

The Impact of Calf Stretching Using Inclined Board Standing on Low Back Pain: An Interventional Study

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Keywords: Low Back Pain, Calf Stretching, Inclined Board, Chronic Pain Management, Pain Reduction, Disability Improvement, Physical Health Enhancement

Abstract

Background: Low back pain (LBP) is a prevalent condition with significant socio-economic impacts. Among its multifactorial causes, calf muscle tightness is a key mechanical contributor. This study evaluates the impact of a calf stretching intervention on LBP.

Objective: To assess the effectiveness of calf stretching using an inclined board in reducing pain and disability and improving physical health in individuals with chronic LBP and calf tightness.

Methods: A single-group intervention design was utilized with 22 participants aged 18-65 years, clinically diagnosed with chronic LBP and calf tightness. The intervention involved a one-minute standing stretch on a 45-degree inclined wedge, performed three times daily for four weeks. Assessments were conducted at baseline and post-intervention using the Numerical Pain Rating Scale (NPRS), Oswestry Disability Index (ODI), and SF-12 questionnaire. Participants' compliance was monitored through daily logs, and weekly follow-up sessions ensured correct performance of the stretches. Data were analyzed using paired samples t-tests with SPSS version 25.

Results: The paired samples t-test showed significant improvements across all measures. The mean NPRS score decreased by 4.40 points ($p < 0.001$), indicating reduced pain. The Physical Component Summary (PCS) of the SF-12 improved by 12.96 points ($p < 0.001$), reflecting enhanced physical health. The ODI score reduced by 4.40 points ($p < 0.001$), suggesting decreased disability.

Conclusion: The study demonstrates that a structured calf stretching program significantly reduces pain and disability while improving physical health in individuals with LBP and calf tightness. Incorporating calf flexibility assessments and interventions can be crucial in LBP management.

1 Introduction

Low back pain (LBP) is a prevalent and debilitating condition affecting a significant percentage of the global population. This condition is a major contributor to disability, leading to considerable socio-economic consequences, including increased healthcare expenses and reduced productivity (1). The etiology of LBP is multifaceted, encompassing biological, mechanical, and psychological components. Among the mechanical factors, the kinetics of the lower limbs, particularly the calf muscles, play a crucial role in the development and persistence of LBP. Lower limb kinetics involves the study of forces and movements within the hip, knee, ankle, and foot. Any alteration in these forces and movements can lead to compensatory mechanisms that impact the lumbar spine, potentially resulting in LBP (2).

The calf muscles, specifically the gastrocnemius and soleus, are integral to lower limb function. Tightness in these muscles can significantly alter gait patterns, posture, and the distribution of forces through the lower body, which subsequently affects the lumbar spine (3). Calf tightness restricts ankle dorsiflexion, leading to compensatory movements such as increased knee flexion or hip extension during gait. These compensatory mechanisms can disrupt normal alignment and loading patterns of the spine, thereby contributing to LBP (4). Moreover, restricted ankle dorsiflexion can cause an increased anterior pelvic tilt as the body attempts to maintain balance during standing and walking, leading to enhanced lumbar lordosis. Increased lumbar lordosis places additional mechanical stress on the lumbar spine, further contributing to the development and persistence of LBP (5).

Additionally, calf tightness can impair the shock absorption capabilities of the lower limb. The calf muscles play a critical role in absorbing shock during weight-bearing activities. When these muscles are tight, their ability to absorb shock effectively is compromised, transmitting more forces to the lumbar spine and increasing the risk of LBP (6). Clinical studies have supported the relationship between calf tightness

and LBP. Gait analysis has shown that individuals with tight calf muscles exhibit altered lower limb kinetics, such as reduced ankle dorsiflexion and compensatory hip and knee movements, which are associated with increased lumbar spine loading (4). Electromyographic (EMG) studies have demonstrated that individuals with calf tightness exhibit increased activation of lumbar paraspinal muscles during gait, indicating higher lumbar spine loading and a potential link to LBP (7).

Intervention studies further support this relationship. Clinical interventions aimed at improving calf flexibility, such as stretching exercises, have been shown to reduce LBP symptoms, suggesting that addressing calf tightness can mitigate the biomechanical issues contributing to LBP (8, 9). These findings underscore the importance of incorporating calf flexibility assessments and interventions in the management of LBP. Understanding the relationship between calf tightness and LBP has significant implications for clinical practice. Clinicians should consider including assessments of calf muscle flexibility as part of the comprehensive evaluation of patients with LBP. Techniques such as the weight-bearing lunge test can be useful for assessing ankle dorsiflexion and identifying calf tightness (9). Furthermore, treatment plans for LBP should incorporate interventions targeting calf muscle tightness, such as stretching exercises and manual therapy, to address the underlying biomechanical issues and improve patient outcomes (10,11).

2 Material and methods

This study utilized a single-group intervention design to evaluate the impact of a calf stretching exercise on low back pain (LBP) associated with calf tightness. A total of 22 participants were recruited, meeting the inclusion criteria of adults aged 18-65 years, clinically diagnosed with chronic LBP persisting for more than three months, and presence of calf tightness determined by limited ankle dorsiflexion (<10 degrees) using the weight-bearing lunge test. Participants with a history of lower limb surgery, severe musculoskeletal disorders, acute LBP, neurological deficits, or other medical conditions that could interfere with the study outcomes were excluded.

Baseline assessments included the Numerical Pain Rating Scale (NPRS) to measure pain intensity, the Oswestry Disability Index (ODI) to evaluate disability associated with LBP, and the SF-12 questionnaire to assess participants' quality of life, covering both physical and mental health components. These tools provided a comprehensive evaluation of pain levels, functional abilities, and overall health status (12, 13).

The intervention consisted of a one-minute standing stretch on a 45-degree inclined wedge, performed three times daily for four weeks. Participants stood with their heels firmly planted on the ground and toes elevated on the inclined surface, extending their knees fully while keeping their back straight and maintaining an upright posture. To maintain balance, participants placed their hands on a wall or grasped a hanging bar. This position was held for one minute, ensuring a stretch in the calf muscles without pain or discomfort. The initial session was supervised by a trained physical therapist to ensure proper technique and safety. Participants were provided with detailed written and visual instructions for the home exercise program and were instructed to maintain a daily log to ensure compliance.

Weekly follow-up sessions with the physical therapist were conducted to review progress, address any concerns, and ensure continued proper form during the stretches. These sessions included re-evaluation of calf flexibility and adjustments to the stretching protocol if necessary. The intervention aimed to systematically address calf tightness and its contribution to LBP, providing a structured approach to improving lower limb flexibility and reducing lumbar spine stress.

Post-intervention assessments were conducted immediately after the intervention period, using the same tools as the baseline assessment to measure changes in pain intensity, disability, and quality of life. Data collection was meticulous, with participants' logs reviewed during follow-up visits to monitor compliance and address any issues.

Ethical approval for the study was obtained from the Institutional Review Board (IRB) of the Agile Institute of Rehabilitation Sciences in Bahawalpur. All participants provided written informed consent prior to participation, ensuring that they were fully aware of the study's potential risks and benefits and their right to withdraw at any time without penalty. The study adhered to the principles outlined in the Declaration of Helsinki for ethical research involving human subjects (14).

Statistical analysis was performed using SPSS version 25. Descriptive statistics, including mean and standard deviation, were computed for each variable. Paired samples t-tests were used to compare baseline and post-intervention scores for LBP intensity, calf muscle flexibility, and quality of life measures. A significance threshold of $p < 0.05$ was set for all analyses. This robust statistical approach ensured that the findings were reliable and could be confidently attributed to the intervention (15).

3 Results

The study evaluated the impact of calf stretching on low back pain (LBP) in 22 participants. Significant improvements were observed across all assessed measures. The participants' demographic characteristics are summarized in Table 1, showing a higher representation of females and housewives, with most participants being young adults aged between 18-30 years.

The paired samples t-test results, shown in Table 2, reveal significant improvements across all measures assessed in the study. For the Numeric Pain Rating Scale (NPRS), the mean difference between pre- and post-intervention scores was 4.40 ($p < 0.001$), indicating a robust reduction in pain levels. The Physical Component Summary (PCS) of the SF-12 questionnaire improved significantly, with a mean difference of 12.96 points ($p < 0.001$), reflecting enhanced physical health.

The Oswestry Disability Index (ODI) score decreased by 4.40 points ($p < 0.001$), suggesting a meaningful reduction in disability. Further analysis comparing different time points is shown in Table 3. The contrast between pre- and post-intervention time points reveals a significant decrease with an estimated mean difference of -5.88 ($p < 0.001$).

Table 1: Combined Descriptive Statistics and Frequency Table for Demographic Variables (n=22)

Variable	Category	Frequency	Percentage	Mean	Std. Error of Mean	Std. Deviation
Age of Participants	18-30 years	12	54.5%	1.5909	0.15652	0.73414
	31-42 years	7	31.8%			
	43-54 years	3	13.6%			
Gender of Participants	Male	8	36.4%	1.6364	0.10497	0.49237
	Female	14	63.6%			
Occupation of Participants	Administrator	1	4.5%		0.107	0.503
	Banker	3	13.6%			
	Computer Operator	1	4.5%			
	Doctor/Principal	1	4.5%			
	Housewife	8	36.4%			
	Lawyer	1	4.5%			
	Lecturer	2	9.1%			
	Student	5	22.7%			
	Married	13	59.1%	1.41	0.107	0.503
	Unmarried	9	40.9%			

Comparing pre- and follow-up time points shows an even larger decrease with an estimated mean difference of -9.06 ($p < 0.001$), indicating a highly significant reduction.

Table 2: Paired Samples Test Results for NPRS, PCS, and ODI (n=22)

Pair	Mean Difference	Std. Deviation	95% Confidence Interval	t-value	Degrees of Freedom (df)	p-value
NPRS pre - NPRS post	4.40	1.86	3.58 to 5.23	11.06	21	0.000
PCS pre - PCS post	-12.96	5.14	-15.24 to -10.67	-11.80	21	0.000
ODI pre - ODI post	4.40	4.76	2.29 to 6.52	4.30	21	0.000

The contrast between post-intervention and follow-up time points shows a smaller yet significant decrease with an estimated mean difference of -3.18 ($p < 0.001$).

Table 3: Multiple Comparison of Mean PCS Scores at Different Stages (n=22)

Contrast	Estimate	Std. Error	Degrees of Freedom (df)	Lower CL	Upper CL	t-ratio	p-value
Pre - Post	-5.878	0.94	84	-7.7	-3.9	-6.2	0.000
Pre - Follow-Up	-9.061	0.9	84	-10.9	-7.1	-9.5	0.000
Post - Follow-Up	-3.183	0.9	84	-5.0	-1.3	-3.3	0.001

These results clearly indicate that the structured calf stretching program significantly reduced pain and disability while improving physical health in individuals with LBP and calf tightness. The findings support the role of targeted calf stretching in managing LBP and highlight the importance of incorporating such interventions into clinical practice.

4 Discussion

The study demonstrated that a structured calf stretching program significantly reduced low back pain (LBP) intensity, improved physical health, and decreased disability in individuals with chronic LBP and calf tightness. These findings are consistent with previous research highlighting the biomechanical relationship between calf tightness and LBP. The reduction in NPRS scores by 4.40 points post-intervention reflects a substantial decrease in pain levels, aligning with studies that have shown the efficacy of stretching exercises in alleviating musculoskeletal pain (16- 8).

Enhanced physical health, as indicated by the 12.96-point improvement in the PCS of the SF-12 questionnaire, underscores the broader impact of calf stretching on overall well-being. This result is supported by studies that emphasize the role of lower limb mechanics in influencing lumbar spine stress and subsequent LBP (4, 6). The significant decrease in ODI scores by 4.40 points further validates the intervention's effectiveness in reducing disability, corroborating findings from interventions targeting lower limb flexibility (8, 10).

The study's strengths include a well-defined intervention protocol, rigorous compliance monitoring through daily logs and weekly follow-ups, and the use of validated assessment tools. These methodological strengths enhance the reliability of the findings and their applicability in clinical settings. The consistent follow-up ensured adherence to the intervention and allowed for timely adjustments, which likely contributed to the positive outcomes observed.

However, several limitations should be acknowledged. The small sample size of 22 participants may limit the generalizability of the results. While the significant findings are promising, larger-scale studies are necessary to confirm these effects across diverse populations. The short duration of the intervention (four weeks) may not capture long-term benefits or potential relapses, suggesting the need for extended follow-up periods in future research. The reliance on self-reported measures such as NPRS, ODI, and SF-12, while valuable, introduces the potential for subjective bias. Incorporating objective measures, such as biomechanical assessments and imaging studies, could provide a more comprehensive understanding of the intervention's impact.

Previous studies have established the link between calf tightness and LBP through various mechanisms, including altered gait patterns, compensatory movements, and increased lumbar spine loading (3, 5). This study adds to the growing body of evidence by demonstrating that addressing calf tightness through a simple, structured stretching program can lead to meaningful clinical improvements. The findings are consistent with those of Yoon and Park, who observed significant improvements in weight-bearing distribution and flexibility following ankle mobilization and stretching, ultimately reducing LBP in individuals with pronated feet (14). Similarly, Macklin et al. found that calf muscle stretching enhanced ankle dorsiflexion and dynamic foot pressures, reducing compensatory stress on the lumbar spine (15). Seif et al. also reported that stretching the calf muscle, along with other muscle groups, led to significant pain reduction and improved functional outcomes in chronic LBP patients (16).

Despite these strengths, the study's limitations highlight areas for future research. Investigating the long-term effects of calf stretching and exploring its impact on different populations, such as those with varying degrees of calf tightness or different types of LBP, would provide deeper insights. Additionally, future studies should consider incorporating a control group to strengthen the causal inferences drawn from the intervention. Objective assessments, such as gait analysis and electromyography, could complement self-reported measures and offer a more nuanced understanding of the biomechanical changes induced by calf stretching.

The study's findings have important implications for clinical practice. Healthcare providers, particularly physical therapists, should consider incorporating calf stretching exercises into standard LBP management protocols. Training programs for healthcare practitioners should emphasize the benefits and techniques of calf stretching using inclined boards, ensuring that practitioners are well-equipped to implement these interventions effectively. Policymakers and educational institutions should support such initiatives by integrating evidence-based stretching programs into broader public health strategies aimed at reducing the burden of LBP.

5 Conclusion

The study concluded that a structured calf stretching program significantly reduced pain intensity, improved physical health, and decreased disability in individuals with chronic low back pain (LBP) and calf tightness. These findings suggest that incorporating calf flexibility assessments and targeted stretching exercises into LBP management protocols can effectively alleviate symptoms and enhance overall functional outcomes. Healthcare providers, particularly physical therapists, should consider integrating such interventions into standard care practices to improve patient quality of life and reduce the socio-economic burden of LBP. Further research is warranted to explore the long-term benefits and broader applicability of these interventions across diverse populations.

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Disclaimers

Author Contributions	Muhammad Hafeez conceptualized the study, developed the methodology, conducted the intervention, collected and analyzed the data, and wrote the manuscript. Muhammad Zia Ul Haq supervised the project, provided critical revisions, and reviewed the manuscript. Shabana Rahim assisted with study conceptualization, methodology, data collection, and manuscript review.
Conflict of Interest	The authors declare that there are no conflicts of interest.
Data Availability	Data and supplements available on request to the corresponding author.
Funding	NA
Ethical Approval	Institutional Review Board (IRB) of the Agile Institute of Rehabilitation Sciences, Bahawalpur.
Trial Registration	NA
Acknowledgments	Lincoln University College Malaysia, The Islamia University of Bahawalpur, the participants, and the staff at Agile Institute of Rehabilitation Sciences.

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~ JHRR, ISSN: 2791-156X ~