

Early Intervention in the Recovery of Psychomotor Developmental Disorders in Preterm Infants – A Systematic Review Analysis –

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ABSTRACT. Introduction: Preterm birth remains a major public health issue, being closely associated with a higher risk of psychomotor developmental disorders. Early physiotherapy interventions play a crucial role in supporting motor and cognitive development during the critical period of the first two years of life, with the potential to reduce long-term disability. **Aim:** The aim of this paper was to analyze and highlight the impact of early intervention in the recovery of psychomotor developmental disorders in preterm infants, through a systematic review of recent literature. **Materials and Methods:** This study is based on a systematic analysis of 20 scientific articles published between 2015 and 2025, identified using databases such as PubMed, Google Scholar, and Sci-Hub. **Results:** Individualized and multidisciplinary early interventions were found to be effective in improving motor, cognitive, and sensory development in preterm infants. Family-centered programs, therapies started during hospitalization or shortly after discharge, and combined interventions (such as sensory stimulation, infant massage, passive exercises, and hydrotherapy) led to significant developmental progress. Additionally, observational studies confirmed that preterm infants exhibit significant motor delays compared to full-term infants. **Conclusion:** The reviewed literature supports the effectiveness of early physiotherapy interventions in the recovery of preterm infants and emphasizes the need to implement such programs in Romanian clinical practice. Active family involvement, early initiation, and personalized approaches are essential to optimizing developmental outcomes in pre-term babies.

Keywords: *early intervention, physical therapy, preterm babies, cognitive-motor skills*

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INTRODUCTION

According to the World Health Organization (2023), premature birth is one of the most common causes of neuro-motor development problems in childhood, affecting millions of newborns globally each year. Infants born before 37 weeks of gestation often experience significant delays in motor development, even in the absence of major neurological damage.

Studies by Elbasan et al. (2017) show that, compared to full-term newborns, premature babies are more prone to visual and hearing impairments and cognitive problems. Early motor skills are essential for social interaction, exploration, and cognitive development. Studies show that early motor performance is associated with later outcomes in cognitive, motor, and language development. Therefore, early assessment of motor development and early intervention are important (Yu-Han et al., 2017).

To prevent as many complications of preterm birth as possible and support extrauterine development in the last weeks of pregnancy, premature newborns are placed in Neonatal Intensive Care Units. Although these units increase survival rates, babies are exposed to stressors and painful procedures that can cause structural and functional changes in certain regions of the brain, negatively affecting neurological and psychological development (Gonzalez et al., 2021).

Recent research highlights the importance of early identification of these deficits and the application of appropriate therapeutic interventions, especially in the first year of life, a period marked by increased brain plasticity.

PURPOSE OF THE STUDY

This paper aims to highlight the essential role of early intervention in the recovery of psychomotor development disorders in prematurely born children, through a systematic analysis of the literature published in the last decade. In the context of an increased incidence of prematurity worldwide, with direct implications for neuro-motor and cognitive development, it is imperative to identify proven therapeutic strategies that respond promptly to the needs of this category of newborns. The analysis also includes observational studies that clearly demonstrate significant motor delays in preterm infants compared to those born at term, underscoring the importance of early detection and prompt intervention.

MATERIAL AND METHODS

The study was conducted as a systematic review of the scientific literature, based on 20 original articles published between 2015 and 2024. PubMed, Google Scholar, and Sci-Hub were used as search engines. Observational and interventional studies evaluating premature infants with a corrected age of up to 24 months were selected. The inclusion criteria were original articles, pilot studies, randomized or comparative studies, published in English.

RESULTS

Table 1. Characteristics of selected studies

Authors	Year	Methods	Subjects	Intervention	Results	Conclusions
Cabral et al.	2015	Comparative cross-sectional study	P.B.G.: N=15, (31,3 weeks, 1506 g) T.B.G.: N=15, (39,2 weeks, 3047 g)	Assessment of motor development (AIMS) and sensory processing (TSFI) in infants aged 4–6 months corrected age	53% of preterm infants had AIMS scores below the 5th percentile. All preterm infants with marked sensory deficits showed motor delay.	Preterm infants with sensory integration disorders (especially tactile and vestibular) showed inferior motor development. Early sensory assessment is essential.
Celik et al.	2018	Comparative study	Full-Term Baby Group (FTBG): N=30 (15M/15F); Preterm Baby Group (PTBG): N=30 (13M/17F)	Assessment of sensory processing using the TSFI and the Alberta Infant Motor Scale (AIMS)	Significant correlation between AIMS scores and total TSFI scores ($r = 0.63$, $p < 0.001$). 36.7% of preterm infants had abnormal sensory processing scores.	Assessment of sensory processing and motor development is essential for the effective implementation of early interventions.
da Silva et al.	2016	Analytical cross-sectional study	N=20 children (10 preterm, 10 full-term)	Early family-based therapeutic intervention for the preterm group; evaluation with the Motor Development Scale (MDS)	Preterm infants had significantly lower scores in fine motor skills (3.5 vs 4.7), gross motor skills (4.3 vs 5.2), spatial awareness (4.1 vs 5.6), and temporal awareness (3.6 vs 4.7).	Early intervention allowed for achieving normal motor levels in balance and body scheme. Other areas remained below the scores of full-term children.

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De Oliveira Tobinaga et al.	2016	Quasi-experimental study	N=15 preterm newborns (average gestational age: 34.2 wks)	Single 10-minute hydro physiotherapy session in a sterilized pool with 37°C water; passive limb maneuvers, trunk rotations, and gentle sensory stimulation.	Salivary cortisol: significant decrease from 0.41 ± 0.14 to 0.29 ± 0.09 $\mu\text{g/dL}$ ($p=0.004$); Heart and respiratory rate: significant decrease ($p<0.005$); O_2 saturation: significant increase ($p=0.002$); NIPS score unchanged.	Hydro physiotherapy has beneficial effects on reducing physiological stress in preterm infants. It can be used as a non-invasive, safe, and effective therapeutic method in neonatal care.
Elbasan et al.	2017	Controlled comparative study	Intervention Group: 78 preterm infants (24–36 wks); Control Group: 76 preterm infants with similar corrected ages.	Family-centered physiotherapy, according to NDT principles; Weekly maternal training; Assessment at 3, 6, 9, 12 months.	Significant intra-group improvements in cognitive development scores (CDS) and motor development scores (MDS) between 3 and 12 months ($p<0.001$). Between groups: CDS ($p=0.059$), MDS ($p=0.334$), non-significant differences.	Family-centered NDT intervention did not generate significant differences compared to the control group. Inclusion of other methods is recommended for a stronger impact on motor and cognitive development.
Fan et al.	2021	Randomized controlled trial	N=73 preterm infants (28–31 wks); EI-SC (early intervention-standard care): N=37; SC-EI: N=36; Reference Group: N=33.	Home-based early intervention program for 30 days, including intellectual stimulation, body massage, and skin-to-skin contact, evaluated with TIMP, DQ, and anthropometric measurements.	TIMP: significant increase in EI-SC group (53.1 ± 8.8 to 83.5 ± 11.9) vs. SC-EI (50.5 ± 8.6 to 76.0 ± 13.4), $p=0.044$; Significant increases in weight, length, and head circumference in EI-SC vs. SC-EI ($p<0.05$); at T2, both groups > reference group ($p<0.05$).	Post-discharge, home-based early intervention is effective in the short term in promoting motor development and physical growth in preterm infants. This model offers a feasible and accessible alternative in areas with limited medical resources.
Fontana et al.	2018	Randomized controlled trial	N=57 preterm infants (25–29 weeks GA, without major comorbidities);	Early intervention consisting of PremieStart and parental training for massage and visual stimulation,	Mean age at acquisition of full oral feeding: 36.8 ± 1.6 wks (EI) vs 37.9 ± 2.4 wks (SC), $p = 0.04$.	Early parental intervention with massage and visual stimulation significantly improved breast milk feeding and accelerated the

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			Early Intervention Group: N=29; Standard Care Group: N=28.	compared to standard care.	Breast milk consumption at discharge: 57.6% (EI) vs 22.9% (SC), $p < 0.001$. Exclusive breast milk percentage: 41.4% (EI) vs 10.7% (SC), $p = 0.003$.	transition to full oral feeding. Active parental participation plays an essential role in the feeding success.
Iqbal et al.	2016	Quasi-experimental study	N = 37 preterm infants	Developmental therapy applied for 6 months, at home and in hospital, evaluated with BSID-II.	54.1% improvement in motor function; 40.5% improvement in mental function; 48.6% improvement in behavior.	Early developmental therapy significantly contributes to the improvement of psychomotor functions in preterm infants. Factors such as socio-economic status or neonatal jaundice can partially influence the results.
Kepenek - Varol et al.	2019	Prospective study	N=32 preterm infants (14M/18F)	A single 40-minute therapy session based on NDT principles, including facilitation, positioning, weight transfer exercises, multiple sensory stimulation.	No statistically significant differences in total MOS scores (26.34 ± 1.56 vs. 26.63 ± 1.48 ; $p=0.44$) or in sub-categories ($p > 0.05$). A weak positive correlation was noted between duration of intensive care hospitalization and repertoire of other movements ($r=0.412$; $p=0.02$).	A single physiotherapy session does not produce acute effects on spontaneous movements of preterm infants, and studies are needed to evaluate the long-term effects of interventions.
Lee et al.	2017	Controlled comparative study	N=96 Intervention Group: 32 preterm infants < 2.5 kg; Control Group: 30 preterm infants; Comparative Group: 34 preterm infants > 2.5 kg.	Neurodevelopmental therapy (NDT): 15 min, 4 times/week until post-conceptual age of 40 weeks.	Significant increase in TIMP scores in the intervention group: Pre-test: 27.2 ± 7.3 Final: 70.8 ± 6.5 vs. 53.8 ± 7.5 (control), $p < 0.01$.	Early NDT applied in intensive care units significantly improves motor development in preterm infants, even surpassing the comparative group with low risk of delay.
Liu et al.	2021	Comparative clinical trial	Intervention Group: N=22 preterm infants (<32 wks/<1500 g);	Early combined therapy: visual, auditory, oral, motor, respiratory stimulation,	Oxygen: 22.8 ± 13.7 vs. 31.9 ± 15.9 days; Gastric tube: 23.1 ± 12.8 vs. 33.4 ± 15.4 days;	Early combined intervention significantly improves short-term clinical outcomes:

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			Control Group: N=29 similar preterm infants.	daily 20–25 min, until discharge.	Hospitalization: 39.1 ± 10.3 vs. 47.4 ± 16.1 days; ROP: 9% vs. 34%; BPD: 23% vs. 55%; NEC: 4.5% vs. 27.6%.	respiratory function, neuromuscular development, and reduces major complications (ROP, NEC, BPD).
Øberg et al.	2022	Multicenter randomized clinical trial	N = 153 pre-term infants (≤ 32 wks gestational age); Experimental Group: N=74; Control Group: N=79.	Parent-administered exercise program in neonatal intensive care units (10 min, 2×/day, for 3 wks, individualized).	No significant differences found between groups at 24 months (PDMS-2). But PDMS-2 scores correlated positively with intervention dose: +0.019/session unit ($p = 0.017$).	Higher intervention dose was associated with better motor scores. Short interventions only in hospital do not seem sufficient for long-term effects.
Ochandorena-Acha et al.	2022	Randomized clinical trial	N=62 preterm infants (born <34 wks); Experimental Group: N=30; Control Group: N=32.	Early individualized therapeutic intervention (1 hour/wk for 11 wks), focused on motor activities and parental participation.	Experimental group achieved significantly higher TIMP scores than the control group after intervention (mean difference = 5.13, $p = 0.003$).	Early therapeutic interventions, personalized and family-centered, can improve early motor development and the parent-child relationship in preterm infants.
Parău et al.	2024	Prospective pilot study	N = 78 preterm infants (GA 34–36 weeks; 1500–2500 g); Intervention Group: N=36; Control Group: N=42.	Early physiotherapy intervention applied using the Bobath method, for 9 months.	Early interventions reduced motor development differences compared to full-term infants. Development is influenced by gestational age and birth weight.	Early therapy can positively influence the neuro-motor development trajectory in preterm infants.
Su et al.	2017	Prospective longitudinal study	N=342 very low birth weight preterm infants (<1500 g).	Motor assessment at 4, 6, 9, and 12 months with Alberta Infant Motor Scale; cognitive and motor assessment at 24 months with BSID-II.	3 motor trajectories: stable normal (55%), deterioration (32%), persistent delay (13%). Deterioration and persistent delay were associated with increased risk of mental and motor delay at 24 months ($p < 0.05$).	Motor trajectories in the first year can predict developmental outcomes at 2 years. Perinatal factors negatively influence motor trajectory. Early monitoring is essential.
Syngelas et al.	2016	Controlled comparative study	Full-Term Baby Group (FTBG): N=1,038 (584M/454F); Preterm Baby	Assessment of motor development using the Alberta Infant Motor Scale (AIMS); comparison be-	Preterm infants had significantly lower AIMS scores compared to full-term children over	AIMS highlights that preterm infants have inferior motor development compared to full-term infants.

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			Group (PTBG): N=403 (251M/152F).	tween preterm and full-term infants and analysis of the influence of neonatal morbidities.	18 months; Respiratory Distress Syndrome: decrease of 1.93 points ($P < 0.0001$) Intraventricular Hemorrhage Grade III: decrease of 0.97 points ($P = 0.008$) Retinopathy of Prematurity: decrease of 1.12 points ($P = 0.012$).	Neonatal morbidity factors negatively influence motor development and must be considered in their assessment.
Torró-Ferrero et al.	2022	Randomized multicenter clinical trial	N = 120 preterm newborns (26–34 wks GA; <2,000 g), divided into 3 groups (n = 40/group).	G.1: passive exercises; G.2: passive exercises + gentle limb compressions; G.3: control (standard NICU care).	Group 2: significant increase in bALP at 4 wks ($p = 0.03$); Group 1: non-significant increase; Group 3: decrease in bALP. No adverse effects.	Early physiotherapy stimulates bone remodelling in preterm infants. The intervention is safe and effective, recommended in early neonatal care.
Ustad et al.	2016	Randomized controlled multicentre study	N=153 preterm infants (gestational age ≤ 32 weeks); Intervention Group: N=74; Control Group: N=79.	3-week intervention (2×10 min/day) administered by parents under supervision, between 34–36 weeks post-menstrual age.	Significant difference in TIMP scores between groups: $\Delta z = 0.42$ (95% CI: 0.13–0.72), $p = 0.005$; intervention effect: $d = 0.40$ (moderate effect size).	Parent-administered physiotherapy before the estimated birth term improves short-term motor performance. The intervention is feasible and well-tolerated in current neonatal practice.
Valentini et al.	2019	Comparative study	Full-Term Baby Group (FTBG): N=1,218; Preterm Baby Group (PTBG): N=1,361.	Assessment using Alberta Infant Motor Scale, in the first 12 months of life.	FTBG: significantly higher AIMS scores at 9–10 months in all four postures. For sitting posture, FTBG had an intensive acquisition window between 1–7 months, compared to PTBG: 3–7 months.	General motor development trajectories in the first year of life are similar in preterm and full-term infants, but preterm infants achieve lower performance in postures requiring high postural control.
Valizadeh et al.	2017	Randomized clinical trial	76 preterm infants (4 groups: N=19/group).	G.1: passive exercises in bed (Moyer-Mileur); G.2: hydro physiotherapy; G.3: combination;	No significant differences recorded between groups in TIMP scores at 34 wks PMA ($p=0.11$).	Interventions with passive exercises, including hydro physiotherapy, are safe but have limited short-term effect on

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				G.4: fetal positioning (control).	Only lower limb recoil tone was significantly influenced ($p=0.04$) by physical activity/hydrotherapy.	motor performance. Muscle tone (foot recoil) was improved.

DISCUSSIONS

Several studies (Syrengelas et al., 2016; Valentini et al., 2019; Torró-Ferrero et al., 2022) have documented significant delays in motor development in premature infants, supporting the early application of personalized assessments and interventions. Furthermore, the strong correlation between sensory integration and motor performance (Celik et al., 2018; Liu et al., 2021) indicates the need to include sensory components in the treatment plan. Other research (Ochandorena-Acha et al., 2022; Øberg et al., 2022; Cabral et al., 2015) has demonstrated the effectiveness of interventions that actively involve parents, highlighting the therapeutic value of the parent-child relationship in the recovery process.

An interesting finding comes from studies that investigated interventions applied directly in neonatal intensive care units (Lee et al., 2017; Ustad et al., 2016), where significant progress in early development was noted, suggesting that the timing of therapy initiation is essential. At the same time, complementary therapies such as hydrophysiotherapy (Tobinaga et al., 2016; Fan et al., 2021) and oromotor stimulation (Varol et al., 2019) have shown promising benefits on motor functions, feeding behavior and self-regulation.

In terms of duration and frequency of interventions, these vary significantly from one study to another, but most support a positive effect when therapy is applied consistently over a period of at least 4–8 weeks. However, not all studies include long-term follow-up assessments, which limits the generalizability of the results.

Furthermore, the analysis of the articles shows that there is no single ideal protocol, but rather a clear need to adapt interventions to the specificities of each case. In a context such as Romania, where access to neonatal recovery services is uneven, it is imperative to promote integrated, child- and family-centered, and culturally adapted early intervention programs. Therefore, this approach highlights not only the effectiveness of the interventions analyzed, but also the priority directions for the development of rehabilitation services in the field of prematurity.

CONCLUSIONS

Analysis of the 20 selected scientific articles revealed that preterm infants experience significant motor development delays, particularly in postures requiring advanced postural control. However, early, structured, and individualized interventions, especially within the first months of life marked by heightened brain plasticity, consistently showed beneficial effects.

Active parental involvement emerged as a key factor in achieving better functional outcomes. Family-centered programs, whether hospital or home-based, not only support the infant's development but also help reduce parental anxiety, boost caregiver confidence, and foster a strong emotional bond.

Initiating intervention as early as the neonatal intensive care stage was another critical factor. Studies in this setting reported improvements in motor coordination, neurobehavioral organization, and early functional autonomy. Additionally, therapies such as hydrophysiotherapy and oromotor stimulation proved effective in enhancing feeding tolerance, lowering stress levels, and shortening hospital stays, highlighting their valuable potential for broader clinical application.

LIMITATIONS

While the reviewed literature consistently supports the benefits of early intervention in preterm infants, several methodological limitations must be acknowledged. Many studies involved small sample sizes, affecting statistical power and the generalizability of findings. Additionally, variations in study design, regarding the duration, intensity, and content of interventions, hinder direct comparisons. The frequent absence of long-term follow-up limits insight into the sustained impact of these interventions on child development. Moreover, few studies address cultural or contextual factors, which are essential to understanding how interventions function within health systems of differing resource levels.

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