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ORIGINAL ARTICLE

Unveiling the Link between Pelvic Inclination and Hamstring Tightness in Middle-Aged Individuals Afflicted with Non-Specific Low Back Pain

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ABSTRACT

Objective: To determine the relationship between hamstring tightness and pelvic inclination in middle-aged subjects with and without low back pain.

Methods: An analytical cross-sectional study was conducted at two hospitals in New Delhi, India from December 2018 to May 2019. Subjects were divided equally into two groups each group formed on the basis of presence and absence of non-specific low back pain. Both males and females between 25-40 years and having nonspecific chronic low back pain with 4 months were included in the study. Hamstring muscle tightness and pelvic inclination angle were the outcome measures. Hamstring tightness was assessed by the right popliteal angle and left popliteal angle

Results: Of the total 70 subjects (35 with low back pain and 35 without low back pain), the mean age of the group with low back pain was 32.51 ± 4.31 years, and of the group without low back pain was 32.4 ± 4.51 years. Mean pelvic inclination was found significantly higher in the group with low back pain as compared to the group without low back pain i.e, 15.57° ± 2.86 vs. 13.11° ± 1.34 (p-value < 0.001). Similarly, the mean right popliteal angle and left popliteal angle were also found significantly higher in the group with low back pain as compared to the group without low back pain i.e., 29.23° ± 6.68 vs. 12.94° ± 4.25 (p-value < 0.001) and 25.0° ± 6.73 vs. 13.05° ± 4.30 (p-value < 0.001) respectively.

Conclusion: This study concluded that individuals experiencing low back pain exhibited significantly higher pelvic inclination and popliteal angle values.

Keywords: Low Back Pain, Musculoskeletal Pain, Pelvic Inclination, Popliteal Angle, Spinal Alignment.

INTRODUCTION

Non-specific low back pain (NSLBP) is a prevalent and significant public health concern worldwide, with a prevalence of 84% and chronic low-back pain affecting approximately 23% population.[1,2] NSLBP refers to low back pain that does not have an identifiable specific cause, such as infection, tumor, osteoporosis, or structural deformity.[1,2] The lower back area, which extends from the end of the ribs to the start of the legs, feels tight, painful, and rigid.[1,2]

While the exact etiology of NSLBP remains elusive, mechanical factors have long been considered to play a role in its development.[3] However, in a review Bradford-Hill causation criteria have cast doubt on the direct causal relationship between occupational factors (e.g., sitting, awkward postures, manual handling) and the occurrence of low back pain in various worker populations.[3]

One potential factor that has gained attention is the influence of hamstring muscle tightness on pelvic and trunk postures.[4] The hamstrings, which originate on the ischial tuberosity of the pelvis, have a significant impact on pelvic alignment and orientation.[4] Reduced hamstring muscle flexibility can restrict pelvic flexion during forward bending, leading to altered movement patterns and potentially excessive loading of lumbar tissues.[4] Previous research has associated hamstring

tightness with various spinal disorders, gait limitations, increased fall risk, and musculoskeletal injuries, including NSLBP.[5]

Additionally, the association between hamstring muscle length (HML) and pelvis inclination has been explored in the context of long-term low-back pain and reported no significant association,[6] while others have found a correlation between hamstring muscle length and pelvis inclination in subjects with chronic low-back pain.[7]

Given the multifactorial nature of NSLBP and the conflicting findings in the existing literature, further investigation is warranted to elucidate the relationship between tight hamstring muscle, pelvic inclination, and low-back ache. This study aims to address this research gap by comparing HML and pelvic tilt range (PTR) in middle-aged individuals with and without low back pain and examining associations between HML and PTR in both groups.

By enhancing our understanding of the biomechanical linkages between hamstring tightness, pelvic inclination, and low back pain, this study may provide valuable insights into the management and prevention of NSLBP. Moreover, it has the potential to inform interventions targeting hamstring flexibility and pelvic alignment as potential therapeutic strategies for individuals suffering from low back pain.

METHODS

An analytical cross-sectional study was conducted at Physiotherapy OPD of Delhi Pharmaceutical Sciences and Research University, M.B Road New Delhi, India, and Dr. Baba Saheb Ambedkar Hospital, Rohini, Delhi, India from December 2018 to May 2019. After obtaining ethical approval from the Research Development Committee of the School of Physiotherapy (DPSR), (10/715/Registraroffice/DPSRU/2018/9947). The subjects learned about the study's methods, risks and benefits, and gave their informed consent before the testing began.

We enrolled 70 subjects, divided equally into two groups each group formed on the basis of presence and absence of non-specific low back pain. Both males and females between 25-40 years and having nonspecific chronic low back pain with 4 months were included in the study. Those with any known orthopedics condition like osteoarthritis of hip or knee, spondylosis, spondylolisthesis, spondylitis, surgical procedure of hamstring or lower back musculature in the past six months, lower limb or spine trauma in six months, any neurological dysfunction, any psychological dysfunction and obese were excluded. Demographic details like age, height, weight, body mass index (BMI) and low back pain history were recorded from all the subjects.

Outcome measures taken were passive knee extension test to assess hamstring muscle tightness and pelvic inclination angle by gravity inclinometer with magnetic base. Gravity pelvic inclinometer with magnetic base, an instrument that is hand-held and designed to measure pelvic bone inclination. The subject was in a standing position on a level surface with feet placed 6 inches apart. The rectangular platform was placed on the spinous process of S1 to form a tangent to it. The angle of the tangent with respect to the vertical plane then was read from the inclinometer and the reading was subtracted from 90 degrees to get the degree of pelvic inclination from the horizontal plane. The pelvic tilt is defined as "the angle between the horizontal plane and the perpendicular to the sacrum in the sagittal plane". The average ranges of anterior and posterior pelvic tilting are 13.0° ± 4.9, and 8.9° ± 4.5, respectively.[8] Muscle length refers to the ability of a muscle, crossing a joint or joints, to lengthen, thus allowing the joint or joints to move through their full available range of motion.[9] The subject was supine, lying on the tested side, hip was in 90° of flexion and keeping the contralateral leg flat on the assessment table. The knee was extended passively until it reached the maximal tolerable stretch of the hamstring muscle, as indicated by the patient maintaining the ipsilateral hip in 90° of flexion. The knee angle, called popliteal angle, the acute angle between tibia and femur when the knee joint was passively extended with the hip flexed at 90 degrees, was then measured with a goniometer. The knee angle of full extension and 20° short of knee extension was considered normal and any value greater than 20° short of full extension indicates hamstring tightness.[10] Both right and left popliteal angles were measured for hamstring tightness.

Data entry and analysis were done using a Statistical Package for Social Sciences (SPSS) version 20.0. Mean ± SD were computed for quantitative variables like age (years), weight (kg), height (cm), and BMI (kg/m^2). Inferential statistics were explored using an Indepen dent t-test to compare mean difference of pelvic inclination angle and hamstring tightness between the group with low back pain and the group without low back pain. Moreover, Pearson's correlation test was applied to see the relationship between pelvic inclination angle and hamstring tightness between the group with low back pain and the group without low back pain. The p-value of ≤ 0.05 was considered statistically significant.

RESULTS

A total of 70 subjects participated in the study. The mean age of the group with low back pain was 32.51 ± 4.31 years, and the group without low back pain was 32.4 ± 4.51 years. The mean BMI of the group with low back pain was 24.11 ± 2.25 kg/m^2 and the group without low back pain was 24.16 ± 2.28 kg/m^2.

There were no significant mean differences in age (p-value 0.971), weight (p-value 0.562), height (p-value 0.537), and BMI (p-value 0.927) between groups with low back pain and without low back pain (Table 1).

A significantly strong negative correlation was observed between pelvic inclination and right popliteal angle in individuals with low back pain (r: -0.879, p-value 0.003). Similarly, a significantly strong negative correlation was observed between pelvic inclination and left popliteal angle among individuals with low back pain (r: -0.792, p-value 0.003). However, a significantly weak negative correlation was observed between pelvic inclination and right popliteal angle among individuals without low back pain (r: -0.039, p-value 0.035) (Table 2). The mean pelvic inclination was found significantly higher in the group with low back pain as compared to the group without low back pain i.e., 15.57° ± 2.86 vs. 13.11° ± 1.34 (p-value < 0.001). Similarly, mean right popliteal angle and left popliteal angle were also found significantly higher in the group with low back pain as compared to the group without low back pain i.e., 29.23° ± 6.68 vs. 12.94° ± 4.25 (p-value < 0.001) and 25.0° ± 6.73 vs. 13.05° ± 4.30 (p-value < 0.001) respectively (Table 3).

Table 1: Mean difference of anthropometric measurment variables between group with low back pain and group without low back pain (n= 70)

Demographic Variables	Group with Low Back Pain Mean ± SD (n= 35)	Group without Low Back Pain Mean ± SD (n= 35)	p-value
Age (years)	32.51 ± 4.31	32.4 ± 4.51	0.971
Weight (kg)	63.57 ± 7.24	64.68 ± 8.64	0.562
Height (cm)	162.34 ± 6.24	163.34 ± 7.02	0.531
BMI (kg/m^2)	24.11 ± 2.25	24.16 ± 2.28	0.927

- SD: Standard Deviation, Kg: Kilogram, Cm: Centimetre, m^2 : meter square
Independent t-test applied, *p-value ≤ 0.05

Table 2: Correlation between pelvic inclination and hamstring tightness in group with low back pain and group without low back pain (n= 70)

	Pelvic Inclination vs. Right Popliteal Angle r (p-value)	Pelvic Inclination vs. Left Popliteal Angle r (p-value)
Group with Low Back Pain (n= 35)	-0.879 (0.003)*	-0.792 (0.003)*
Group without Low Back Pain (n= 35)	-0.039 (0.035)*	-0.068 (0.068)

Pearson's correlation test was applied, Vs: Versus, *p-value ≤ 0.05

Table 3: Mean difference of pelvic inclination angle and hamstring tightness between group with low back pain and group without low back pain (n= 70)

Outcome Measures	Group with Low Back Pain Mean ± SD (n= 35)	Group without Low Back Pain Mean ± SD (n= 35)	p-value
Pelvic Inclination (degrees)	15.57 ± 2.86	13.11 ± 1.34	<0.001*
Hamstring Tightness			
Right Popliteal Angle (degrees)	29.23 ± 6.68	12.94 ± 4.25	<0.001*
Left Popliteal Angle (degrees)	25.0 ± 6.73	13.05 ± 4.30	<0.001*

Independent t- test applied, SD: Standard Deviation, *p value ≤ 0.05

DISCUSSION

The findings of the current study indicated that individuals with low back pain had less hamstring muscle flexibility and a decreased pelvic range of motion compared to those without low back pain. Back discomfort is a result of the hamstring muscles being shorter and less flexible. The pelvic posture can be affected by tension in the hamstring muscles that are connected to the posterior ischial tuberosities of the pelvis. Because it produces non-specific low back pain or alterations in lumbar pelvic rhythm, decreased hamstring flexibility is a key contributor to injuries and is crucial to controlling and preventing low back pain.[12]

Previous research corroborates the results of this study conducted by Fasuyi *et al*. which also observed that individuals without low back pain had longer hamstring muscle length than those with low back pain. However, there were no significant differences in pelvic tilt range between the two groups in their study. The tightness of the hamstring muscles can limit anterior pelvic tilt, which may lead to posterior pelvic tilt and flatten the natural lumbar arch, increasing pressure on the vertebral discs and potentially contributing to low back pain.[13]

According to Radwan *et al.* individuals with mechanical low back pain who had tighter hamstrings also had more severe pain in their lower back. The authors explained that the lumbopelvic rhythm could be disturbed by stiff hamstring muscles, which could increase the stress on the lower spine and cause low back pain.[14]

Another study compared healthy people with those who had low back pain and found that the latter group had less pelvic mobility and more rigid hamstrings. The researchers suggested that these factors might reduce the pelvic tilt and lead to lower back pain.[15]

However, some studies did not find a clear link between hamstring flexibility and low back pain. For example, Stutchfield and Coleman studied rowers and did not observe any significant relationship between the two variables. They speculated that this might be due to differences in hamstring flexibility or muscle balance between rowers and non-rowers.[16]

Similarly, Koley and Likhi did not find an association between hamstring flexibility and low back pain in aged individuals. They suggested that factors such as muscle weakness, degenerative conditions like osteoarthritis and osteoporosis, and degenerative disc diseases could be responsible for low back pain in the elderly population, rather than hamstring flexibility alone.[17]

In a study by Jo *et al*, it was shown that manually stretching the hamstring muscle increased its flexibility while keeping the pelvis neutral.[18] In a different research, low back pain sufferers who performed hamstring stretches with pelvic control three times per week for six weeks saw both a large improvement in hamstring flexibility and a significant reduction in pain.[19]

The discrepancies among these studies may be attributed to variations in the definition of hamstring tightness, as well as differences in the methods used to assess muscle extensibility and pelvic inclination. The current study utilized the passive knee extension test, which involves less motion in the lumbar spine and pelvis, to assess hamstring flexibility.

According to Cejudo *et al.*[20] there is a substantial correlation between hamstring flexibility, pelvic tilt, and lumbar curve. A thorough evaluation of 24 research conducted by Yoo *et al*. in a systematic review revealed a substantial association between left and right pelvic imbalance and back pain.[21]

This study suggests a link between pelvic inclination and tight hamstrings in individuals with and without low back pain.Tight hamstrings can restrict pelvic movement, leading to a flattened lower back and increased stress on the spine, potentially causing chronic low back pain. Imbalances in muscle strength, with tight hamstrings and weak quadriceps, glutes, and lower back muscles, can contribute to low back pain and a posterior pelvic tilt.

However, our study had limitations. It had a small sample size, limiting its generalizability. The participants may not represent the wider population. The study design only collected data once, so causation and the order of events couldn't be determined. Other factors like exercise levels, occupation, weight, and other conditions affecting muscles and bones were not considered. The methods used to measure hamstring flexibility and pelvic inclination may also be inaccurate.

In the future, longitudinal studies can provide insights into the long-term relationship between hamstring flexibility, pelvic inclination, and low back pain. Interventions aimed at improving hamstring flexibility and correcting pelvic inclination should be investigated to assess their impact on low back pain. Different populations should be studied to understand potential variations in this relationship. Biomechanical studies can explore the underlying mechanisms connecting hamstring flexibility, pelvic inclination, and low back pain.

Understanding these relationships can inform targeted treatment and prevention strategies. Healthcare professionals can incorporate interventions to improve hamstring flexibility and pelvic alignment in managing

low back pain. Rehabilitation programs should include exercises and techniques targeting these areas. Assessing hamstring flexibility and pelvic inclination can be part of routine assessments for low back pain patients. Raising awareness about the importance of hamstring flexibility and pelvic alignment can promote early intervention and self-care strategies, reducing the impact of low back pain.

CONCLUSION

This study concluded that there is a strong linkage between pelvic inclination and hamstring tightness in individuals afflicted with non-specific low back pain. The participants with low back pain displayed higher pelvic inclination and increased popliteal angles compared to without low back pain. Moreover, strong negative correlations were identified between pelvic inclination and popliteal angles in the low back pain group, suggesting a potential link between pelvic posture and hamstring tightness in this population

ETHICAL APPROVAL: This study obtaining ethical approval from Research Development Committee of School of Physiotherapy (DPSR) Delhi, India (10/715/Registrar office/DPSRU/2018/9947).

AUTHORS' CONTRIBUTION: NK: Conception or design of the work, data acquisition. MK: Conception or design of the work, final approval of the manuscript. CC: Data analysis, drafting of the work. HK: Data interpretation, revising it critically.
All authors approved the final version of manuscript.

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