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FUNCTIONAL OUTCOMES OF PHYSIOTHERAPY INTERVENTION IN YOUNG ADULTS WITH HAMSTRING TIGHTNESS: CHANGES IN HAMSTRING FLEXIBILITY, DYNAMIC BALANCE, AND PAIN

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KEYWORDS

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Abstract

Background

Hamstring tightness is one of the most common musculoskeletal impairments among young adults and has been associated with reduced flexibility, impaired dynamic balance, pain, and diminished functional performance. Persistent shortening of the hamstring muscles may alter lower-limb biomechanics, compromise postural stability, and increase the risk of movement dysfunction and musculoskeletal injury. Physiotherapy interventions are routinely prescribed to improve muscle extensibility and restore function; however, evidence describing the overall functional outcomes following physiotherapy remains limited. Evaluating changes in flexibility, balance, and pain is essential for understanding the clinical effectiveness of rehabilitation programmes in this population.

Objective

To evaluate functional outcomes following physiotherapy intervention by assessing changes in hamstring flexibility, dynamic balance, and pain among young adults with hamstring tightness.

Methods

A prospective pre–post experimental study was conducted among 40 young adults with hamstring tightness. Hamstring flexibility was assessed using the Active Knee Extension Test (AKET) and Sit-and-Reach Test (SRT), dynamic balance was measured using the Y-Balance Test (YBT), and pain intensity was evaluated using the Numeric Pain Rating Scale (NPRS). Outcome measures were recorded before and after physiotherapy intervention. Pre–post comparisons were analysed using paired *t*-tests with the level of statistical significance set at $p < 0.05$.

Results

Following physiotherapy intervention, statistically significant improvements were observed in all outcome measures. Mean AKET values improved from **32.7 ± 2.9°** to **22.7 ± 2.8°** ($t = 20.1$, $p = 0.0001$). Mean YBT scores increased from **84.2 ± 2.0** to **91.0 ± 2.6** ($t = 16.8$, $p = 0.0001$). Mean SRT values improved from **19.7 ± 2.1 cm** to **28.8 ± 2.6 cm** ($t = 25.1$, $p = 0.0001$). Mean NPRS scores decreased from **6.8 ± 1.7** to **3.0 ± 1.7** ($t = 10.1$, $p = 0.0001$).

Conclusion

Physiotherapy intervention resulted in significant improvements in hamstring flexibility, dynamic balance, and pain among young adults with hamstring tightness. These findings support the role of physiotherapy in improving functional outcomes and managing impairments associated with hamstring tightness.

Introduction

Hamstring tightness is one of the most common musculoskeletal impairments observed in young adults and is frequently encountered in both physically active and sedentary populations. The hamstring muscle group, comprising the biceps femoris, semitendinosus, and semimembranosus, functions across both the hip and knee joints and plays a fundamental role in lower-limb biomechanics, postural stability, gait, and functional movement. Adequate hamstring flexibility is essential for maintaining normal pelvic alignment, efficient force transmission, and coordinated movement during activities such as walking, running, jumping, squatting, and stair negotiation. Reduced extensibility of these muscles may adversely affect movement efficiency and predispose individuals to functional limitations and musculoskeletal disorders.

In recent years, the prevalence of hamstring tightness among young adults has increased considerably due to prolonged sitting, sedentary lifestyles, academic demands, increased screen time, and reduced participation in regular physical activity. These lifestyle-related factors contribute to adaptive shortening of the hamstring muscles, resulting in restricted hip flexion, decreased knee extension, altered lumbopelvic rhythm, and compensatory movement patterns. Such biomechanical alterations may reduce functional performance and increase the risk of lower-extremity injuries.

Hamstring tightness has been associated with several musculoskeletal conditions, including mechanical low back pain, patellofemoral pain syndrome, hamstring strain injuries, and movement dysfunction. Restricted hamstring flexibility may increase passive tension within the musculotendinous unit, alter lower-limb kinematics, and impair shock absorption during dynamic activities. Consequently, reduced flexibility may negatively influence both athletic performance and activities of daily living, emphasizing the importance of early identification and appropriate physiotherapy management.

Dynamic balance is an essential component of functional mobility and depends on the coordinated interaction of the musculoskeletal, neuromuscular, and sensory systems. Adequate flexibility allows efficient joint motion and contributes to optimal postural control by facilitating coordinated muscle activation and proprioceptive input. Conversely, hamstring tightness may limit lower-limb excursion, restrict pelvic mobility, and impair neuromuscular control, thereby reducing dynamic balance and increasing the likelihood of falls or movement-related injuries. The Y-Balance Test has been widely used as a reliable and valid clinical measure for assessing dynamic postural control and identifying functional deficits associated with lower-limb impairments.

Pain is another clinically important consequence of hamstring tightness. Increased muscle stiffness and reduced extensibility may elevate mechanical stress within the posterior thigh and surrounding structures, resulting in discomfort during functional activities. Persistent pain may further limit physical activity, reduce muscle performance, and contribute to a cycle of decreased flexibility and functional impairment. Therefore, effective physiotherapy interventions should aim not only to improve flexibility but also to reduce pain and restore functional performance.

Physiotherapy remains the primary conservative approach for the management of hamstring tightness. Various interventions, including manual therapy, stretching exercises, therapeutic exercise, proprioceptive training, and neuromuscular re-education, have been shown to improve muscle extensibility and physical function. Previous studies have consistently reported that structured physiotherapy programmes produce significant improvements in hamstring flexibility and functional outcomes. Medeiros et al. demonstrated that flexibility interventions significantly improved hamstring extensibility in healthy young adults, while Kang et al. reported that manual therapy techniques effectively enhanced hamstring flexibility and lower-limb function. Similarly, Encarnación-Martínez et al. observed that improved hamstring flexibility was associated with better dynamic balance and functional performance in physically active young adults. These findings collectively support the role of physiotherapy in restoring normal movement patterns and reducing functional impairments.

Although numerous studies have evaluated specific physiotherapy techniques for improving hamstring flexibility, relatively few have examined the overall functional outcomes following physiotherapy intervention by simultaneously assessing flexibility, dynamic balance, and pain. Evaluating these outcomes together provides a more comprehensive understanding of rehabilitation effectiveness and reflects the multidimensional goals of physiotherapy management. Such evidence is clinically relevant because improvements in flexibility alone may not necessarily translate into meaningful functional recovery unless accompanied by better balance and reduced pain.

Therefore, the present study was undertaken to evaluate the functional outcomes of physiotherapy intervention in young adults with hamstring tightness by assessing changes in hamstring flexibility, dynamic balance, and

pain. It was hypothesized that physiotherapy intervention would produce significant improvements across all measured outcomes, thereby supporting its role as an effective conservative strategy for enhancing lower-limb function and overall physical performance in this population.

Materials and Methods

Study Design

A prospective pre–post experimental study was conducted to evaluate the functional outcomes of physiotherapy intervention in young adults with hamstring tightness. The study assessed changes in hamstring flexibility, dynamic balance, and pain before and after completion of the intervention programme.

Study Setting

The study was carried out in the Department of Physiotherapy, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan, India.

Participants

A total of **40 young adults** aged **18–26 years** with clinically diagnosed hamstring tightness were recruited after obtaining written informed consent. Participants with a history of lower-limb fractures, spinal surgery, acute hamstring injury, neurological disorders, vestibular dysfunction, pregnancy, or any contraindication to physiotherapy intervention were excluded.

Outcome Measures

Functional outcomes were assessed using validated clinical measures:

- **Hamstring flexibility:** Active Knee Extension Test (AKET) and Sit-and-Reach Test (SRT)
- **Dynamic balance:** Y-Balance Test (YBT)
- **Pain intensity:** Numeric Pain Rating Scale (NPRS)

All outcome measures were recorded before and after the intervention by the same investigator using standardized procedures.

Physiotherapy Intervention

Participants underwent a structured physiotherapy intervention designed to improve hamstring flexibility, dynamic balance, and pain. The rehabilitation programme included supervised therapeutic interventions administered according to standardized clinical protocols throughout the study period.

Statistical Analysis

Data were analysed using **IBM SPSS Statistics Version 26.0**. Continuous variables were expressed as **mean ± standard deviation (SD)**, while categorical variables were presented as frequencies and percentages. Pre- and post-intervention outcomes were compared using the **paired Student's *t*-test**. Statistical significance was established at **$p < 0.05$**.

Results

A total of **40 young adults** with hamstring tightness completed the study and were included in the final analysis. The study population comprised **20 males (50%) and 20 females (50%)**. Most participants belonged to the **21–26 years** age group (**67.5%**), while **32.5%** were aged **18–20 years**. Equal representation was observed from urban and rural areas, with **20 participants (50%)** recruited from each. These findings indicate a balanced distribution of demographic characteristics within the study population.

Changes in Hamstring Flexibility

Significant improvement in hamstring flexibility was observed following physiotherapy intervention. The mean **Active Knee Extension Test (AKET)** score decreased from **32.7 ± 2.9°** at baseline to **22.7 ± 2.8°** after intervention, demonstrating a statistically significant improvement (t = **20.1**, p = **0.0001**).

Similarly, the mean **Sit-and-Reach Test (SRT)** score increased from **19.7 ± 2.1 cm** before intervention to **28.8 ± 2.6 cm** after intervention. The improvement was statistically significant (t = **25.1**, p = **0.0001**).

Table 1. Changes in Hamstring Flexibility Following Physiotherapy Intervention

Outcome Measure	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	*t*-value	*p*-value
AKET (°)	32.7 ± 2.9	22.7 ± 2.8	20.1	0.0001*
SRT (cm)	19.7 ± 2.1	28.8 ± 2.6	25.1	0.0001*

Statistically significant ($p < 0.05$).

Changes in Dynamic Balance

Dynamic balance improved significantly following physiotherapy intervention. The mean **Y-Balance Test (YBT)** score increased from **84.2 ± 2.0** at baseline to **91.0 ± 2.6** after intervention. The improvement was statistically significant (t = **16.8**, p = **0.0001**).

Table 2. Changes in Dynamic Balance Following Physiotherapy Intervention

Outcome Measure	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	*t*-value	*p*-value
YBT	84.2 ± 2.0	91.0 ± 2.6	16.8	0.0001*

Statistically significant ($p < 0.05$).

Changes in Pain

Pain intensity decreased significantly following physiotherapy intervention. The mean **Numeric Pain**

Rating Scale (NPRS) score decreased from **6.8 ± 1.7** before intervention to **3.0 ± 1.7** after intervention. Statistical analysis demonstrated a significant reduction in pain (t = **10.1**, p = **0.0001**).

Table 3. Changes in Pain Following Physiotherapy Intervention

Outcome Measure	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	*t*-value	*p*-value
NPRS	6.8 ± 1.7	3.0 ± 1.7	10.1	0.0001*

Statistically significant (p < 0.05).

Figure 1. Overall Functional Outcomes

Overall Functional Outcomes Following Physiotherapy Intervention

Comparison of pre- and post-intervention mean scores for all functional outcome measures.

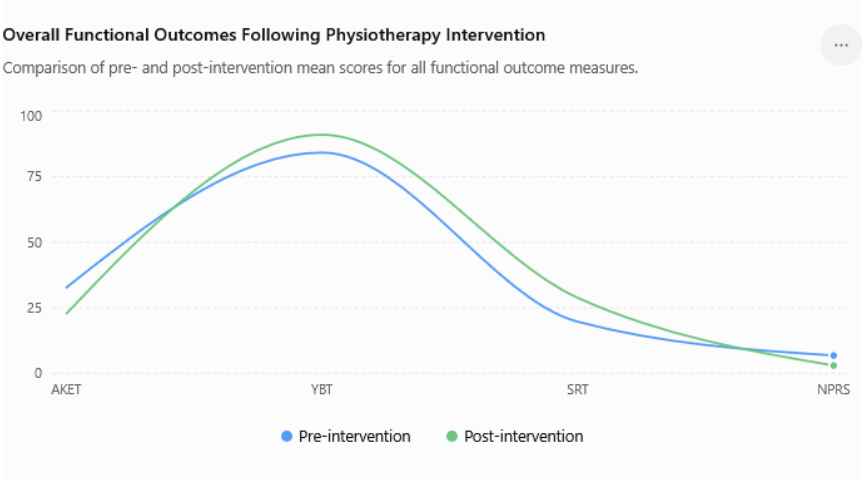


Figure 2. Percentage Improvement

Percentage Improvement in Functional Outcomes

Percentage change from baseline after physiotherapy intervention.

YBT

Improvement8.1%

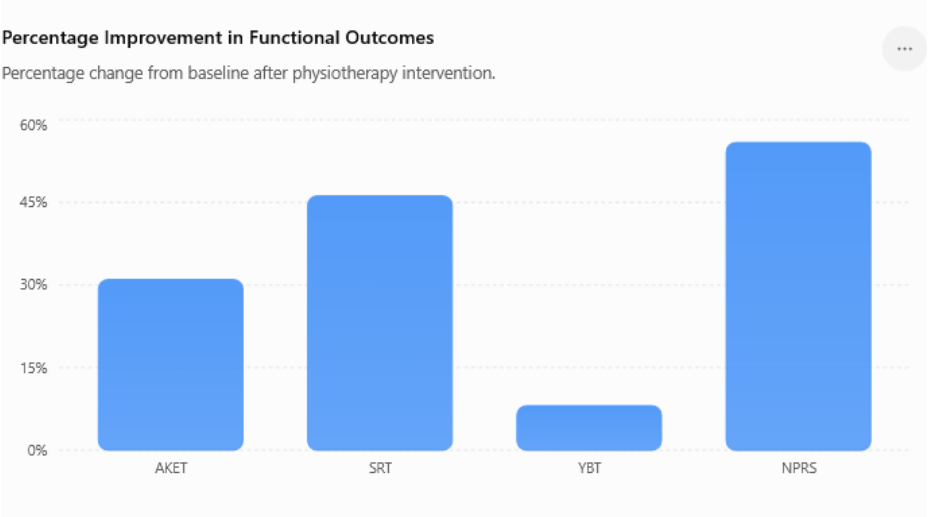


Figure 3. Baseline Characteristics

Gender Distribution

Distribution of participants by gender (n = 40).

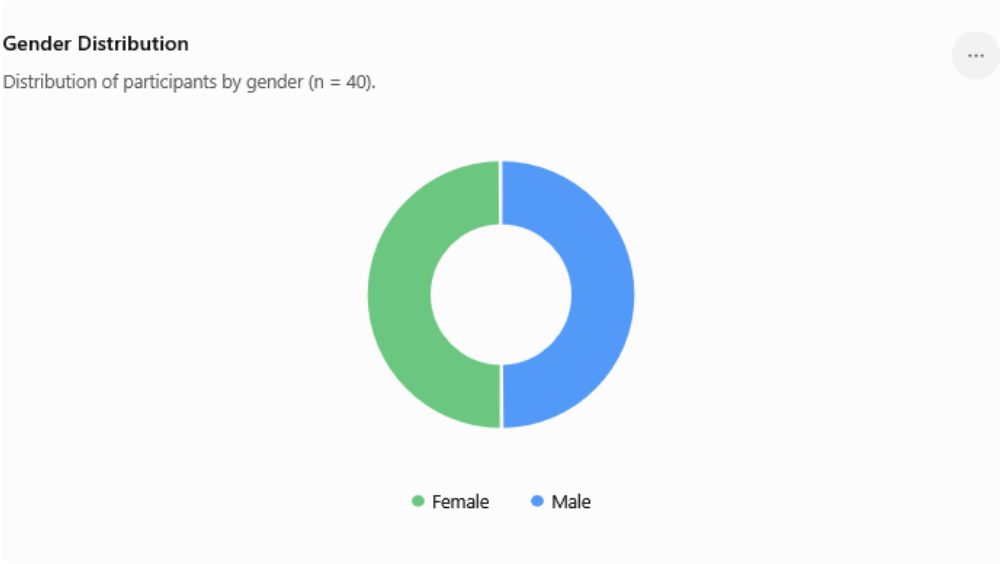


Figure 4. Age Distribution
Age Distribution of Participants
Distribution of participants across age groups.

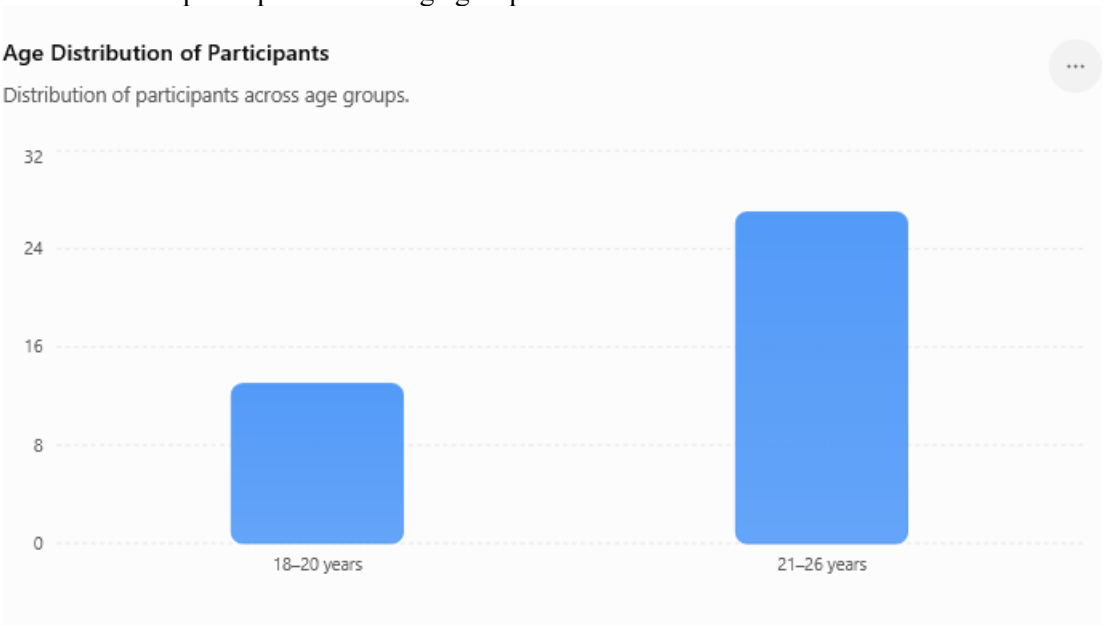
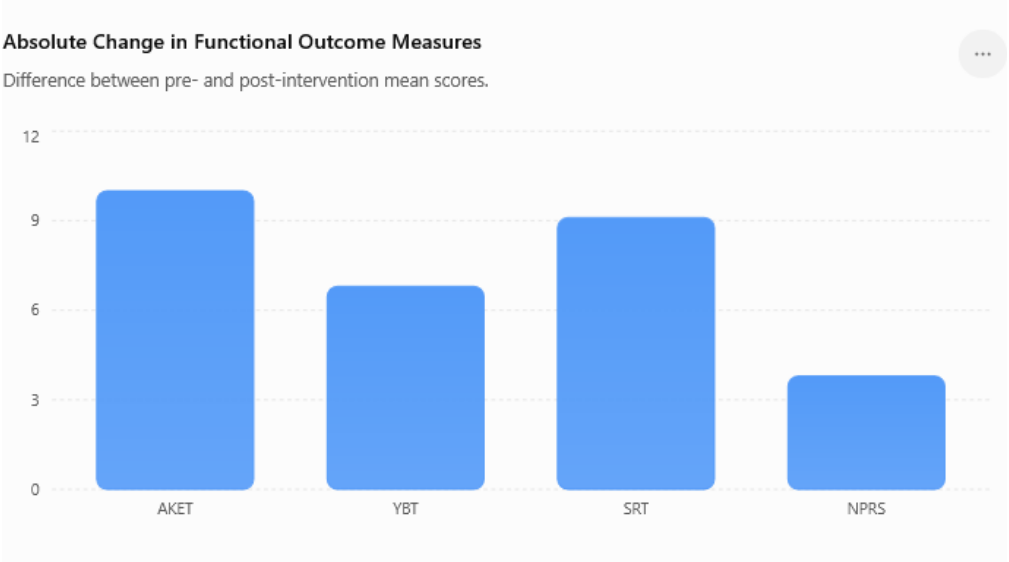


Figure 5. Functional Improvement Across Outcome Measures
Absolute Change in Functional Outcome Measures
Difference between pre- and post-intervention mean scores.



Overall Functional Outcomes

The physiotherapy intervention resulted in significant improvements across all functional outcome measures. Hamstring flexibility improved substantially, as evidenced by reduced AKET scores and increased SRT scores. Dynamic balance showed significant enhancement, reflected by improved YBT performance, while pain intensity was significantly reduced following intervention. Collectively, these findings demonstrate that physiotherapy intervention effectively improved flexibility, balance, and pain in young adults with hamstring tightness.

Discussion

The present study evaluated the functional outcomes of physiotherapy intervention in young adults with hamstring tightness by examining changes in hamstring flexibility, dynamic balance, and pain. The findings demonstrated significant improvements across all measured outcomes following the intervention. Significant reductions in Active Knee Extension Test (AKET) scores, together with improvements in Sit-and-Reach Test (SRT) and Y-Balance Test (YBT) performance and a reduction in Numeric Pain Rating Scale (NPRS) scores, indicate that physiotherapy intervention effectively enhanced lower-limb flexibility, postural control, and functional performance while reducing pain in this population.

The improvement in hamstring flexibility observed in the present study is consistent with previous literature reporting the beneficial effects of physiotherapy interventions on muscle extensibility. Medeiros et al. conducted a systematic review and meta-analysis and concluded that structured flexibility interventions significantly improve hamstring flexibility in healthy young adults. Similarly, Decoster et al. reported that regular stretching interventions effectively increase hamstring extensibility and contribute to improved lower-extremity function. The substantial improvement observed in the present study further supports the effectiveness of physiotherapy in restoring normal muscle length and joint mobility.

The mean AKET score demonstrated a clinically meaningful reduction following intervention, indicating improved hamstring extensibility. Hamstring flexibility is essential for maintaining normal hip and knee mechanics during functional activities. Increased muscle extensibility reduces passive resistance to movement, improves pelvic mobility, and allows greater range of motion during gait and other functional tasks. These biomechanical adaptations may explain the significant improvement observed in the present study.

The significant improvement in Sit-and-Reach Test performance further confirms the positive effect of physiotherapy on posterior chain flexibility. Similar findings have been reported by Bandy and Irion, who demonstrated that regular stretching programmes significantly improve hamstring flexibility regardless of the stretching technique employed. Likewise, Konrad et al., in a recent systematic review, concluded that chronic stretching interventions consistently improve joint range of motion and flexibility, supporting the improvements observed in the present investigation.

Dynamic balance also improved significantly following physiotherapy intervention. Balance is a complex motor function requiring coordinated interaction between the musculoskeletal, proprioceptive, vestibular, and central nervous systems. Hamstring tightness may restrict lower-limb movement, alter pelvic mechanics, and impair neuromuscular coordination, ultimately reducing postural stability. Restoration of muscle extensibility through physiotherapy may therefore improve

sensorimotor control and facilitate more efficient balance strategies.

The improvement in Y-Balance Test performance observed in this study agrees with the findings of Encarnación-Martínez et al., who reported that individuals with hamstring tightness exhibited poorer dynamic balance than those with normal flexibility. They suggested that restricted hamstring extensibility alters lower-limb biomechanics and limits reach distance during dynamic balance tasks. Similarly, Martínez-López et al. demonstrated that interventions aimed at improving flexibility and proprioception significantly enhanced balance and functional mobility, further supporting the present findings.

Pain intensity also decreased significantly following physiotherapy intervention. Hamstring tightness increases passive tension within the musculotendinous unit and may contribute to discomfort during movement and functional activities. Improved muscle extensibility may reduce mechanical stress, improve tissue compliance, and normalize movement patterns, thereby decreasing pain. In addition, therapeutic exercise and manual physiotherapy techniques may improve local circulation, reduce muscle guarding, and enhance neuromuscular control, contributing to symptom relief.

The overall findings of the present study indicate that improvements in flexibility were accompanied by improvements in dynamic balance and pain reduction. These changes suggest that physiotherapy intervention influences not only muscle extensibility but also functional performance. Improved hamstring flexibility may facilitate more efficient lower-limb biomechanics, enhance proprioceptive input, and improve postural stability during dynamic activities. Consequently, rehabilitation programmes targeting hamstring tightness should focus on functional recovery rather than flexibility alone.

From a clinical perspective, the findings support the routine use of physiotherapy interventions in young adults with hamstring tightness. Improvement in flexibility, balance, and pain may contribute to enhanced participation in sports, recreational activities, and activities of daily living while potentially reducing the risk of future musculoskeletal injury. The use of validated outcome measures, including AKET, SRT, YBT, and NPRS, also provides clinicians with practical tools for monitoring rehabilitation progress and treatment effectiveness.

Despite these encouraging findings, several limitations should be acknowledged. The study was conducted at a single institution and included a relatively small sample of young adults, which may limit the generalizability of the results. The absence of long-term follow-up prevents assessment of the sustainability of the observed improvements. Furthermore, objective biomechanical assessments such as three-dimensional motion analysis, electromyography, or ultrasound imaging were not included and may have provided additional insight into the mechanisms underlying functional improvement.

Future studies should include larger multicentre cohorts, longer follow-up periods, and objective biomechanical outcome measures to evaluate long-term treatment effectiveness. Further research should also investigate whether improvements in hamstring flexibility are associated with reductions in injury risk and enhanced athletic performance across different populations. Additionally, studies comparing different physiotherapy approaches using standardized protocols would strengthen the evidence base for the conservative management of hamstring tightness.

Overall, the present study demonstrates that physiotherapy intervention significantly improves hamstring flexibility, dynamic balance, and pain in young adults with hamstring tightness. These findings reinforce the role of physiotherapy as an effective conservative approach for restoring lower-limb function and improving overall physical performance in this population.

Conclusion

The present study demonstrated that physiotherapy intervention significantly improved hamstring flexibility, dynamic balance, and pain in young adults with hamstring tightness. Significant improvements were observed in the Active Knee Extension Test, Sit-and-Reach Test, and Y-Balance Test, accompanied by a clinically meaningful reduction in pain intensity following intervention. These findings indicate that physiotherapy is effective in restoring muscle extensibility, enhancing postural control, and improving functional performance in individuals with hamstring tightness. The results support the integration of structured physiotherapy interventions into routine clinical practice for the conservative management of hamstring tightness and emphasize the importance of comprehensive functional assessment during rehabilitation.

Clinical Implications

The findings of the present study have important implications for physiotherapy practice.

- Physiotherapy intervention can effectively improve hamstring flexibility, dynamic balance, and pain in young adults with hamstring tightness.
- Improvement in hamstring flexibility may contribute to better functional performance and postural control during daily and sports-related

activities.
- The Active Knee Extension Test, Sit-and-Reach Test, Y-Balance Test, and Numeric Pain Rating Scale are practical clinical tools for evaluating treatment outcomes.
- Early physiotherapy intervention may help reduce functional limitations and potentially decrease the risk of future lower-extremity musculoskeletal injuries.

Strengths of the Study
- Prospective pre–post experimental study design.
- Assessment of multiple clinically relevant functional outcomes.
- Use of standardized and validated outcome measures.
- Inclusion of flexibility, balance, and pain assessment within the same study.
- Findings directly applicable to routine physiotherapy and sports rehabilitation practice.

Limitations
- The study was conducted at a single centre, which may limit the generalizability of the findings.
- The sample size was relatively small.
- Long-term follow-up was not performed; therefore, the persistence of treatment effects could not be determined.
- Biomechanical and electromyographic assessments were not included to objectively evaluate movement adaptations.
- The study population consisted only of young adults; therefore, the findings may not be generalizable to older adults or individuals with specific musculoskeletal disorders.

Future Recommendations

Future studies should include larger multicentre samples with longer follow-up periods to evaluate the long-term effectiveness of physiotherapy interventions for hamstring tightness. Incorporating objective biomechanical assessments, electromyography, and motion analysis may provide further insight into the mechanisms underlying functional improvement. Comparative studies evaluating different physiotherapy interventions across athletic and non-athletic populations are also recommended to strengthen clinical evidence and optimize rehabilitation protocols.

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Ethical Approval

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee of Pacific Medical University, Udaipur, Rajasthan, India.

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