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Postural Stability in Pediatric Palliative Care: Effects of an Individualized Physiotherapy Program in a Child with Cerebral Palsy

Alexandra-Mihaela Ionică¹, Silvia-Violeta Teodorescu²

Abstract: In this study, we aimed to investigate the evolution of postural stability in a child with Cerebral Palsy within a pediatric palliative care context, using the Stability domain of the MotriCore instrument. Previous studies have shown that balance and trunk stabilization interventions improve motor performance in children with CP; however, traditional tools often fail to capture subtle yet clinically relevant changes in palliative settings. A prospective single-case design was applied to a 12-year-old child (GMFCS level III) who participated in a 12-week individualized physiotherapy program targeting trunk control, balance, and task-oriented activities. Stability was assessed pre- and post-intervention using quantitative and qualitative measures. The Stability score increased from 8/15 to 11/15, with significant improvements across all items. Qualitative findings indicated enhanced trunk activation, improved postural alignment, reduced compensatory strategies, and increased tolerance to sustained activities. The findings suggest that targeted physiotherapy can generate meaningful functional improvements, even in complex pediatric palliative conditions. The study supports the sensitivity of the MotriCore tool in detecting subtle, domain-specific changes and highlights the relevance of individualized rehabilitation approaches.

Keywords: trunk control; motor function; balance training; functional mobility; neuromotor control

JEL Classification: I10; I19; I12

1. Introduction

Pediatric palliative care represents a holistic and multidisciplinary approach aimed at improving the quality of life in children living with life-limiting or life-threatening conditions, as well as supporting their families throughout the course of the illness. Cerebral Palsy (CP) represents one of the most frequent causes of motor disability in childhood, characterized by persistent disorders of movement and posture, which limit functional activity and participation. Among the multiple motor impairments associated with this condition, postural stability occupies a central role, as it underpins the ability to maintain body alignment, control movement, and interact effectively with the environment (Shumway-Cook & Woollacott, 2017). Impaired stability is directly associated with limitations in sitting balance,

¹ National University of Physical Education and Sport, Romania, Address: 140 Constantin Noica Street, Bucharest, Romania, Corresponding author: alexandraionica99@yahoo.com.

² Professor, PhD, National University of Physical Education and Sport, Romania, Address: 140 Constantin Noica Street, Bucharest, Romania, E-mail: teo.silvia@yahoo.com.



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transfers, mobility, and the performance of daily activities, thereby significantly influencing overall functional independence.

In the context of pediatric palliative care, the therapeutic approach shifts from a purely rehabilitative perspective toward a more comprehensive model that integrates functional maintenance, comfort, and participation. In such settings, even minimal improvements in postural stability can lead to meaningful changes in the child's ability to engage in daily activities (Hain et al., 2013; Feudtner et al., 2011), tolerate positioning, and interact with caregivers and the surrounding environment. However, traditional assessment tools often fail to capture these subtle yet clinically significant changes, as they tend to focus on global functional outcomes rather than domain-specific progress (Damiano, 2006; Verschuren et al., 2016).

The MotriCore instrument was developed to address this gap, offering a multidimensional evaluation of motor performance with particular sensitivity to domains such as stability, participation, pain, manipulation and functional engagement. Unlike conventional scales, the tool allows for the identification of incremental changes that are highly relevant in complex clinical scenarios, including pediatric palliative care (Ryan et al., 2017). The stability domain of MotriCore is operationalized through five specific items that reflect both basic and advanced components of postural control, including the ability to maintain an unsupported standing position, the capacity to preserve balance in static conditions, postural control during dynamic movements, stability during changes of direction, and control during landing tasks (Graham et al., 2016).

The purpose of this study was to examine the evolution of postural stability in a child with Cerebral Palsy receiving an individualized physiotherapy program, using one domain of the MotriCore instrument, and to interpret the clinical significance of these changes within a palliative care framework.

2. Materials and Methods

The subject of this study is a 12-year-old child diagnosed with CP, a prospective single-case experimental design, presenting spastic paraparesis, functional dorso-lumbar scoliosis, and multiple lower limb deformities. The orthopaedic history includes subtalar arthrodesis with fibular graft, reflecting the structural complexity of the case. From a functional perspective, the child was classified as GMFCS level III, indicating the ability to walk with assistive devices but significant limitations in balance, coordination and endurance.

The study was realized at Hospice Casa Speranței Adunații Copăcenii Pediatric Palliative and Rehabilitation Unit from January to March 2026, conducted under the supervision of a licensed physiotherapist specialized in pediatric rehabilitation, in accordance with ethical standards, with informed consent obtained from the participant's legal guardians.

At the initial evaluation, the child exhibited reduced trunk control, difficulty maintaining a stable sitting position without support, and limited ability to perform transfers independently. Standing posture required assistance, and dynamic balance was markedly impaired. Functional mobility was possible only under supervision, and prolonged activity resulted in rapid fatigue. The presence of scoliosis contributed to asymmetrical postural alignment, further affecting stability and movement efficiency. The patient exhibited cognitive abilities that supported the understanding of verbal instructions and facilitated engagement in task-oriented exercises.

3. Intervention Protocol

The intervention protocol was structured as a 12-week individualized physiotherapy program and incorporated multiple complementary components, targeting the gradual development of stability across increasing levels of motor complexity.

The first component focused on postural control and trunk stabilization, aiming to improve segmental muscle activation. Exercises were performed in supported and unsupported sitting, kneeling, and assisted standing positions, emphasizing controlled activation of deep stabilizing musculature, particularly at the level of the trunk and pelvis (Sadowska et al., 2020). Special attention was given to correcting asymmetrical weight distribution. The level of external support was progressively reduced in order to stimulate active postural control and neuromuscular adaptation (Figure 1).



Figure 1. Postural Control in Gait

The second component addressed static and dynamic balance training, with the objective of improving the child's ability to maintain equilibrium under varying conditions. Static balance was trained through sustained positioning tasks in sitting and standing, gradually reducing manual assistance and increasing the duration of postural maintenance. Dynamic balance exercises included controlled reaching, guided weight shifting, and transitional movements between positions (Jackman et al., 2021). The complexity of tasks was progressively increased by modifying the base of support, introducing directional changes, and applying gentle external perturbations, thereby stimulating adaptive postural responses and enhancing coordination.

The third component focused on functional stability during movement, emphasizing the integration of postural control into dynamic motor activities. Exercises targeted assisted gait, transfers, and directional changes, with the aim of improving movement efficiency and reducing compensatory patterns (Figure 2). Particular emphasis was placed on coordinating trunk and lower limb activity, enhancing stability during step initiation, and maintaining alignment during movement (Booth et al., 2018). Due to the presence of orthopedic limitations, tasks involving higher mechanical demand, such as rapid directional changes or landing phases, were adapted to ensure safety while preserving their functional relevance.



Figure 2. Postural Control into Dynamic Activities

The fourth component incorporated task-oriented and play-based activities designed to increase motivation and engagement while reinforcing motor learning. These activities included obstacle navigation, target-reaching exercises, and structured movement challenges requiring postural adjustments and coordination (Gannotti et al., 2014). The integration of playful elements allowed for sustained attention and active participation, facilitating the transfer of motor skills into functional contexts and daily routines.

In parallel, a structured home-based exercise program was implemented under caregiver supervision, aiming to reinforce therapeutic gains and ensure continuity of intervention beyond the clinical settings. This component was considered essential, particularly in the context of pediatric palliative care, where consistency, repetition, and integration into daily routines play a crucial role in facilitating motor learning and maintaining functional abilities. Emphasis was placed on the repetition of key motor patterns developed during in-clinic sessions, such as trunk activation, weight shifting, and postural correction, thereby promoting neuromuscular consolidation and functional carryover.

Assessments were conducted at three time points: baseline (T0) and post-intervention (T1), allowing for the analysis of progression over time and the identification of potential fluctuations. Given the single-case design, the focus of data interpretation was placed on individual evolution and the clinical significance of observed changes.

Each in-clinic session lasted approximately 30 minutes and was conducted twice weekly, with intensity adjusted according to the child's tolerance, fatigue levels, and daily clinical condition. The intervention followed a progressive model, beginning with low-complexity tasks focused on basic stability and advancing toward more dynamic and functionally relevant activities. Each exercise was performed in short, controlled sequences, followed by adequate rest periods (30-60 seconds), in order to prevent overexertion and ensure optimal motor performance. The number of repetitions and task duration were progressively increased, maintaining a balance between therapeutic challenge and safety.

All therapeutic sessions were carried out in a controlled pediatric palliative care environment, under professional supervision, in order to guarantee safety and appropriate clinical management. The intervention framework was carefully structured and consistently applied, with detailed records maintained regarding session organization, progression strategies, and individualized adaptations. To minimize variability and ensure methodological coherence, the entire intervention was delivered by the same physiotherapist. No negative reactions or adverse events were identified during the implementation of the program.

Each item was analyzed not only quantitatively, through scoring, but also qualitatively, through clinical observation of movement patterns, compensatory strategies, and the child's ability to adapt to task demands. This dual approach allowed for a more comprehensive understanding of stability, capturing both measurable progress and functional relevance. All outcome measures were documented at each evaluation stage and subsequently processed using descriptive statistics (mean and standard deviation). The evolution of functional performance was interpreted in relation to the initial assessment, with changes expressed proportionally to baseline values and summarized through descriptive indicators. To complement the clinical analysis, paired comparisons between assessment points were conducted, offering an additional perspective on the significance of observed changes.

4. Results

The analysis of postural stability, as assessed using the MotriCore instrument, revealed a moderate but consistent positive evolution between baseline and post-intervention. The results highlight both quantitative improvements in domain-specific scores and qualitative refinements in motor control, supporting the clinical relevance of the implemented physiotherapy program within a pediatric palliative care framework.

4.1. Quantitative Outcomes

At the level of the Stability domain (maximum score = 15), the subject demonstrated a moderate increase in total score, from 8/15 at T0 to 11/15 at T1, corresponding to a progression from predominantly assisted performance toward increased functional independence. This change reflects a clinically meaningful improvement. When analysed at the item level (scored from 0 to 3), the following evolutions were observed (Table 1):

Table 1. Evolution of Stability Domain Score between Baseline and Post-Intervention

Item	T0 (Mean $\pm$ SD)	T1 (Mean $\pm$ SD)	Change
Unsupported standing	1.5 $\pm$ 0.5	2.2 $\pm$ 0.4	+0.7
Static balance	2.0 $\pm$ 0.4	2.5 $\pm$ 0.5	+0.5
Dynamic postural control	1.6 $\pm$ 0.5	2.3 $\pm$ 0.4	+0.7
Stability during direction changes	1.4 $\pm$ 0.5	2.0 $\pm$ 0.4	+0.6
Control during landing tasks	1.2 $\pm$ 0.4	1.7 $\pm$ 0.5	+0.5
Total score (max = 15)	8	11	3

Note: T0=baseline; T1=post-intervention; SD=standard deviation; Change=T1-T0

4.2. Qualitative Outcomes

Complementing the clinically meaningful improvements observed across all items of the stability domain, the qualitative analysis provided further insight into the nature and functional relevance of these changes. The evolution of scores from predominantly assisted performance (scores 1-2) toward increased independence (scores approaching 2-3) was paralleled by observable refinements in movement quality, postural organization, and adaptive motor strategies.

At T1, the subject exhibited: improved trunk activation and postural alignment, reflected in a more symmetrical weight distribution, particularly in supported and semi-supported positions, consistent with the increased scores in static balance and unsupported standing; reduced reliance on compensatory upper limb support, indicating a transition toward more intrinsic postural control mechanisms, in line with the progression from moderate to minimal assistance levels; enhanced responsiveness to external perturbations, especially during guided dynamic tasks, suggesting improved neuromuscular coordination and correlating with the observed gains in dynamic balance; more efficient and coordinated transitions between positions, characterized by smoother execution and reduced hesitation, supporting the quantitative improvements recorded in tasks involving directional changes; increased tolerance to sustained postural demands, with decreased signs of fatigue during short activity sequences, reflecting improved postural endurance and control.

Despite these positive adaptations, certain limitations persisted. Residual postural asymmetry, primarily associated with structural scoliosis, continued to influence alignment. Additionally, delayed postural reactions were still evident in complex dynamic tasks, and supervision remained necessary during activities with higher motor demands. These findings are consistent with the subject's GMFCS level III classification and underlying orthopedic constraints, indicating that while functional gains were achieved, they occurred within the expected limits of the clinical condition.

4.3. Clinical Interpretation

The integration of quantitative and qualitative findings indicates that the intervention led to moderate yet functionally meaningful improvements in postural stability, and observable enhancements in motor control, confirming that the changes were not only measurable but also clinically relevant. The transition from higher levels of assistance toward partial independence was reflected in improved functional performance, including: increased active participation in therapeutic tasks, improved postural tolerance and endurance, and enhanced interaction with the environment and caregivers.

Within the context of pediatric palliative care, such outcomes should be interpreted as clinically significant progress, as even incremental better results in postural stability can substantially influence comfort, safety and overall quality of life.

Furthermore, the findings support the sensitivity of the MotriCore tool in capturing subtle yet meaningful changes that may not be detected by more global functional scales. This is particularly relevant in complex clinical scenarios, where progress is often gradual and multifactorial.

5. Discussion

The present study demonstrated that a 12-week individualized physiotherapy program led to moderate but significant improvements in postural stability in a child with CP within a pediatric palliative care context. The increase from 8/15 to 11/15 reflects a transition from assisted performance toward greater functional control, consistent with findings that targeted exercise interventions can improve balance and postural control in children with CP (Novak et al., 2013; Dewar et al., 2015).

The improvements observed in unsupported standing, static balance, and dynamic control can be attributed to the structured focus on trunk stabilization, progressive reduction of support, and task-specific training, which are known to enhance neuromuscular coordination and postural alignment (Saether et al., 2013). The qualitative findings further support this mechanism, as the child demonstrated

improved trunk activation, reduced compensatory strategies, and better responsiveness to postural challenges.

The smaller gains identified in more complex tasks, such as directional changes and landing control, are consistent with the literature, which indicated that higher-level motor tasks are more resistant to change due to increased biomechanical and coordination demands, particularly in children classified as GMFCS level III. In this case, structural factors such as scoliosis and orthopedic impairments likely contributed to these limitations.

Importantly, the results should be interpreted within the framework of pediatric palliative care, where even small improvements are considered clinically meaningful. Previous studies emphasize that physiotherapy in this context aims not only at functional gains, but also at enhancing comfort, participation and quality of life (Ortiz-Campoy et al., 2021). The observed improvements in postural tolerance, participation and interactions with the environment support this perspective.

The findings also highlight the utility of the MotriCore instrument in detecting subtle, domain-specific changes, which may not be captured by more global functional scales. This aligns with the growing emphasis on sensitive, multidimensional assessment tools in complex pediatric conditions (Bartlett & Palisano, 2002).

However, the single-case design limits generalizability, and the absence of a control condition restricts causal interpretation. Additionally, the use of analysis in a single-subject context should be interpreted cautiously, reflecting consistency of change rather than population-level inference.

6. Conclusions

The present study provides evidence that a structured physiotherapy intervention can induce moderate yet significant improvements in postural stability in a child with CP within a pediatric palliative care framework. The progression observed in the Stability domain of the MotriCore tool reflects a shift from predominantly assisted motor performance toward enhanced postural control and functional autonomy.

Although the magnitude of change remained moderate, the findings underscore the clinical relevance of incremental motor gains in complex conditions, where therapeutic objectives extend beyond recovery toward the optimization of comfort, positioning, and functional engagement (Weaver et al., 2016). The improvements identified at both quantitative and qualitative levels indicate a more efficient organization of postural strategies, contributing to increased tolerance to sustained positions, improved participation, and interaction with the surrounding environment.

Moreover, the results support the utility of the MotriCore instrument as a sensitive and domain-specific assessment tool, capable of capturing subtle but meaningful changes in motor performance, particularly in contexts where traditional scales may lack sufficient responsiveness (Kallem Seyyar et al., 2019).

Despite the inherent limitations associated with a single-case experimental design, the study highlights the potential of task-oriented, stability-focused physiotherapeutic interventions to facilitate adaptive motor responses, even in the presence of significant neuromotor and structural impairments. Further research involving larger cohorts and longitudinal follow-up is warranted to substantiate these findings and to enhance the evidence base for pediatric palliative rehabilitation.

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Informed Consent Statement. The written informed consent for the participant was obtained.

Conflicts of Interest. The authors declare no conflicts of interest.

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