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PERSPECTIVES” CONFERENCE**

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**EARLY INTERVENTION AND MEDICAL
REHABILITATION IN CHILDREN WITH
CEREBRAL PALSY: CHALLENGES AND
PERSPECTIVES IN INCLUSIVE EDUCATION**

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Abstract

Early intervention acts as a primary component in improving developmental and functional results among persons with cerebral palsy. The aim of this research is to assess the effects and challenges of integrating medical rehabilitation in inclusive early education programs in western and southwestern part of Macedonia. A total of 20 children with cerebral palsy from different rehabilitation and educational centres in Prilep, Bitola, Kicevo, Ohrid and Struga were included. A mixed method is implemented, with combination of quantitative assessment and qualitative observation. Functional abilities were evaluated with the Gross motor function classification system - GMFCS and Pediatric evaluation of disability inventory - PEDI. Statistical analysis included descriptive measures, paired t-tests and Pearson correlation to assess the relationship between therapy frequency, functional independence and school participation. The results showed improvements in self-care, mobility and social interaction, showing the value of coordinated therapeutic and educational approaches. This research identifies systemic barriers such as limited access to multidisciplinary services and insufficient teacher training. Strengthening collaboration between physiotherapists and special educators and rehabilitators is important for sustainable inclusive models in early childhood care for children with cerebral palsy.

Keywords: early intervention, cerebral palsy, medical rehabilitation, inclusive education, functional development.

INTRODUCTION

Cerebral palsy is one of the most common causes of motor impairment in childhood that affects approximately 1.5-3 per 1,000 live births around the globe (Patel et al., 2020). This condition is a non-progressive and is characterized by impairments of movement, posture, and motor control, accompanied by disturbances of sensation, perception, cognition, communication, and behaviour (Twum & Hayford, 2024). These impairments influence a child's functional independence, participation in everyday activities, and long-term educational inclusion and consequently, early childhood is a critical window for therapeutic intervention, especially when neuroplasticity is highest and functional trajectories can be shaped (Morgan et al., 2021).

Early intervention has shown as a basis of the management of cerebral palsy. It includes medical rehabilitation, physiotherapy, occupational therapy, and developmental support provided during the first years of life, with aim not only to prevent secondary complications but also to improve motor learning, autonomy, and participation (Damiano & Longo, 2021). Research confirms that children who receive timely, intensive, and coordinated rehabilitation show superior results in gross motor function, self-care, mobility and social engagement compared to those who enter therapy later or receive inconsistent services (Opheim et al., 2025). On the other hand, the effectiveness of early intervention does not depend only on the intensity of therapy, but also on how well rehabilitation is integrated into the daily environment of the child, especially within inclusive education (Harniess et al., 2021). Inclusive education based on the principles of equity, participation, and non-discrimination became a fundamental component of modern child development policies (Michopoulou, 2025). For children with cerebral palsy inclusion in early childhood education offers not only academic stimulation but also opportunities for social interaction, communication, emotional regulation, and functional skill acquisition in natural contexts (Kılınç et al., 2025). When medical rehabilitation is integrated in the inclusive education, therapy extends beyond clinical environments and becomes part of everyday learning and participation and this ecological approach connects with the International Classification of Functioning, Disability and Health (Simon et al., 2024).

Despite the strong theoretical and empirical support, the integration of medical rehabilitation into inclusive early education is a big challenge, especially in low- and middle-income countries and transitional health-education systems (Almasri et al., 2023). In many regions, rehabilitation and education operate in parallel rather than in partnership, resulting in inconsistent services and therapeutic goals, as also reduced functional transfer into school participation (Abdi et al., 2025). In North Macedonia, and especially in its western and southwestern regions children with cerebral palsy face unequal access to early rehabilitation services and inclusive educational support (Karovska-Ristovska et al., 2023). While rehabilitation centres and special education institutions exist in cities such as Bitola, Prilep, Ohrid, Kičevo, and Struga, the collaboration between these sectors is largely informal and dependent on individual professionals rather than structured systems (Ajdinski, 2006).

The aim of this research paper is to evaluate the effects of medical rehabilitation in inclusive early education among children with cerebral palsy in western and southwestern North Macedonia. With standardized functional assessments with qualitative observations of school participation, this research identifies the benefits and the systemic barriers that determine early developmental results.

METHODOLOGY

Study design

For this research, a mixed-methods design was used combining quantitative functional assessment with qualitative observation of participation in inclusive early education.

Setting and participants

The sample consisted of 20 children with cerebral palsy recruited from Prilep, Bitola, Kičevo, Ohrid, and Struga - western and southwestern part of North Macedonia. Children represented a range of types of cerebral palsy and functional severities enabling analysis across different levels of motor limitation.

Procedures and data collection

For the ecological validity and reduce assessment-related stress, quantitative assessments were collected in home conditions - domestic environment with the presence of a parent/caregiver. In parallel, participation within inclusive early education was

documented through structured qualitative observation and recording of a school participation score used for correlational analysis with rehabilitation intensity.

Outcome measures

The outcome measures were Gross Motor Function Classification System (GMFCS) and its used to classify gross motor functional level (I–V) as an indicator of motor severity. Also, Pediatric Evaluation of Disability Inventory (PEDI) for functional abilities in three categories: self-care, mobility, and social function with pre-intervention and post-intervention scores recorded for each participant. It was measured the rehabilitation intensity and weekly therapy frequency was recorded as ≤ 2 sessions/week, 3-4 sessions/week, or ≥ 5 sessions/week., and inclusive participation - a participation indicator (school participation score) was obtained from the qualitative observation component and included in correlation analyses.

Statistical analysis

Data were analyzed with descriptive statistics (n, %, mean $\pm$ standard deviation). Change in PEDI categories scores were examined with paired t-tests (pre-post) to determine statistically significant functional improvements. Associations between weekly rehabilitation frequency and functional change scores (Δ = post-pre), as well as school participation were assessed with Pearson correlation coefficients (r).

Ethics, consent, and confidentiality

Participation was voluntary. Prior to inclusion, written informed consent was obtained from parents/legal guardians. All data were handled anonymously: participants were coded, and no identifying personal information was included in analyses or reporting. Data collection in home conditions was conducted respectfully, minimizing problems on the child and family and ensuring privacy throughout the assessment process.

RESULTS

Table 1. Gender of children included in this research.

Gender	n	%
Male	12	60

Female	8	40
Total	20	100

Table 1 shows the gender of the participants with cerebral palsy. The sample included 12 boys (60%) and 8 girls (40%), showing a higher representation of male participants in this research.

Table 2. Age distribution of children with cerebral palsy.

Years	n	%
3-4	6	30
5-6	8	40
7-8	6	30
Total	20	100

Table 2 shows the age distribution of the participating children with cerebral palsy and the largest proportion of children were 5-6 years (40%), while the 3-4 and 7-8 years were equally represented (30% each).

Table 3. Type of cerebral palsy among the participants.

Type of cerebral palsy	n	%
Spastic diplegia	7	35
Spastic quadriplegia	5	25
Spastic hemiplegia	4	20
Dyskinetic	3	15
Ataxic	1	5
Total	20	100

Table 3 shows the types of cerebral palsy in the study sample. Spastic forms were dominant types, with spastic diplegia (35%) and spastic quadriplegia (25%) being the most common, followed by spastic hemiplegia (20%). Non-spastic types were less frequent, including dyskinetic cerebral palsy (15%) and ataxic cerebral palsy (5%).

Table 4. GMFCS level of the participants.

GMFCS level	n	%
Level I	3	15
Level II	4	20
Level III	5	25

Level IV	5	25
Level V	3	15
Total	20	100

Table 4 shows the distribution of functional severity according to the Gross Motor Function Classification System. The sample included children with all GMFCS levels, with the highest representation in levels III and IV (25%), showing moderate-to-severe functional limitations. Levels I and V were equally represented, while Level II represented for 20%.

Table 5. Weekly rehabilitation frequency.

Weekly rehabilitation frequency	n	%
≤ 2 sessions/week	6	30
3-4 sessions/week	9	45
≥5 sessions/week	5	25
Total	20	100

Table 5 shows the rehabilitation intensity expressed as the number of therapy sessions per week among children with cerebral palsy. Most of the participants received 3-4 sessions per week (45%), while 30% received two or fewer sessions, and 25% attended five or more sessions weekly.

Table 6. PEDI category scores before and after rehabilitation.

PEDI category	Pre-intervention Mean ± standard deviation	Post- intervention Mean ± standard deviation	Mean change	p-value (paired t- test)
Self-care	41.2 ± 9.6	48.9 ± 9.1	+7.7	0.002
Mobility	38.5 ± 10.4	45.3 ± 10.0	+6.8	0.004
Social function	44.8 ± 8.7	50.6 ± 8.2	+5.8	0.010

Table 6 shows the changes in Paediatric Evaluation of Disability Inventory (PEDI) category scores before and after the rehabilitation. Statistically significant improvements were found across all PEDI categories including self-care, mobility, and social function, indicating improved functional independence and participation-

related skills after coordinated medical rehabilitation within early education contexts.

Table 7. Pearson correlations between weekly rehabilitation frequency and functional results.

Outcome variable	Pearson r	p-value
Change in PEDI self-care (post-pre)	0.56	0.010
Change in PEDI mobility (post-pre)	0.62	0.004
Change in PEDI social function (post-pre)	0.48	0.032
School participation score	0.59	0.006

Table 7 shows the association between weekly rehabilitation frequency and changes in functional results among the participants. Higher therapy frequency was moderately and correlated with greater improvements in PEDI categories. In addition, therapy frequency showed a positive correlation with observed school participation, suggesting that more consistent rehabilitation may support not only functional independence but also engagement within inclusive education.

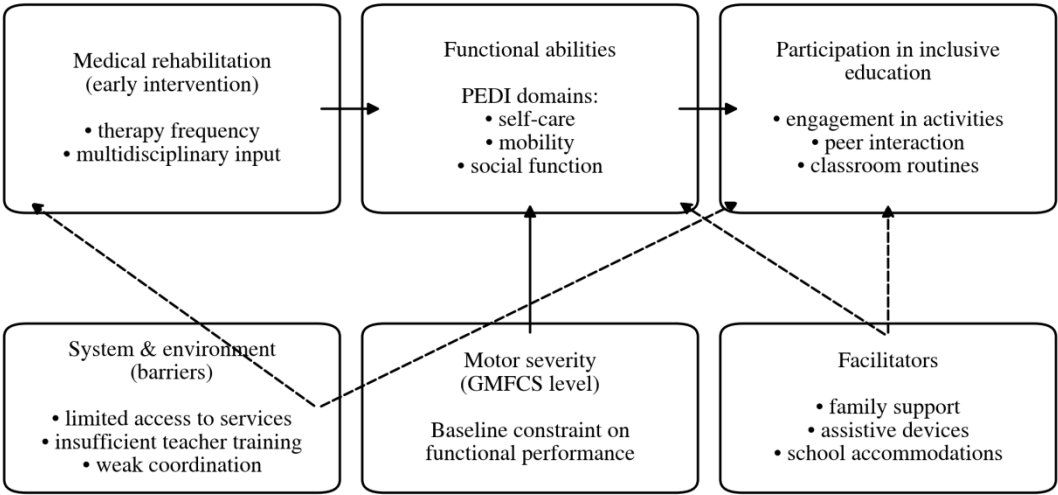


Figure 1. ICF informed conceptual model for early intervention and inclusive participation in cerebral palsy.

Figure 1 shows the ICF-informed conceptual model connecting early medical rehabilitation to functional abilities and subsequent participation in inclusive education. Motor severity is represented as general constraint that influences functional performance. System and environmental barriers and facilitators are shown as contextual factors that can obstruct or support the rehabilitation-to-participation pathway.

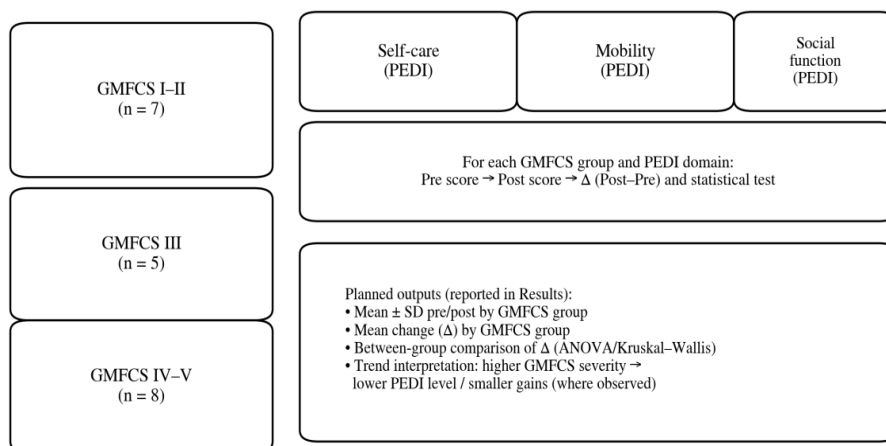


Figure 2. PEDI results stratified by GMFCS - analysis structure for pre/post comparison and change scores (Δ).

Figure 2 shows the analytical structure connecting motor severity with functional results measured by the PEDI categories. For each GMFCS and each PEDI category, pre-intervention and post-intervention scores are compared and summarized as a change score (Δ = post-pre), followed by appropriate statistical testing. The model supports interpretation of severity-related patterns, where higher GMFCS levels are associated with lower functional performance and smaller observed gains.

DISCUSSION

This research showed the role of early intervention and medical rehabilitation for children with cerebral palsy in the inclusive education in western and southwestern North Macedonia. With mixed-methods approach - quantitative functional assessment combined with qualitative observation of school participation, the

results show that coordinated therapeutic and educational support can contribute to improved functional independence and greater engagement in everyday school activities. At the same time, the results showed motor severity as an important factor forming the extent and pattern of functional gains, while also revealing important systemic barriers like limited access to multidisciplinary services, inconsistent therapy intensity, and insufficient teacher training, which may obstruct sustainable inclusion.

Hanson et al. (2024) show important point for interpreting our results - improving results in young children with cerebral palsy is not only about which early rehabilitation interventions exist, but also about how reliably evidence-based practices are implemented in clinical environments. Their co-developed, knowledge-translation approach addresses common barriers faced by rehabilitation workers when trying to adopt evidence-based early interventions. In the context of our results, this supports the argument that strengthening early intervention in inclusive education requires system-level implementation supports structured training, accessible evidence summaries, and coordinated leadership.

Bufteac et al. (2020) give a useful comparison point for our research because they examined early intervention (EI) and follow-up (FU) programs in a low-/middle-resource setting and showed that coverage and referral patterns matter as much as the intervention itself. In Moldova, less than half of children with cerebral palsy were enrolled in EI/FU, and enrolment was biased toward the most vulnerable groups. While they did not find differences in several associated impairments between enrolled vs non-enrolled children, they reported important protective effect: non-walking children who were not enrolled had a markedly higher risk of developing contractures, suggesting EI/FU may reduce secondary musculoskeletal complications.

Mantilla et al. (2022) add an important family-centred perspective that connects with the inclusive education component of our research. With a bioecological framework and survey data from 98 parents in Australia, they report generally high satisfaction with inclusion when educators show positive attitudes, when there is strong communication between home and early childhood environments, and when partnerships exist between families, allied health workers, and

educators. At the same time, parents stressed barriers that are not only physical or organizational, including concerns about children's psychological wellbeing, especially anxiety (for example separation anxiety) and the emotional challenges of participating in early education environments. This defines the argument that effective inclusion for children with cerebral palsy depends on collaborative, cross-sector teamwork and not only therapy delivery, and it stress the need to address both participation and psychosocial safety within inclusive early childhood programs.

Karim et al. (2021) provide evidence from a low-/middle-resource context that structured, community-based early intervention can improve functional results in children with cerebral palsy, especially under age five. In their quasi-experimental research in rural Bangladesh, children who received a 6-month caregiver-led community program showed greater improvements in gross motor function and communication-related classifications, while the standard-care group tended to worsen or show no improvement over time.

CONCLUSION

This research shows the practical value of integrating early medical rehabilitation with inclusive early education for children with cerebral palsy in western and southwestern part of North Macedonia. Improvements observed across functional categories such as self-care, mobility, and social functioning support the premise that coordinated rehabilitation connected to everyday educational participation can improve functional independence and engagement in schools. At the same time, the results show that motor severity remains important determinant of participation capacity and should guide individualized planning and realistic goals within inclusive programs.

Beyond these outcomes, our results stress that sustainable inclusion depends on system readiness. Limited access to multidisciplinary services, inconsistent therapy intensity, and insufficient training and support for educators continue to constrain the translation of rehabilitation into meaningful participation. In line with recent international evidence on knowledge translation and implementation, the development of structured collaboration pathways between physiotherapists, special educators and rehabilitators, and early

childhood staff supported by practical training tools and shared intervention plans are essential for strengthening inclusivity. Future researches should expand samples, standardize participation measures, and evaluate implementation strategies that improve access, continuity, and inter-sector coordination.

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