Modern Journal of Health and Applied Sciences *(MJHAS)*

E-ISSN 3078-2791; P-ISSN 3078-2783

Journal homepage: https://mucjournals.muc.edu.ps/index.php/MJHAS

Static Stretch on Calf Muscle Spasticity in Cerebral Palsy Children

Fatima Alawad [1], *Hassan Abdelnour* [2,3]*, *and Wisal Ahmed* [4,5]

[1] Faculty of Physiotherapy, Al Neelain University, Khartoum. Sudan.
[2] Department of Rehabilitation Sciences. College of Medical Sciences, Northern Border University, Arar, KSA.
[3] Department of Physiotherapy, School of Health Sciences, Ahfad University for Women, Omdurman, Sudan.
[4] Department of Pediatrics, Faculty of Medicine, Al Neelain University, Khartoum, Sudan.
[5] Pediatric Specialists, Department of Pediatrics, Sultan Qaboos Hospital, Dhofar, Oman.

ARTICLE INFO

Received:03rd March 2026
Received in revised form: 21st May 2026
Accepted: 29th May 2026
Published: 15th September 2026

***Corresponding Author:**
Hassan Abdelnour
E-mail :
hasphysio@gmail.com

Citation : Alawad, F., Abdelnour, H., & Ahmed, W. (2026). Static stretch on calf muscle spasticity in cerebral palsy children. *Modern Journal of Health and Applied Sciences*, 3(2), 01-08.

Copyright © 2026 The Author(s). Published by Modern University College.

Open Access

This work is licensed under a Creative Commons Attribution Non Commercial 4.0 International license.

ABSTRACT

Cerebral palsy (CP) encompasses a group of developmental disorders affecting movement and posture, leading to activity limitations. These conditions stem from non-progressive disturbances in the brain that occur during fetal or infant development. Spastic cerebral palsy is the most common, affecting about 70% to 80% of children with the condition. Functional and clinical assessments were performed pre- and post-intervention using the Modified Ashworth Scale (MAS) to evaluate calf muscle spasticity and goniometry to measure the Range of Motion (ROM) for passive ankle dorsiflexion. Structured questionnaires used to assess socioeconomic and functional status. The intervention consisted of static muscle stretching for the calf muscles to reduce spasticity and increase ankle range of motion. Data were analyzed using SPSS version 21. All ethical considerations were maintained.

The study involved 26 participants, primarily characterized by quadriplegic cerebral palsy (CP) (66%, n = 17) and high levels of motor disability, with 53.8% (n=14) classified at Gross Motor Function Classification System (GMFCS) Level 5. Clinical evaluations focusing on spasticity using the Modified Ashworth Scale (MAS) showed no statistically significant reduction following the intervention; instead, mean scores increased from 2.0 to 2.5 on the right side ($p = 0.916$) and from 1.9 to 2.3 on the left side ($p = 0.437$). The treatment produced significant improvements in joint flexibility. Paired sample t-tests for passive ankle dorsiflexion range of motion (ROM) revealed a statistically significant increase on both the right side (12° to 15°; $p = 0.001$) and the left side (12° to 15°; $p = 0.004$). Despite no positive change in calf muscle spasticity, the intervention significantly improved ankle dorsiflexion ROM. This helps high-dependency patients reach the mobility levels needed for functional gait.

Keywords: Static stretch, Cerebral Palsy (CP), Spasticity, Calf muscle.

DOI: https://doi.org/10.70411/MJHAS.3.2.2026375

1. Introduction

Cerebral palsy (CP) refers to a set of lifelong neurological disorders that emerge during infancy and result from abnormal brain development or damage. These non-progressive conditions lead to enduring challenges with movement, posture, and coordination. The incidence rate is around 3.4 per 1,000 live births, making it the most common motor impairment, which can also affect cognitive and intellectual abilities (Almalty et al., 2025).

Spasticity refers to a condition where muscles become stiff and rigid, accompanied by overactive reflexes. This results from damage to the brain or spinal cord and often leads to involuntary muscle spasms, pain, and limited mobility (National Institute of Neurological Disorders and Stroke, 2023). Spasticity is frequently occurring in individuals affected by CP. Spasticity impacts over 12 million people globally, with prevalence rates differing widely depending on the associated neurological condition. It is most commonly observed in individuals with CP, affecting between 70% and 90% of patients (Barnes & Johnson, 2008).

Stretching is a physical activity focused on intentionally flexing and extending muscles and tendons to enhance elasticity, flexibility, and the range of motion in joints. Stretching serves as an essential, evidence-supported, and non-invasive approach to managing spasticity in individuals with CP. It helps decrease muscle stiffness, enhances range of motion (ROM), and minimizes the risk of contractures. Stretching interventions for spastic CP produce mixed outcomes, with research indicating an average improvement of around 10° in maximum ankle dorsiflexion after stretching (Kruse et al., 2022). Additionally, acute stretching may result in a 14.6% elongation of the muscle-tendon unit.

Calf muscle spasticity, commonly known as equinus gait, is highly prevalent in cases of spastic CP, impacting a significant proportion of children with diplegia or hemiplegia (Graham et al., 2016a). Among the 60–80% of CP cases classified as spastic, lower limb spasticity is a frequent concern. Research shows particularly high rates of rigid equinus, with some studies reporting its occurrence in over 90% of the populations examined (Horsch et al., 2021).

Sudan, known officially as the Republic of Sudan, is a nation situated in Northeast Africa (Horsch et al., 2021). Spasticity represents the most common type of CP in Sudan, encompassing a substantial majority of cases. Research consistently identifies spastic quadriplegic CP as the predominant subtype, with reported frequencies ranging from 43.5% to 86.6%. Among Sudanese children, spastic forms account for over 69% of cases, often attributed to perinatal factors such as asphyxia (Satti et al., 2026).

Usratuna Sudanese Association for Disabled Children (USADC) is a non-governmental organization (NGO) founded in 1999 (Abdullahi et al., 2013). It has maintained a long-term partnership with the Italian NGO, Organismo di Volontariato per la Cooperazione Internazionale (OVCI). The organization focuses on providing rehabilitation services for children with disabilities, including spastic CP conditions (Abdelnour, 2020). Therefore, this study aimed to evaluate the effect of stretching on the spastic calf muscle in CP children at USADC.

2. Methodology

This study employed a quasi-experimental, pre- and post-interventional design focusing on a single cohort of children with spastic-type CP. The research was conducted at the USADC, located on Arda Street in Omdurman, Khartoum, Sudan. The center serves approximately 35 cases monthly, primarily children with neurological and musculoskeletal disorders. In collaboration with Ahfad University for Women (AUW) and OVCI, the center provides comprehensive, cost-free physiotherapy and rehabilitation services to the community.

The target population consisted of children diagnosed with CP, aged 2 to 10 years, presenting with calf muscle spasticity of Grade 3 or less on the Modified Ashworth Scale (MAS). For the sampling technique, total coverage sampling was used. For Sample Size, 26 children included. Due to the specific clinical population, a total coverage sampling technique was used, enrolling all 26 eligible children who met the inclusion criteria during the study period. No a priori power analysis was performed, and this sample size should be considered exploratory, particularly for detecting changes in spasticity.

Data collection took place between March 8, 2022, and September 27, 2022. Data were collected through structured questionnaires to capture participants' socioeconomic status and functional levels. Clinical assessments were conducted twice (pre-intervention and post-intervention) using the following tools. First, the MAS score was used to measure the grade of spasticity in the calf muscles of both the right and left lower limbs. Second, the goniometry was used to measure the range of motion (ROM) for passive ankle dorsiflexion.

The intervention consisted of a structured static stretching protocol targeting the spastic calf muscles. Each participant received manual static stretching for 3 sets of 30 repetitions, with each stretch held for 5 seconds. Sessions were conducted 3 times a week over a duration of 3 months (12 weeks).

Two independent physiotherapists with BSc degrees helped in data collection. The two physiotherapists underwent a standardized four-day training program prior to the intervention. The training focused on calf muscle static stretching and the assessment of ROM and MAS.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 21. Descriptive statistics summarized the demographic and functional data. A paired t-test was utilized to compare the pre-test and post-test means to determine the intervention's efficacy. The threshold for statistical significance was set at $p < 0.05$.

Ethical approval was granted by the Institutional Review Board of Al Neelain University (NU). Administrative authorization was obtained from the USADC management. Informed consent was obtained from each participant's caregiver through a signed form. This document clearly outlined the study's objectives, procedures, and duration while explicitly stating the right to voluntary participation and withdrawal at any stage without penalty.

3. Results

This study included 26 pediatric patients with cerebral palsy, aged 2 to 9 years, along with their primary caregivers. Demographic data showed a higher prevalence of females (57.7%) compared to males (42.3%).

Table 1, illustrates the distribution of motor disability levels among the 26 study participants, revealing that the majority (53.8%, n=14) function at Level 5, requiring transportation in a wheelchair. This is followed by Level 4 (self-mobility with limitations) at 34.6% (n = 9), while the remaining minority consists of Level 2 (walks with limitations) at 7.7% (n = 2) and Level 3 (walks using a hand-held mobility device) at 3.8% (n = 1).

Table 1. Level of motor disability (n = 26).

Level	Frequency	Percent
Level 5 (transported in wheelchair)	14	53.8
Level 4 (self-mobility with limitations)	9	34.6
Level 3 (walks using hand –held mobility device)	1	3.8
Level 2 (walks with limitation)	2	7.7
Total	26	100.0

Figure 1 shows data analysis regarding the clinical classification of the study participants (n = 26). It revealed that the quadriplegic type of CP was the most predominant form of CP, observed in 66% (n = 17) participants in this study. This was followed by the hemiplegia type, which accounted for 19% (n = 5) of the cases. The remaining 15% (n = 4) of the sample represented the diplegic type of CP.

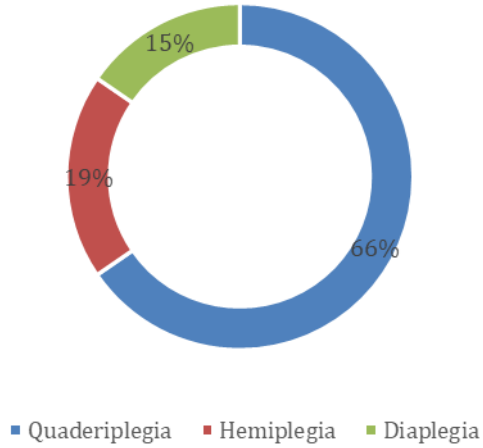


Figure 1. Type of CP (n = 26).

As shown in Table 2, a paired sample t-test (n = 26) analyzing right-side calf spasticity revealed an increase in the mean MAS score from 2.0 pre-treatment to 2.5 post-treatment. The increase in spasticity was not statistically significant (p = 0.916), indicating that the treatment did not produce a measurable reduction in this cohort study.

Table 2. Comparison of the right side pre- and post-treatment for calf spasticity in MAS (n = 26).

Paired Sample T-test					
	Variables	Number	MAS		P -value
			Mean	Std. Deviation	
Pair 1	Pre-treatment	26	2.0	1.13	0.916
	Post-treatment	26	2.5	1.74	

Based on the data provided in Table 3, a paired sample t-test was conducted to evaluate the changes in passive ROM for right-side ankle dorsiflexion following treatment. The results show a statistically significant improvement (p = 0.001), with the mean ROM increasing from 12° at pre-treatment to 15° at post-treatment. This indicates that the intervention effectively increased the flexibility and joint mobility of the ankle in the 26 participants studied.

Table 3. Comparison of the right side pre- and post-treatment for ankle dorsiflexion passive ROM (n = 26).

Paired Sample T-test					
	Variables	Number	ROM		P- value
			Mean	Std. Deviation	
Pair 1	Pre-treatment	26	12	3.6	0.001
	Post-treatment	26	15	4.8	

As shown in Table 4, a paired sample t-test (n = 26) analyzing left-side calf spasticity revealed an increase in the mean MAS score from 1.9 pre-treatment to 2.3 post-treatment. The increase in spasticity was not statistically significant (p = 0.437), indicating the treatment did not produce a measurable reduction in this cohort study.

Table 4. Comparison of the left side pre- and post-treatment for calf spasticity in MAS (n = 26).

Paired Sample T-test					
	;Variables	Number	MAS		P- value
			Mean	Std. Deviation	
Pair 1	Pre-treatment	26	1.9	1.02	0.437
	Post-treatment	26	2.3	1.59	

Based on the data provided in **Table 5**, a paired sample t-test was conducted to evaluate the changes in passive ROM for left-side ankle dorsiflexion following treatment. The results show a statistically significant improvement ($p = 0.004$), with the mean ROM increasing from 12° at pre-treatment to 15° at post-treatment. This indicates that the intervention effectively increased the flexibility and joint mobility of the ankle in the 26 participants studied.

Table 5. Comparison of the left side pre- and post-treatment for ankle dorsiflexion passive ROM (n = 26).

Paired Sample T-test					
	Variables	Number	ROM		P-value
			Mean	Std. Deviation	
Pair 1	Pre-treatment	26	12	3.6	0.004
	Post-treatment	26	15	4.8	

4. Discussion

The study found a significant concentration of motor disability at the more severe end of the functional spectrum, with participants categorized at Levels 4 and 5, which require extensive mobility support or wheelchair transportation. This distribution contrasts with larger population-based registries, where mild impairments at Levels 1 and 2 typically represent the majority, often exceeding 50% of cases (Hassan Abdelnour et al., 2023). The high prevalence of Level 5 in this cohort is clinically critical, as individuals at this stage exhibit profound limitations in head and trunk control and often rely entirely on caregivers for basic mobility (Oskoui, Majnemer, et al., 2013). Such severe motor impairment is consistently associated with a significantly higher caregiver burden, increased psychosocial stress, and a greater need for complex assistive technology (Palisano et al., 2008). Consequently, these results emphasize the urgent need for specialized rehabilitation strategies and robust family support systems tailored to high-dependency populations.

Our findings deviate slightly from large-scale Western registries. For instance, many studies in high-income countries report diplegia or hemiplegia as the most common subtypes, often linked to the increased survival of preterm infants (13). However, the high prevalence of quadriplegia observed in this study aligns more closely with studies conducted in developing regions or specialized tertiary care settings. Research by Oskoui et al. (2013) suggests that in areas where neonatal care may be less accessible or where birth asphyxia remains a primary etiology, the more severe spastic quadriplegic forms of CP tend to be more frequent (Murugasen, 2022). The dominance of quadriplegia in this study suggests a high burden of disability among the participants. Quadriplegic CP is typically associated with greater Gross Motor Function Classification System (GMFCS) levels, which often require total assistance for mobility. It is also associated with increased comorbidities such as oromotor dysfunction, epilepsy, and cognitive impairment (Oskoui, Coutinho, et al., 2013). On the other hand, the relatively lower percentage of diplegic cases in our study is a point of interest. In the literature, spastic diplegia is the "hallmark" of prematurity-related brain

injury. The lower frequency here suggests that the underlying etiologies in this specific participant group are more likely related to extensive cortical damage rather than isolated white matter injury (Rosenbaum et al., 2007)

The analysis of calf spasticity in this study demonstrated a numerical increase in mean MAS scores for both the right side and the left side following treatment. However, these changes failed to reach statistical significance. These findings suggest that the intervention did not produce a measurable reduction in muscle tone within this specific group. The lack of significant improvement may be attributed to the inherent limitations of the MAS, which is often criticized for its subjectivity and lack of sensitivity to subtle clinical changes, particularly in the lower extremities (Graham et al., 2016b). Consequently, while the treatment did not demonstrate efficacy in reducing spasticity according to the MAS, future studies should consider incorporating objective measures, such as electromyography or biomechanical analysis, to better capture physiological shifts in muscle resistance (Graham et al., 2016b).

The findings of this study demonstrate that the intervention led to a statistically significant increase in ROM for ankle dorsiflexion bilaterally. The symmetry in improvement across both ankles suggests that the intervention provides a consistent mechanical or neurophysiological effect. The transition to 15° of dorsiflexion moves participants closer to the functional requirements for normal gait, which typically necessitates at least 10° to 15° of flexion during the terminal stance phase. These results align with previous research indicating that targeted manual therapy or stretching interventions can effectively modulate soft tissue extensibility and joint arthrokinematics (Meseguer-Henarejos et al., 2018). Given the significance of these improvements in a cohort of 26 participants, this intervention appears to be a viable strategy for enhancing joint mobility and potentially reducing compensatory movements associated with limited ankle flexibility (Neumann, 2024).

A limitation of this study is the single-group pre–post design, which lacks a counterfactual control group. Consequently, the observed changes cannot be definitively attributed to the intervention, as external factors or natural progression. In addition, while the MAS was chosen for its clinical feasibility, these measurement constraints mean that subtle changes in spasticity may not have been captured, and these specific findings must be interpreted with caution.

5. Conclusion

This exploratory study highlights a high concentration of severe motor disability (GMFCS Levels 4 and 5) and spastic quadriplegia within the cohort, reflecting a significant burden of care and a likely etiology linked to extensive cortical damage. While the intervention did not yield statistically significant reductions in calf spasticity according to MAS scores, a statistically significant increase in bilateral ankle dorsiflexion range of motion was observed. Although these preliminary findings suggest potential for enhancing joint mobility in high-dependency populations, given the exploratory nature of this single-group study and the lack of change in the primary spasticity outcome, these results must be interpreted with caution. Further controlled trials are necessary to rigorously evaluate the efficacy of this strategy.

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Data Availability

No data was used for the research described in the article.

References

Abdelnour, H. M. (2020). Evaluating the feasibility of the expansion of community based rehabilitation into the physiotherapy curriculum in ,ahfad university for women. *University of the Western Cape*. https://hdl.handle.net/10566/11699

Abdullahi, H., Satti, M., Rayis, D. A., Imam, A. M., & Adam, I. (2013). Intra-partum fever and cerebral palsy in Khartoum, Sudan. *BMC Research Notes*, *6*(1), 163. https://doi.org/10.1186/1756-0500-6-163

Almalty, A. R., Mashaal, A. H., Hawamdeh, M., Abdelnour, H. M., & Mahmood, S. (2025). *Efficacy of massage and stretching for controlling hamstring muscle spasticity in children with spastic diplegia cerebral palsy: A comparative study*.

Barnes, M. P., & Johnson, G. R. (Eds). (2008). *Upper Motor Neurone Syndrome and Spasticity: Clinical Management and Neurophysiology* (2nd edn). Cambridge University Press. https://doi.org/10.1017/CBO9780511544866

Graham, H. K., Rosenbaum, P., Paneth, N., Dan, B., Lin, J.-P., Damiano, D. L., Becher, J. G., Gaebler-Spira, D., Colver, A., Reddihough, D. S., Crompton, K. E., & Lieber, R. L. (2016a). Erratum: Cerebral palsy. *Nature Reviews Disease Primers*, *2*(1), 16005. https://doi.org/10.1038/nrdp.2016.5

Graham, H. K., Rosenbaum, P., Paneth, N., Dan, B., Lin, J.-P., Damiano, D. L., Becher, J. G., Gaebler-Spira, D., Colver, A., Reddihough, D. S., Crompton, K. E., & Lieber, R. L. (2016b). Erratum: Cerebral palsy. *Nature Reviews Disease Primers*, *2*(1), 16005. https://doi.org/10.1038/nrdp.2016.5

Hassan Abdelnour, Abuelgasim Mohamed, Duaa El Tigani, & Balsam Abdallha. (2023). Physical Disabilities and Rehabilitation Services in Khartoum State, Sudan. *The International Journal of Humanities & Social Studies*. https://doi.org/10.24940/theijhss/2023/v11/i9/HS2309-016

Horsch, A., Klotz, M. C. M., Platzer, H., Seide, S., Zeaiter, N., & Ghandour, M. (2021). Is the Prevalence of Equinus Foot in Cerebral Palsy Overestimated? Results from a Meta-Analysis of 4814 Feet. *Journal of Clinical Medicine*, *10*(18), 4128. https://doi.org/10.3390/jcm10184128

Kruse, A., Habersack, A., Jaspers, R. T., Schrapf, N., Weide, G., Svehlik, M., & Tilp, M. (2022). Acute Effects of Static and Proprioceptive Neuromuscular Facilitation Stretching of the Plantar Flexors on Ankle Range of Motion and Muscle-Tendon Behavior in Children with Spastic Cerebral Palsy—A Randomized Clinical Trial. *International Journal of Environmental Research and Public Health*, *19*(18), 11599. https://doi.org/10.3390/ijerph191811599

Meseguer-Henarejos, A.-B., Sánchez-Meca, J., López-Pina, J.-A., & Carles-Hernández, R. (2018). Inter- and intra-rater reliability of the Modified Ashworth Scale: A systematic review and meta-analysis. *European Journal of Physical and Rehabilitation Medicine*, *54*(4). https://doi.org/10.23736/S1973-9087.17.04796-7

Murugasen, S. (2022). *A systematic review of cerebral palsy in African paediatric populations* [Stellenbosch : Stellenbosch University]. http://hdl.handle.net/10019.1/126157

National Institute of Neurological Disorders and Stroke. (2023). https://www.ninds.nih.gov/

Neumann, D. A. (2024). *Neumann's Kinesiology of the Musculoskeletal System-E-Book: Neumann's Kinesiology of the Musculoskeletal System-E-Book*. Elsevier Health Sciences.

Oskoui, M., Coutinho, F., Dykeman, J., Jetté, N., & Pringsheim, T. (2013). An update on the prevalence of cerebral palsy: A systematic review and meta-analysis. *Developmental Medicine & Child Neurology*, *55*(6), 509–519. https://doi.org/10.1111/dmcn.12080

Oskoui, M., Majnemer, A., Dagenais, L., & Shevell, M. I. (2013). The Relationship Between Gross Motor Function and Manual Ability in Cerebral Palsy. *Journal of Child Neurology*, *28*(12), 1646–1652. https://doi.org/10.1177/0883073812463608

Palisano, R. J., Rosenbaum, P., Bartlett, D., & Livingston, M. H. (2008). Content validity of the expanded and revised Gross Motor Function Classification System. *Developmental Medicine & Child Neurology*, *50*(10), 744–750. https://doi.org/10.1111/j.1469-8749.2008.03089.x

Rosenbaum, P., Paneth, N., Leviton, A., Goldstein, M., Bax, M., Damiano, D., Dan, B., & Jacobsson, B. (2007). A report: The definition and classification of cerebral palsy April 2006. *Dev Med Child Neurol Suppl*, *109*(suppl 109), 8–14.

Satti, L., Abdelnour, H., Alawad, S., Gabrallah, M., & Alshiekh, R. (2026). Prevalence of Stress and Neck Pain Among Accountants: A Cross-Sectional Study. *European Journal of Medical and Health Research*, *4*(1), 156–161. https://doi.org/10.59324/ejmhr.2026.4(1).22