provide temporary relief. Thus, a balanced approach is crucial, focusing on both identifying and addressing the root causes of LBP rather than solely correcting pelvic posture.

Pain and disability assessments often rely on subjective rating scales, which can be influenced by individual variability, sensory loss, and psychological factors. These factors can affect the accuracy of the data collected. While bioelectricity-based measurement methods offer a promising research direction, they also present challenges in detecting pain and injury levels objectively.

Short-term interventions such as strengthening exercises and stretching for the hamstrings and gluteus muscles can offer rapid relief from LBP. However, many studies have not observed significant changes in lumbar lordosis or pelvic tilt, raising questions about the direct causal relationship between pelvic tilt and LBP. It remains uncertain whether LBP is directly caused by skeletal misalignment or indirectly through muscle imbalances and tension resulting from improper alignment. This ambiguity highlights the need for further research to clarify the causality between pelvic tilt malposition and LBP.

## 5. Conclusion

This paper highlights that hamstring tightness and weakness are associated with excessive pelvic tilt, with tightness leading to PPT and weakness resulting in APT. Both types of pelvic tilt have been identified as potential contributors to LBP. Specifically, hamstring stretching and strengthening exercises have been shown to effectively address PPT and APT, respectively.

Additionally, hamstring asymmetry poses a risk for LBP by causing imbalanced compensatory lumbar rotation. This imbalance can exacerbate low back pain, though the specific role of pelvic alignment in this context remains unclear. The interaction between muscle imbalances and bone alignment, and how they contribute to LBP, requires further investigation.

Future research should focus on clarifying the role of pelvic malposition in LBP and developing targeted interventions to address both muscle imbalances and skeletal misalignment. A deeper understanding of these factors will be crucial for advancing effective treatments and improving patient outcomes in LBP management.

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