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COMPARE THE EFFECTIVENESS OF DYNAMIC STRETCHING WITH CONVENTIONAL PHYSICAL THERAPY ON HAMSTRING FLEXIBILITY IN CHILDREN WITH SPASTIC CEREBRAL PALSY

Original Article

Gulnaz Yamin[1]*, Suriyakala Perumal Chandran[1]
[1]Lincoln University College, Malaysia

Corresponding Author: Gulnaz Yamin, gyamin@lincoln.edu.my, Lincoln University College, Malaysia

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ABSTRACT

Background: Cerebral palsy is a permanent, non-progressive neurodevelopmental condition characterized by impaired movement, posture, and muscle tone, often resulting in functional limitations in daily activities. Spastic cerebral palsy is the most prevalent subtype and is commonly associated with hamstring shortening due to persistent spasticity, leading to restricted knee extension and compromised mobility. Stretching interventions are routinely used in rehabilitation; however, evidence comparing the effectiveness of dynamic and conventional stretching in children with spastic cerebral palsy remains limited.

Objective: To compare the effectiveness of dynamic stretching versus conventional stretching in improving hamstring flexibility in children with spastic quadriplegic cerebral palsy.

Methods: A pre-test/post-test quasi-experimental study was conducted over eight weeks at three pediatric rehabilitation centers in Lahore. Thirty-six children aged 5–14 years with spastic quadriplegic cerebral palsy were recruited using convenience sampling and divided into two equal groups. Both groups received standardized moist heat prior to intervention. One group underwent dynamic hamstring stretching, while the other received conventional stretching, under the supervision of certified physiotherapists. Therapy was administered for 30 minutes per session, five times per week, totaling 20 hours. Hamstring flexibility was assessed using goniometric measurement of the popliteal angle in a non-weight-bearing position before and after intervention.

Results: Within-group analysis demonstrated significant improvements in hamstring flexibility in both groups ($p < 0.05$). In the dynamic stretching group, mean improvement in popliteal angle was 9.44 ± 5.87 degrees in the left leg and 11.11 ± 6.12 degrees in the right leg. In the conventional stretching group, improvements were 6.33 ± 2.59 degrees in the left leg and 5.28 ± 1.93 degrees in the right leg. Between-group analysis revealed significantly greater improvements in the dynamic stretching group for both limbs ($p < 0.05$).

Conclusion: Both dynamic and conventional stretching were effective in improving hamstring flexibility in children with spastic cerebral palsy; however, dynamic stretching demonstrated superior outcomes, supporting its integration into routine pediatric neurorehabilitation programs.

Keywords: Cerebral palsy; Flexibility; Hamstring muscles; Physical therapy modalities; Rehabilitation; Spasticity; Stretching exercises

INTRODUCTION

Cerebral palsy is a group of permanent, non-progressive neurological disorders originating from injury or abnormal development of the immature brain, primarily affecting movement, posture, and functional mobility. Although the underlying brain lesion is non-progressive, the musculoskeletal manifestations evolve over time, often leading to progressive activity limitations and reduced participation in daily life. Children with cerebral palsy frequently present with associated impairments in sensation, cognition, communication, behavior, and musculoskeletal alignment, all of which compound functional disability and caregiver burden (1). Globally, cerebral palsy remains one of the most common causes of childhood physical disability, with reported prevalence ranging from approximately 1.5 to over 4 per 1,000 live births (2). Regional data from Pakistan further highlight the burden of this condition, where a substantial proportion of pediatric neurological cases are attributed to cerebral palsy, predominantly characterized by abnormalities in muscle tone, posture, and locomotion (3).

Spastic cerebral palsy is the most prevalent clinical subtype, accounting for nearly three-quarters of all cases, and is defined by velocity-dependent increases in muscle tone and exaggerated tendon reflexes (3). Within this category, spastic quadriplegia represents one of the most severe presentations, involving significant impairment of all four limbs along with trunk and neck control, thereby profoundly affecting gross motor function and independence (4). A central and clinically relevant feature of spastic cerebral palsy is muscle spasticity, which contributes to increased muscle stiffness, shortened muscle length, and reduced extensibility of the muscle–tendon unit. Over time, these changes predispose children to joint contractures, restricted range of motion, gait abnormalities, and functional decline, particularly in bi-articular muscles such as the hamstrings, which play a critical role in posture and mobility (5).

Management of cerebral palsy is inherently multidisciplinary and aims to optimize function, minimize secondary complications, and enhance quality of life. Therapeutic strategies commonly include pharmacological interventions such as antispasticity agents, orthotic management, botulinum toxin injections, task-oriented and bimanual training, fitness and activity-based programs, caregiver-guided home exercise plans, and surgical procedures in selected cases (6). Within this spectrum, physical therapy remains a cornerstone of conservative management, focusing on improving muscle strength, endurance, joint mobility, and functional skills through individualized and goal-directed interventions (7). Traditional or conventional physical therapy approaches in children with cerebral palsy have demonstrated beneficial effects on overall motor performance and joint range; however, persistent muscle tightness and spasticity often limit the magnitude and sustainability of these gains (7).

Stretching interventions are routinely incorporated into rehabilitation programs for children with spastic cerebral palsy to address muscle shortening and resistance to elongation caused by altered muscle fiber properties and increased passive stiffness (8). Sustained stretching has been reported to improve joint range of motion and may contribute to short-term reductions in spasticity by influencing the mechanical and neurophysiological characteristics of the muscle–tendon unit (8). Nevertheless, conventional stretching techniques are frequently passive, therapist-dependent, and time-intensive, which may limit adherence and functional carryover into daily activities. In contrast, dynamic stretching, characterized by controlled, active movements through the available range of motion, has gained increasing attention for its potential to enhance muscle extensibility while simultaneously engaging neuromuscular control mechanisms (9). Despite its growing use in pediatric rehabilitation, evidence directly comparing dynamic stretching with conventional physical therapy approaches in children with spastic cerebral palsy remains limited, particularly with respect to clinically meaningful outcomes such as hamstring flexibility.

Given the pivotal role of hamstring flexibility in posture, gait, and functional mobility, and the ongoing need for effective, practical interventions that can be integrated into routine therapy and home programs, there is a clear need to evaluate alternative stretching strategies in this population. Therefore, the objective of the present study is to compare the effectiveness of dynamic stretching versus conventional physical therapy in improving hamstring flexibility in children with spastic cerebral palsy, with the rationale of identifying a more effective and functionally relevant approach to address muscle tightness and enhance rehabilitation outcomes.

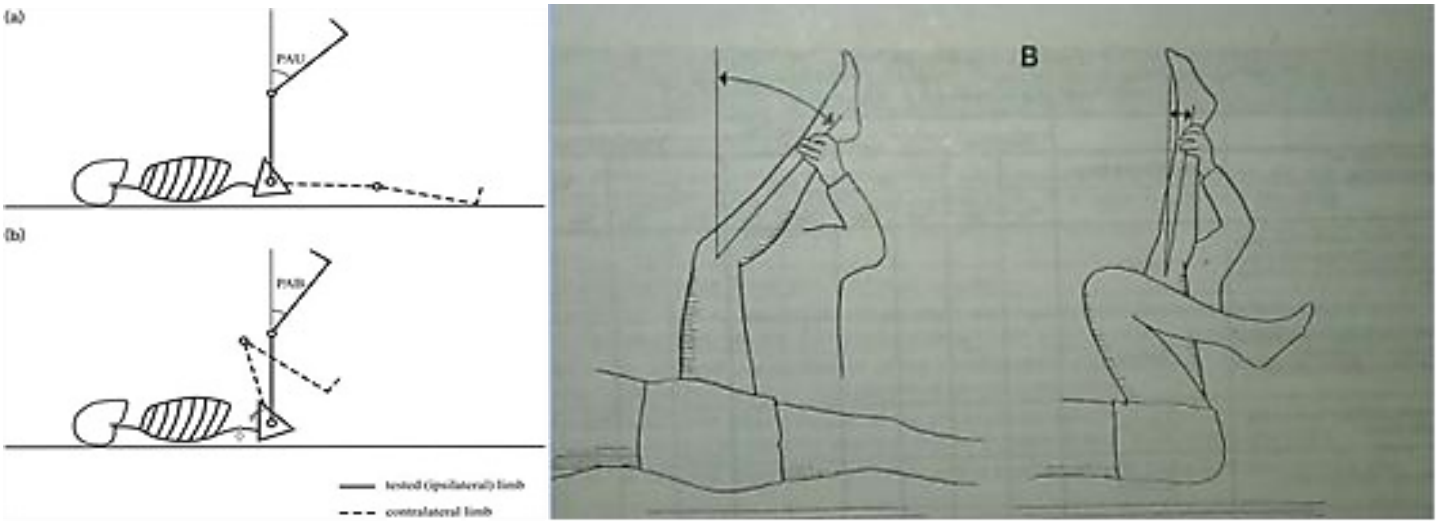
METHODS

This pre-test/post-test quasi-experimental study was conducted over a period of six months following formal ethical approval obtained from the relevant institutional ethical review committee prior to initiation of data collection. The study was carried out across three pediatric rehabilitation centers in Lahore, Pakistan, namely Mobility Quest Lahore, Rising Sun Lahore, and Compass Lahore. Ethical principles outlined in the Declaration of Helsinki were adhered to throughout the study, and written informed consent was obtained from the parents or legal guardians of all participating children before enrollment. A total of 36 children were recruited using a non-probability convenience sampling technique. Participants included children aged between 5 and 14 years who had a confirmed medical diagnosis of spastic quadriplegic cerebral palsy. Eligibility criteria further required that children had the cognitive ability to follow simple verbal commands, demonstrated lower limb impairment as documented by a medical practitioner, were able to sit independently or maintain fundamental sitting balance, and exhibited reduced knee extension as evidenced by an increased popliteal angle. Children were excluded

if they had a history of uncontrolled seizures, significant visual or hearing impairments that could interfere with therapy participation, or any form of cerebral palsy other than spastic quadriplegia.

Following enrollment, participants were allocated into two equal groups, each comprising 18 children. Both groups received standardized preparatory intervention consisting of 10 minutes of moist heat application using a thermal pack prior to stretching. Subsequently, one group underwent dynamic hamstring stretching, while the second group received conventional hamstring stretching. All interventions were delivered under the direct supervision of certified physiotherapists to ensure consistency and safety. The treatment protocol was administered for a total of 20 hours over an eight-week period, with sessions lasting 30 minutes per day, five days per week. Outcome assessment focused on hamstring flexibility, which was evaluated using a universal goniometer. Measurements were taken at baseline (pre-test) and at the completion of the eight-week intervention period (post-test). Hamstring flexibility was quantified through measurement of the popliteal angle in a non-weight-bearing position. For this assessment, the hip and knee were initially positioned at 90 degrees of flexion, after which the knee was passively extended, and the angle between the longitudinal axes of the femur and tibia was recorded. A popliteal angle of zero degrees indicated full knee extension and absence of hamstring tightness, whereas angles exceeding 20 degrees were indicative of hamstring shortening. Given the underlying neuromuscular pathology in children with cerebral palsy, baseline popliteal angles around 40 degrees were considered consistent with values reported in existing literature and were deemed appropriate for this population (10).

Data were analyzed using the Statistical Package for Social Sciences (SPSS) software, version 20 (SPSS Inc., Chicago, USA). Descriptive statistics were calculated for demographic and baseline characteristics. Within-group comparisons of pre- and post-intervention values were performed using paired t-tests, while between-group differences were analyzed using independent sample t-tests. Statistical significance was determined through hypothesis testing, with p-values interpreted according to conventional thresholds.



RESULTS

A total of 36 children diagnosed with spastic cerebral palsy completed the study, with 18 participants allocated to the dynamic stretching group and 18 to the conventional stretching group. Baseline socio-demographic characteristics demonstrated that both groups were comparable prior to intervention. The mean age of participants in the dynamic stretching group was 8.94 ± 2.60 years, while the conventional stretching group had a mean age of 9.89 ± 2.56 years. Mean height was 4.17 ± 0.62 feet in the dynamic stretching group and 4.53 ± 0.44 feet in the conventional stretching group, whereas mean body weight was 37.94 ± 5.21 kg and 41.39 ± 3.85 kg, respectively. Gender distribution was also similar between groups, with males comprising 55.6% in the dynamic stretching group and 50% in the conventional stretching group. Statistical comparison using independent sample t-tests and chi-square analysis showed no significant differences in baseline characteristics between groups ($p > 0.05$), confirming group comparability prior to intervention.

Data normality was assessed using the Shapiro–Wilk test and was found to be normally distributed, allowing the use of parametric statistical analyses. Within-group analysis revealed significant improvements in hamstring flexibility in both intervention groups following the eight-week treatment period. In the dynamic stretching group, the mean popliteal angle of the left leg decreased from 40.28 ± 12.98 degrees at baseline to 30.83 ± 11.43 degrees post-intervention, reflecting a mean improvement of 9.44 ± 5.87 degrees. Similarly, the right leg showed a reduction from 43.06 ± 13.20 degrees to 31.94 ± 11.38 degrees, with a mean improvement of 11.11 ± 6.12 degrees. These changes were statistically significant for both limbs ($p < 0.05$).

In the conventional stretching group, significant improvements were also observed, though of lesser magnitude. The left leg popliteal angle improved from a baseline value of 45.11 ± 10.75 degrees to 38.78 ± 11.10 degrees post-treatment, yielding a mean improvement of 6.33 ± 2.59 degrees. For the right leg, the mean popliteal angle decreased from 42.17 ± 12.69 degrees to 36.89 ± 12.12 degrees, corresponding to an improvement of 5.28 ± 1.93 degrees. Paired sample t-test analysis confirmed that these within-group changes were statistically significant ($p < 0.05$).

Between-group analysis demonstrated a statistically significant difference in the magnitude of improvement favoring dynamic stretching. The mean improvement in left leg hamstring flexibility was 9.44 ± 5.87 degrees in the dynamic stretching group compared to 6.33 ± 2.59 degrees in the conventional stretching group ($p = 0.04$). For the right leg, improvement was 11.11 ± 6.12 degrees in the dynamic stretching group versus 5.28 ± 1.93 degrees in the conventional stretching group, with a highly significant difference between groups ($p < 0.05$). These findings indicated that dynamic stretching resulted in greater gains in hamstring flexibility than conventional stretching in children with spastic cerebral palsy, leading to rejection of the null hypothesis and acceptance of the alternative hypothesis.

Table 1 Socio-demographic comparison

Variable		**Group A (Dynamic Stretching) n=18**	**Group B (Conventional Stretching) n=18**	**p-value**
Age		8.94±2.6	9.89±2.56	0.28
Height		4.17±0.62	4.53±0.44	0.52
Weight		37.94±5.21	41.39±3.85	0.31
Gender	**Male**	10(55.6%)	9(50%)	0.99
	Female	8(44.4%)	9(50%)	

P value significant ≤ 0.05*

Table 2 Within Group Analysis (Effectiveness of treatments)

Variable and Group		Pre Treatment	Post Treatment	Improvement	P-Value
Group A (Dynamic Stretching)	Left Leg	40.28±12.98	30.83±11.43	9.44±5.87	0.00*
	Right Leg	43.06±13.2	31.94±11.38	11.11±6.12	0.00*
Group B (Conventional Stretching)	Left Leg	45.11±10.75	38.78±11.1	6.33±2.59	0.00*
	Right Leg	42.17±12.69	36.89±12.12	5.28±1.93	0.00*

P value significant ≤ 0.05*

Table 3 Between Group Analysis (Comparison of effectiveness of treatments)

Variable	**Group A (Dynamic Stretching)**	**Group B (Conventional Stretching)**	**P-Value**
	Improvement	**Improvement**	
Left Leg	9.44±5.87	6.33±2.59	0.04*
Right Leg	11.11±6.12	5.28±1.93	0.00*

P value significant ≤ 0.05*

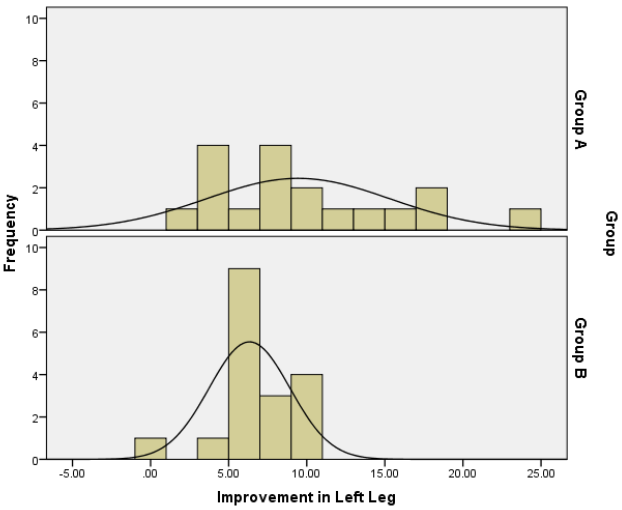


Figure 1: Comparison of improvement of hamstring flexibility in left leg among both groups

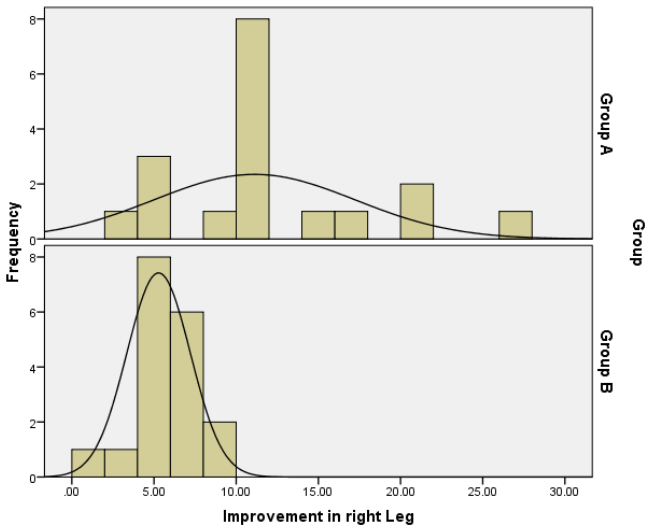


Figure 2 Comparison of improvement in hamstring flexibility of right leg among both groups

DISCUSSION

The present study examined the comparative effectiveness of dynamic stretching and conventional stretching in improving hamstring flexibility among children with spastic cerebral palsy. The findings demonstrated that both stretching approaches produced statistically significant improvements in hamstring length, as reflected by reductions in the popliteal angle; however, dynamic stretching resulted in significantly greater improvements than conventional stretching. These results support the study objective and suggest that incorporating active movement components within stretching protocols may enhance flexibility outcomes in this population. The observed improvement in hamstring flexibility following both interventions aligns with existing evidence indicating that stretching interventions can effectively address muscle shortening and increased stiffness commonly seen in spastic cerebral palsy (11). Stretching is widely used in pediatric neurorehabilitation to counteract the biomechanical consequences of spasticity, including reduced muscle extensibility and altered muscle–tendon unit properties. The greater gains associated with dynamic stretching in the present study may be attributed to its active nature, which combines controlled movement with muscle elongation, potentially facilitating improved neuromuscular coordination and more functional lengthening of the muscle compared to passive techniques alone (12).

Comparable findings have been reported in previous investigations evaluating functional or dynamic stretching approaches in children with spastic cerebral palsy, where greater reductions in popliteal angle and improved lower limb flexibility were observed compared to conventional stretching methods (13). Additionally, studies examining combined stretching and active movement interventions in children with spastic diplegia have demonstrated improvements not only in muscle flexibility but also in motor performance and walking efficiency, likely mediated through reductions in spasticity and enhanced voluntary muscle control (14). These findings collectively reinforce the notion that interventions integrating active components may yield broader neuromuscular benefits than passive stretching alone. The present results are also consistent with evidence from other neurological populations, where prolonged or functionally oriented stretching has been shown to reduce spasticity and improve functional abilities (15). Chronic spasticity is known to contribute to progressive contracture formation, particularly in bi-articular muscles such as the hamstrings, and stretching interventions remain a key strategy for mitigating these secondary musculoskeletal complications (16). Furthermore, structural studies have demonstrated that muscles in children with cerebral palsy exhibit increased stiffness and altered fiber composition compared to typically developing children, which may limit responsiveness to passive stretching and underscore the potential advantage of dynamic, movement-based approaches (17).

Several strengths of this study should be acknowledged. The use of standardized goniometric measurement of the popliteal angle provided an objective and clinically relevant assessment of hamstring flexibility. The inclusion of comparable groups at baseline and the application of supervised, protocol-driven interventions enhanced internal validity. Additionally, the intervention duration and frequency reflected realistic clinical practice, supporting the practical relevance of the findings (18). Despite these strengths, certain limitations warrant consideration. The quasi-experimental design and use of convenience sampling may limit generalizability and introduce selection bias. The relatively small sample size and absence of random allocation further restrict the strength of causal inferences. Moreover, the study focused solely on hamstring flexibility, without assessing functional outcomes such as gait parameters,

balance, or participation-level measures, which are critical for understanding the real-world impact of improved muscle extensibility. The lack of long-term follow-up also precluded evaluation of the sustainability of treatment effects (18, 12).

Future research should address these limitations by employing randomized controlled designs with larger sample sizes and extended follow-up periods. Incorporation of functional outcome measures and spasticity grading scales would provide a more comprehensive understanding of the clinical significance of dynamic stretching. Additionally, exploring the effects of combining dynamic stretching with other evidence-based interventions may further optimize rehabilitation strategies for children with spastic cerebral palsy. Overall, while both stretching techniques were beneficial, the present findings suggest that dynamic stretching may offer superior improvements in hamstring flexibility and represents a promising adjunct to conventional physical therapy in this population.

CONCLUSION

The findings of this study demonstrated that both dynamic stretching and conventional stretching were effective in improving hamstring flexibility in children with spastic cerebral palsy; however, dynamic stretching produced superior outcomes. These results highlight the clinical value of incorporating active, movement-based stretching into routine rehabilitation programs to more effectively address muscle tightness associated with spasticity. By offering greater improvements in flexibility within a practical therapeutic framework, dynamic stretching may enhance the quality of physical therapy interventions and contribute to better functional potential in this population, thereby supporting its broader application in pediatric neurorehabilitation.

AUTHOR CONTRIBUTIONS

Author	Contribution
Gulnaz Yamin	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Suriyakala Perumal Chandran	Methodology, Investigation, Data Curation, Writing - Review & Editing

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